Tanzania Economic Review, Vol. 14, No. 2, December 2024

Impact of Banana Value Chain Participation on the Welfare of Farm Households in Tanzania

Hildo Mrema*, Onesmo Selejio†, and Razack Lokina‡

Abstract
Banana is an important staple food for many people, featuring among the ten most cropped plants worldwide. This study establishes the link between banana value chain participation and household welfare using consumption as a proxy for welfare. Using panel data, methods like pooled probit, fixed effects, and Heckit models were applied. The pooled probit results show that working outside agriculture reduces the likelihood of participating in the banana value chain, while factors like the number of banana plants, harvested quantity, and organic fertilizer use increase participation likelihoods. The fixed effects model indicates that banana value chain participation, working outside agriculture, mobile phone ownership, and household size positively impact welfare, contributing to poverty reduction and food security. The Heckit model results support the fixed effects findings. Therefore, agricultural policies promoting improved banana seeds and better market access are crucial for addressing food insecurity and improving the welfare of smallholder banana farmers.

Keywords: *Banana, value chain participation, welfare, panel data, fixed effects*

JEL Classification: *C33; D23; D60; L14; O17; Q13.*

1. Introduction

Banana crop is an important staple food for many people in the world. Bananas and plantains feature among the ten most cultivated crops globally; they are positioned after maize, rice, wheat, cassava, and potatoes; and yet, they are in front of sorghum, millet, and sweet potatoes; they are the great source of household income, main staple food and provide a wider nutritional range for many people (Calberto et al., 2015). Up to 179 million metric tons of bananas and plantains were harvested worldwide in 2022; out of these, 13% were from Eastern Africa (FAOSTAT, 2024). The largest individual consumption of bananas globally is in the East African highlands; accordingly, one-third of the people in the East African highlands rely on bananas as their main staple food, and the crop covers around 20 to 30% of total cultivated land (Karamura et al., 2012). Bananas fall fourth in the list

* Department of Economics, Institute of Accountancy Arusha, Email: mrema.hildo@gmail.com
† University of Dar es salaam School of Economics, Email: oselejio2@gmail.com
‡ 3The University of Dodoma, Email: razack.lokina@udom.ac.tz

 ◆ *https://doi.org/10.56279/ter.v14i2.202*

of major crops planted in developing countries, the crop is ranked behind rice, wheat, and maize (Sipen et al., 2011). Bananas stay as the main export crop to some countries like Ecuador and Costa Rica (Ferreira et al., 2018).

Large quantity of bananas produced in SSA emerges from small portions of land and garden-like plots which are very close to where the households live (Marimo et al., 2020). In Tanzania, about 60% of the total banana output is consumed at the homestead either cooked or ripened as dessert, and the remaining 40% is either sold or given out to friends and relatives as handouts (Kilimo Trust, 2015). It is reported that over 60% of bananas are grown in Kagera and Kilimanjaro regions and the crop is a staple food for 75-95% of the population in those two regions (Kilimo Trust, 2012).

The demand for bananas in Tanzania is high due to the growing population, urbanization, and changing consumption habits of consumers. The increase in banana demand is also related to the crop being the staple food for a large population in the country. Banana being a perennial crop, is capable of yielding fruits in the whole year. This makes it a reliable staple food crop across seasons for large populations. Most of the banana produced in Tanzania is consumed at homesteads as the majority of smallholder banana farmers' production is primarily for household consumption i.e. subsistence (Bezu & Villanger, 2019). While there is growing domestic demand for bananas, the crop is also frequently exported to countries like Zambia, Malawi, Germany, Switzerland, and Austria from Tanzania (OEC, 2020).

Despite the presence of the market potential for banana production and its dependence as a main staple food for a larger population, the productivity of the crop is very low. In Tanzania, banana yield for smallholder farmers is reported to be around 6.25 tons per hectare as opposed to the required 80 tons per hectare (FAO, 2012; Lucas & Jomanga, 2021). The total banana production appears to be less than 10% of the required potential of over 60-70 tons per hectare per annum (Shell Foundation, 2023). The low productivity of bananas is explained by factors such as poor crop management coupled with production challenges like low soil fertility, persistent drought, the occurrence of pests and diseases, low genetic base, and numerous social and economic factors (FAO, 2012; Chabi et al., 2018). Also, the lack of credit to smallholder banana farmers and the unavailability of agricultural technologies and extension services limits the efficient production of bananas (Mgbenka & Mbah, 2016). In addition, banana chains to markets have several connections which are valueless, while a meager portion of the price paid by the consumers reaches the producers which retards efforts to commit more capital to improve productivity (Beed et al., 2012).

Curbing banana-related challenges can improve the productivity of banana smallholders. However, any attempt to improve smallholders' banana productivity won't succeed if banana farmers have not begun to transform their marketing channels by selling to specific groups of buyers, supermarkets, processing firms, and agricultural crop exporters (Barrett, 2008). The transformation of banana value chains from traditional spot markets and farm gate prices to modern value chains can improve farmers' welfare (Barrett et al., 2010; Ørtenblad et al., 2023). When all other factors are held constant, a person who consumes more is thought to have higher welfare than someone who consumes less (OECD, 2013). According to Smith (1937), the only goal of all production is consumption, and the producer's welfare should only be prioritized to the extent that it may be required to advance consumer welfare. Consumption covers a large part of the expenditures of the household in both goods and services (Drakopoulos, 2021).

The demand for bananas increases with an increase in consumers' income, population growth, urbanization, and free trading. Commercialization of small-scale farming paves the way for improvement in productivity, processing, and overall supply systems. Commercialization also gives rise to formal markets and channels that involve grading and standards throughout the chain. Through formal markets, farmers move from traditional value chains to modern agricultural value chains where value is added to fresh farm products like bananas through storage, processing, and transportation (Barrett et al., 2010).

However, smallholder farmers' participation in the value chain is always limited due to subsistence farming, insufficient water for irrigation (Arias et al., 2013; Barrett et al., 2010), limited productive assets such as land, livestock, labour, and tools similarly constrain the capacity of smallholders to generate a marketable surplus (Barrett et al., 2012). Smallholder farmers in rural, remote areas are particularly more limited as they are located off-roads, far from basic social services, and they also depend on agriculture as their mainstay (IFAD, 2010).

Several empirical works have been done in this area, i.e. value chain participation and its welfare to smallholder farmers but in different locations, using different approaches and data, and for different crops (Islam, 2018; Kikulwe et al., 2014; Mossie et al., 2020; Warsanga & Evans, 2018). By using panel data (2008, 2010, and 2013), this study sought to add to the literature by empirically determining whether there is household welfare improvement that is attributed to banana (as a perennial crop) value chain participation.

The rest of this paper is organized as follows: Section 2 covers the conceptual and theoretical framework, while Section 3 dwells on the empirical literature review of selected prior works. Section 4 discusses the methodology, whereas Section 5 presents and discusses the empirical results. The final section (Section 6), provides the study's conclusion and policy implications.

2. Conceptual and theoretical framework

The channel which connects a farmer and crop product consumer, where the product goes through different nodes and includes numerous transactions and activities is commonly known as a value chain, marketing and processing chain, or a supply chain (Westlake, 2005). In this study, we refer to it as a value chain [1]. In value chains, farmers may coordinate their activities horizontally, advance to vertical coordination, strengthen the supply side, engage in agricultural product processing, and application of quality measures all over the chain. If farmers lack an alternative market for their agricultural produce, hold-ups by buyers (e.g. broker, trader, processor, retailer, or exporter) possess considerable threats especially with perishable products like banana. Consequently, horizontal coordination may reduce the threat of opportunistic behavior of buyers by processing perishable products into preserved products or by increasing the collective bargaining power of the farmers. Horizontal coordination is common among producers of perishable crops where assets specificity is high and the produce need to be processed quickly or distributed to the consumer upon harvesting.

Theoretical efforts to explain smallholder farmers' participation in value chain is dominated by neo-institutionalism or new institutional economics particularly the transactions cost viewpoint (Williamson, 1985). According to the theory, the economic activities which take place in an economy have several transactions, adaptive decision making and resource particularity in the condition which is unpredictable and individual self-motivated moves. The transaction costs economics (TCE) also argues that organizations have developed because markets are imperfect and therefore, give rise to transactional risks. High risks occur when uncertainties are huge and when one of the parties to the exchange has made transaction specific investments. Transaction costs can be reduced by aligning to a proper governance structure. Shifting the transactions from vertical or market governance to horizontal or internal governance, coordination costs and transaction risks can be significantly reduced since firms' benefit for coordination and control are superior to those of the market.

Transactions which are carried in the market generate costs. The transaction costs generated are such as knowledge search, contracting discussions, and keeping track of ensuing payments and implementation (Coase, 1937). In analyzing the relationship between horizontal coordination in the value chain and transaction costs given the rural economy, this study sees an individual farmer or household who grows bananas as a particular type of firm.

[1] According to Westlake (2005), a value chain in agriculture determines the group of participants and their activities that present crude agricultural good from farming area to the final consumption where at each point value is added to the good.

According to Sexton (2008), for two households i and j, the horizontal coordination will occur if the following condition holds:

$$\beta(i \cup j) < \beta_i + \beta_j, (\beta(i \cup j) > 0) \quad (1)$$

where β_i and β_j, are the transaction costs of the two households i and j respectively, ($\beta_i > 0$ and $\beta_j > 0$). The equation depicts that, with horizontal coordination $(i \cup j)$, the transaction costs $\beta(i \cup j)$ are lower than without horizontal coordination$(\beta_i + \beta_j)$.

Following Barrett (2008), Key et al. (2000), Mossie et al. (2020), and Olwande et al. (2015), this study assumes that, a smallholder farmer participates in the banana value chain if he/she sells some of his/her banana harvest to earn income.

3. Empirical literature review

Different approaches and designs have been applied to study the impact of value chain participation on the welfare of farm households. For instance, Islam (2018) examined the linkage between integrated aquaculture-agriculture (IAA) value chain participation dynamics and the welfare of households using panel dataset of 2007, 2009, and 2012 from Bangladesh. The study applied pooled ordinary least squares, random effects, and standard fixed effects. Results show that IAA value chain participation is associated positively with household welfare. Wealthier households were found to benefit more from IAA value chain participation than the landless, poorer households that were involved in several activities along the chain.

Warsanga & Evans (2018) examined the connection between value chain participation and the welfare of wheat farmers in some regions of Tanzania. The study uses cross-sectional data from Arusha and Kilimanjaro regions and Propensity Score Matching (PSM) for impact estimation. The PSM procedure revealed that the earnings accrued from the value chain participation through vertical coordination was 126 TZS/kg in excess of nonparticipants. In horizontal coordination, farmers who participate in the value chain obtain a profit of 46 TZS/kg in excess of nonparticipants.

Mossie et al. (2020) investigated the factors that influence smallholder farmers’ decisions and the magnitude of participating in value chains. The study employed descriptive statistics and the double-hurdle model to analyze the data. They found that the likelihood of a farmer participating in the value chain is directly proportional to the head’s education level, farming experience, number of extension visits, and the head’s integration into farmers' groups. Also, they found that participation in the value chain declines with an increase in household size and incidence of disease and insect pests.

Kikulwe et al. (2014) examined the effects of mobile money usage on smallholder farmers' welfare. The study used a panel dataset collected at the end of 2009 and the end of 2010. Fixed effects and random effects regression models were used. The findings show that using mobile money influences household welfare positively. The welfare was found to be enhanced by money obtained from different people who are related to the household including friends. Berhane & Gardebroek (2011) evaluated the lasting effect of microfinance credit from the magnitude of involvement in borrowing. They used a panel dataset and a fixed-effects model to take care of potential selection biases. They found that participation in microfinance borrowing induces increased welfare for the households. They also show that the frequency of borrowing successful increases welfare.

The current study uses panel dataset (2008-2013) to model the impact of value chain participation on annual per adult equivalent consumption as a proxy for welfare of banana growers of Tanzania. Currently few studies focus on the production of bananas and their contribution to the livelihood of farm households. Studies like Berhane & Gardebroek (2011), Islam (2018), Kikulwe et al. (2014), Mossie et al. (2020) and Warsanga & Evans (2018) focused on effects of value chain involvement on welfare of farmers from different areas and different crop types apart from banana. This study focuses on a single perennial crop, which is banana, as a crop capable of being harvested throughout the year.

This study contributes to the ongoing literature in three ways; first, by identifying and exploring the impact of participating in value chain for a perennial and highly perishable crop which is banana on household welfare using panel data and several panel data models like pooled probit, Fixed Effects (FE), Random Effects (RE), and Heckman's two-stage. Second, by providing evidence of the contributions of banana as a perennial crop in addressing local and global development challenges like food security. Lastly, by mainstreaming the concept of banana as a perennial crop into research practice in national, regional and global policy agenda.

4. Methods and data

4.1 Econometric specifications

Banana value chain participation is not random; hence the effect of banana value chain participants and non-participants cannot be compared directly. There are several challenges in how to estimate the welfare function because banana value chain participation and non-participation states cannot be compared directly. The challenges include how the unobserved heterogeneity and possible endogeneity which are caused by the selection of the variables included in the model are treated. According to Heckman (1979), sample selection bias can occur due to self-selection by the individuals or data used in a study and by sample selection choices made by the researcher. Maddala (1983) also described three types of decisions that create self-selection, which are, individual selection, administrator selection, or attrition selection which is common in panel data.

4.1.1 Pooled probit model for participation decision

The choice of smallholder banana farmers to participate in the value chain is determined by:

$$VC^*_{p_{it}} = \beta X_{it} + C_i + \varepsilon_{it} \quad (2)$$

$$VC_{pit} = 1 \text{ if } VC^*_{pit} > 0$$

$$VC_{pit} = 0 \text{ if } VC^*_{pit} < 0$$

where VC^*_{pit} is a dummy variable that takes the value of 1 if the household participates in the banana value chain and 0 otherwise, X_{it} is a group of household features that influence the choice to participate in the banana value chain, C_i is unobserved heterogeneity, and ε_{it} is an error term. In this study, banana value chain participants were defined as those who sell a portion of their banana harvest in the market to earn income. Non-participant households are farmers who do not sell a part of their banana harvest.

With linear models, it is simple to get rid of unobserved heterogeneity or individual effects C_i by instituting the first difference or within the transformation. First differencing or within transformation procedures do not apply to nonlinear models. For example, differencing Equation 2 does not get rid of C_i. Again, if C_i is measured directly by including $N - 1$ dummies in the probit model, it will render to severely biased estimates of β unless we have a large time T (Söderbom, 2009). With a small time, span T, the coefficients of C_i are not consistent. Raising the value of N does not get rid of the bias, and the lack of consistency in C_i has a secondary effect which means the coefficient of β is not consistent as well (Söderbom, 2009).

If we employ a random effects (RE) probit by imposing strictly exogeneity, conditional independence, and normal distribution assumptions, it will be possible to estimate the probability of seeing a given chain of events as the result of individual probabilities. Yet, the assumptions for exogeneity, conditional independence, and normal distribution are very limiting as endogeneity in independent variables is eliminated. The minor advantage of random effects (RE) probit over a pooled probit model is that the RE model permits for serial correlation of the unobserved factors that determine VC_{pit}, i.e. in ($c_i + \varepsilon_{it}$) (Söderbom, 2009; Wooldridge, 2002). This study used a pooled probit model to establish the decisions of a farmer to participate in the banana value chain.

4.1.2 A model for welfare outcome

Banana value chain participation differs from the level of banana commercialization in that the latter entails the extent to which a particular

household's banana production is oriented toward the output markets (Cazzuffi et al., 2020). Essentially, it is expected that smallholder commercialization of bananas should spur increased productivity of the banana value chain culminating in increased welfare of smallholder farmers. The proxy for household welfare in this study is the consumption of different items including food measured per adult equivalent.
The welfare impact of participating in the banana value chain was modelled as follows:

$$Y_{it} = \alpha + \beta_1 X_{it} + \beta_2 VCp_{it} + \gamma T_t + C_i + \mu_{it} \qquad (3)$$

where, Y_{it} is a proxy for welfare which in our case is consumption per adult equivalent. Consumption per adult equivalent was achieved by putting forward the household's composition and individuals' biological needs. It's calculated by dividing a household's total consumption by its adult equivalent unit. Value chain participation (VCp_{it}) is a dummy variable that takes the value of 1 if the household participates in the banana value chain and 0 otherwise, and (X_{it}) is a group of exogenous observable features of the household. The coefficient β_2 of the participation regime in this model is the effect of existing in a specific class on welfare in the banana value chain. T_t is a dummy variable for the year data were collected and will take care of time-fixed effects, C_i is an individual-specific effect, and μ_{it} is an idiosyncratic error term.

Banana value chain participation is a choice variable and thus it can correlate with the idiosyncratic error term in the welfare equation. The correlation can also emerge from unobserved heterogeneity which lies in the middle of banana value chain participants and non-participants. Unobserved heterogeneity is highly possible because households select themselves from the banana value chain participation side. Those households that select themselves to banana value chain participation side may be influenced by unobservable characteristics that are as well influence household welfare (Heckman & Hotz, 1989). Households who are well endowed with resources, skills, entrepreneurial abilities, and determination, which can also impact household welfare, may decide to participate in the banana value chain, while those who are less endowed may not participate in the banana value chain.

Using panel data, it is feasible to employ a fixed effects (FE) model that allows banana value chain participation choices to correlate with unobservable characteristics in order to take care of self-selection bias (Berhane & Gardebroek, 2011; Heckman & Hotz, 1989). If a strict exogeneity assumption is instituted, that is, the time-invariant unobserved heterogeneity, C_i, is uncorrelated to explanatory variables, then we can use the random effects (RE) model to estimate equation 3. This can be done by establishing a composite error term v_{it} between an individual specific effect or time-invariant unobserved heterogeneity C_i and an idiosyncratic error term μ_{it} such that $\upsilon_{it} = c_i + \mu_{it}$.

Assuming a strict exogeneity is so powerful, it raises doubt about whether unobserved heterogeneity is statistically independent and not related to the explanatory variables (Bezu et al., 2014). Therefore, if the strict exogeneity assumption is implemented, it can render selection bias in the computed welfare impact of banana value chain participation. A usual and simple method of dealing with the selection bias dilemma is to apply the fixed effects model (Greene, 2008; Wooldridge, 2002). The fixed effects estimator lets a particular household's specific effect, C_i, be endogenous to the stream of independent variables, X_{it}. Fixed effects model yields consistent estimates of welfare impacts by demeaning or differencing out every effect which is due to time-invariant unobserved heterogeneity (Wooldridge, 2002). The study determined the welfare outcome by employing fixed effects and random effects models due to their linearity nature. Hausman test was implemented to find out if the correlation between the observed independent variables and C_i exists in order to specify the correct model. When correlation in large samples does not exist, the outcome received after instituting the two models (FE and RE) must be the same (Hill et al., 2011). Furthermore, if a correlation exists, the coefficients received from the two models are distinct.

4.1.3 Self-selection bias

As hinted in the preceding discussion, the banana value chain participation in equation 3 may be correlated with the error term. The study used a framework similar to Heckman's two-stage model (Heckman, 1979), with panel settings to control for possible endogeneity of the selection of participants in the banana value chain. The purpose is to check the robustness of the estimated results. This is a stepwise procedure where the first step involves estimating the banana value chain participation selection equation using a pooled probit model for different T by including the exclusion restrictions and then computing the T inverse Mills ratio λ_{it} for participation. Following Campa & Kedia (2002), Eggert & Lokina (2010), and Islam (2018), the second step involves including the inverse Mills ratio to the welfare outcome equation in order to take care of the presence self-selection bias. The welfare outcome equation was then estimated by excluding the exclusion restriction variables. We tested for the existence of selection bias by specifying the null hypothesis that, there is no selection bias (H_0:ρ=0) using the t-statistic. The welfare outcome equation 3 was modified to:

$$Y_{it} = \alpha + \beta_1 X_{it} + \beta_2 VCp_{it} + \delta\lambda_{it} + \gamma T_t + C_i + \mu_{it} \quad (4)$$

where X_{it} contains all variables used in a pooled probit model, less three variables that influence banana value chain participation other than household welfare.

In the Heckman model, government extension service, the number of banana plants on the plot, and the value of banana productivity in (TZS) are placed as exclusion restrictions. Government extension service, number of banana plants on the plot, and value of banana productivity variables are assumed to affect participation in the banana value chain. The variables stand as likely exclusion restrictions because agricultural extension services in Tanzania are offered by the government irrespective of household endowment, so it is accessible to all farmers. Furthermore, households that are included in this analysis are assumed to be involved in banana production by having some banana tree plants on their plots to be regarded as banana farmers. Production-wise, almost every household that grows bananas harvests some, irrespective of whether the household sells or does not sell some of the produce. Hence, government extension service, the number of banana plants on the plot, and the value of banana productivity variables were incorporated in the value chain participation equation to serve as exclusion restrictions in the selection equation, and the variables were not incorporated in the welfare outcome equations. The variables are certainly not anticipated to influence the welfare outcome equations rightly after taking care of banana value chain participation.

Following Wooldridge (2009) on the estimation of models with endogenous independent variables plus sample selection bias, the study assumed that banana value chain participation VCp_{it} is endogenous in addition to sample selection bias. The study used exclusion restrictions to take care of endogenous variables. We tested the plausibility of the exclusion restrictions used for value chain participation to make sure that they are appropriate for our model. This study borrowed a lot from Stock & Yogo (2005) procedure for testing weak instruments. When exclusion restrictions are slightly correlated with the endogenous independent variable, then a little correlation between the exclusion restrictions and the error term can severely bias coefficient estimates and result to a huge inconsistency in the instrumental variable estimates (Bound et al., 1995). Using a Stock & Yogo (2005) procedure, we tested the null hypothesis that the instruments are weak. If minimum eigenvalue statistic obtained is lower than the critical value, we infer that the instruments are weak, or else we infer that they are powerful i.e. the test rejects if g_{min} (minimum eigenvalue) is higher than the critical value. In case of one endogenous explanatory variable, Staiger & Stock (1997) recommended instruments to be deemed weak if the first-stage F-statistic is less than 10.

4.2 Data type and source

The data for this study comes from the first three waves of the Tanzania National Panel Survey (NPS), i.e., wave 1 (2008/2009), wave 2 (2010/11) and wave 3 (2012/13)[2]. The NPS is a country-wide household survey that collects data on the living standards of the people comprising of socioeconomic features, household consumption, agricultural activities, and non-agricultural related activities that generate income for the household. The NPS data were a segment of the Living Standard Measurement Studies (LSMS) gathered by the World Bank and the Tanzania National Bureau of Statistics (NBS). The initial wave of the data was carried out around October 2008 and September 2009. Wave two survey was carried around October 2010 to September 2011 while wave three was carried from October 2012 to September 2013.

While the initial wave of the NPS comprised 3,265 households, the sample for the second wave increased to 3,924 households and 5,010 households in the third wave respectively. The increase in the number of households in each wave is explained by the presence of members of households who left their earlier households to establish their households (NBS, 2014b). Wave two of the NPS traced 97% of wave one households whereas wave three traced 96% of wave two households. The attrition rate that was found between the initial wave and the second wave was 3% (NBS, 2014b). The attrition rate between the second wave and the third stays down at 3.9% although marginally above the attrition between the first two waves (NBS, 2014b). Three waves of the dataset were used because of the high attrition rate in the remaining wave.

In this study, the NPS data were customized by selecting households who grow banana. Households were defined by their heads. The households' heads were censored at 18 years of age or above to be included in the analysis. This led us to obtain 351 households in 2008, 956 households in 2010, and 1,116 households in 2013 respectively. The total number of observations across all waves was 2,423 households in Tanzania (Mainland and Zanzibar), which led the study to an unbalanced panel dataset. Panel data have several advantages over cross-section and time series data because they can control for individual heterogeneity; they can track changes within individual units over time; they have more statistical power as they contain information from considerable periods and numerous households, individuals or entities; and they can easily deal with endogeneity by using fixed effects. These advantages are missed when other types of data like cross-sectional are used.

Table 1 provides the summary of variables used in the study and their sign. Consumption is a proxy for household welfare and the dependent variable

[2] Writing of this paper commenced in 2019 when we had only four waves of NPS data. This study opted against using wave four (2015) because it was highly refreshed. The detection of attrition rate for the whole wave three of the NPS relative to wave four was impossible (NBS, 2016). Using extended panel households, the attrition rate was found to be 8%.

which is expected to be constantly positive. Other variables included are summarized in Table 1.

Table 1: Description of variables used in the study

Variable	Description of variable	Sign
Consumption	Total household annual consumption	+
Valuechain_part	1 if the household head participates in the banana value chain	+
Intercropping	1 if the banana plot was intercropped	+/-
Non-agriculture	1 if the household head works outside farm activities	-
Mobile ownership	1 if the household head owns a mobile phone	+
Age	A continuous variable, age in years	+/-
Area (Farm size)	Size of the banana plot (Acres)	+
Lnbanana_harvest	Banana harvested in the past 12 months (Kg)	+
Hhsize	Total number of household members	+/-
Credit_access	1 if the household head has access to credit	+
Organic_fertilizer	1 if organic fertilizer was applied to the banana plot	+
Livestock_ownership	1 if the household head owns livestock	+
Irrigation	1 if the household head irrigates his/her farm	+
Farmer_association	1 if the household head joined the farmer association	+
Extension1	1 if the household access to government extension	+
Year	Year the data was collected	+/-

5. Results

5.1 Descriptive statistics

Descriptive statistics of the variables used in this study are shown in Table 2. The table reports sample mean values, standard deviation, and minimum and maximum values for the variables used.

Table 2: Descriptive statistics

Variable	**Obs**	**Mean**	**Std**	**Min**	**Max**
Consumption	2423	3077527	2732637	210931.1	46600000
Valuechain_part	2423	0.30	0.46	0	1
Non_agriculture	2423	0.17	0.38	0	1
Intercropping	2423	0.864	0.343	0	1
Mobilephone_ ownership	2423	0.54	0.49	0	1
Age	2423	50.63	15.95	18	107

Area	2423	2.83	1.07	0.1	25
Banana_harvest	2423	769.18	1348.93	50	26300
Hhsize	2423	5.57	2.76	1	35
Credit_access	2423	0.04	0.20	0	1
Organic_fertilizer	2423	0.124	0.329	0	1
Livestock_ownership	2423	0.464	0.499	0	1
Farmer_association	2423	0.02	0.14	0	1
Irrigation	2423	0.02	0.13	0	1
Extension1	2423	0.094	0.29	0	1

Source: *Computed from pooled NPS (2008, 2010, and 2013) household survey data*

5.2 Factors influencing banana value chain participation

A binary pooled probit model of participation in banana value chain (Equation 2) was estimated. The findings are presented in Table 3. The model is statistically significant at 1% level, thus suggesting the variables were good predictors of banana value chain participation.

As expected, non-agriculture exhibits a negative and significant relationship with value chain participation. The marginal effect of -0.136 shows that being employed outside agriculture (non-agriculture) reduces the probability that household heads participate in the banana value chain by about 13.6% compared to those working in agriculture constantly.

Table 3: Pooled probit model of banana value chain participation

Value chain participation (Dependent variable)	Coefficient	Standard Error	Marginal effect
Non_agriculture	-0.462***	0.0854	-0.1364
Intercropping	-0.074	0.0820	-0.0219
Age	0.001	0.0018	0.0003
Mobilephone_ownership	-0.101	0.0629	-0.0298
Irrigation	-0.090	0.188	-0.0267
Lnbananaplants_number	0.158***	0.0232	0.0468
Area	0.028	0.0256	0.0082
Lnbanana_harvest	0.166***	0.0198	0.0489
Hhsize	-0.011	0.0109	-0.0034
Credit_access	-0.159	0.147	-0.0469
Organic_fertilizer	0.214**	0.0888	0.0634

Livestock_ownership	0.060	0.0624	0.0177
Farmer_association	-0.177	0.200	-0.0523
2010 year	-0.195**	0.0873	-0.0601
2012 year	-0.269***	0.0889	-0.0819
Constant	-1.668***	0.166	
Observations	2,423		
Pseudo r-squared	0.1447		
Chi-square	347.86***		

***, **; *: Significant at the 1%, 5%; 10% respectively.
Source: *Authors calculation based on NPS data*

Increase in number of banana plants on a plot increases the likelihood of a household to participate in banana value chain. A unit increase in banana plants on a plot increases the likelihood of participating in the value chain by 15.8%. The table also shows that banana harvest had a positive and significant association with banana value chain participation. Each additional unit of banana output produced increases the likelihood that a household participates in the banana value chain by about 4.9%. The application of organic fertilizer on banana plots appeared to raise the probability of participating in the banana value chain. The study found that households who applied organic fertilizer on their plots increased the probability of participating in the banana value chain by about 6.3% compared to those who did not apply organic fertilizer on their banana plots.

In the year 2010, the chance of a household participating in the banana value chain was reduced by 6.0% compared to 2008. Again, in the year 2012, the chance of a household participating in the banana value chain was reduced by 8.2% compared to 2008.

5.3 Banana value chain participation and household welfare

The chosen indicator for welfare outcome was total annual household consumption adjusted for variations in the structure and number of people living in a household. The NPS data had equivalence scales established to reflect variations in the structure and number of people living in the household and all household members were converted into equivalent adults (NBS, 2014a). Table 4 shows the findings of the FE model of the impact of the banana value chain participation on household consumption as a proxy for household welfare. The Fixed effects model was implemented after the Hausman test, the test results rejected the random effect (RE) model assumptions. The dependent variable (consumption) was log-transformed to reduce the skewness.

Table 4: Relationship between household welfare and banana value chain participation

Lnconsumption (Dependent variable)	Fixed Effects
Valuechain_part	0.060*
	(0.035)
Non_agriculture	0.141***
	(0.052)
Intercropping	0.015
	(0.042)
Age	-0.0003
	(0.008)
Mobilephone_ownership	0.099***
	(0.037)
Irrigation	0.100
	(0.102)
Area	0.015
	(0.011)
Lnbanana_harvest	-0.006
	(0.008)
Hhsize	0.079***
	(0.014)
Credit_access	0.028
	(0.058)
Organic_fertilizer	0.014
	(0.047)
Livestock_ownership	0.054
	(0.037)
Farmer_association	-0.066
	(0.076)
2010 year	0.057
	(0.039)
2012 year	0.315***
	(0.051)
Constant	13.94***
	(0.400)
Observations	2,423
F-test	18.30***
R-squared	0.222
Rho	0.650

***, **; *: Significant at the 1%, 5%; 10% respectively
Source: *Authors calculation based on NPS data*
NOTE: Robust standard errors in parentheses

Fixed effects results suggest that banana value chain participation is correlated significantly with higher welfare. The coefficient of value chain participation was found to be positively and significantly related to household consumption at a 10% significance level. The fixed effects estimates depict that banana value chain participation corresponds to an increase of 6% in household welfare compared to non-participants. Furthermore, working outside agriculture (non-agriculture) positively influences household welfare at a 1% significance level. The results show that working outside agriculture increases household welfare by about 14.1% compared to those working in agriculture. Also, the study found that owning a mobile phone is positively associated with household welfare at a 1% level of significance. Mobile phone ownership enhances household welfare by about 10% compared to those who do not own it. In addition, the estimate of household size is positive and significant at 1%. It means that a rise in household size by one person will lead to an increase in household welfare by about 8%. For the years fixed effects, Table 4 shows that household welfare was higher in 2012 by 31.5% than in 2008 at a 1% significance level.

5.4 Self-selection bias

To check the robustness of the fixed effects (FE) model estimates and control for possible selection bias and endogeneity in banana value chain participation, the study used a Heckman bias-corrected FE model. The inverse Mills ratio from the first stage selection pooled probit model was used to control for individual specific, time-variant observations and time-invariant unobservable characteristics related to the selection problem. The generalized residual from the first stage participation equation was incorporated in the fixed effects model to test and control for the endogeneity of banana value chain participation.

According to the Stock & Yogo (2005) procedure, the study rejected the null hypothesis at a 5% significance level based on two-stage least squares (TSLS) bias. The minimum eigenvalue statistic obtained is 641.9 which is larger than the desired range of the critical values (5% - 30%), therefore the conclusion is that the exclusion restrictions chosen are strong. Additionally, the exclusion restrictions used were able to explain the value chain participation variable (VCp_{it}) for about 44.5%. This is evidenced by the acquired partial R-squared of 0.4447.

Heckit panel model results are presented in Table 5. The table shows that the inverse Mills ratio estimate and residual for banana value chain participation is not statistically significant. This indicates that participation in the banana value chain is not endogenous as anticipated. The estimate of $\hat{\lambda}$ has a very little t statistic (-0.21), so the study fails to reject the null H_0:ρ=0. The test result indicates that there are no big variations in the calculated slope coefficients of fixed effects results (Table 4) and that of Table 5. So, there is no selection bias in banana value chain participation. That is to say, the FE model with inverse Mills ratio as an independent variable result reinforces the results acquired by the standard fixed effects model. The coefficient of value chain participation was again found to be positively and significantly related to household consumption at a 10% significance level. The Heckit model results depict that, banana value chain participation corresponds to an increase of 6% in household welfare compared to non-participants.

Table 5: Heckit model for the relationship of welfare and banana value chain participation

Lnconsumption (Dependent variable)	Coefficient	Robust Standard Error	t-value
Valuechain_part	0.059*	0.035	1.69
Non_agriculture	0.148**	0.063	2.35
Intercropping	0.016	0.042	0.39
Mobilephone_ownership	0.099***	0.037	2.69
Irrigation	0.102	0.103	0.99
Area	0.015	0.011	1.32
Lnbanana_harvest	-0.009	0.017	-0.58
Hhsize	0.079***	0.014	5.52
Credit_access	0.030	0.059	0.50
Organic_fertilizer	0.011	0.049	0.22
Livestock_ownership	0.053	0.037	1.43
Farmer_association	-0.062	0.078	-0.80
IMR	-0.022	0.106	-0.21
2010 year	0.059	0.036	1.62
2012 year	0.318***	0.041	7.65
Constant	13.96***	0.200	
Observations	2,423		

***, **; *: Significant at the 1%, 5%; 10% respectively

Source: *Authors calculation based on NPS (2008 -2013) data*

5.5 Discussion

The descriptive statistics show that the average amount of household annual consumption is close to the estimated country average household annual consumption of TZS 3,105,012 in the period of (2011/12) (NBS, 2014c). The current average household annual consumption lies at TZS 5,003,124 annually (NBS, 2019). Few households participate in the banana value chain due to low productivity, fewer buyers, remoteness to the market areas, and most farmers produce solely for subsistence purposes. In Tanzania, most of the household heads are working in agriculture constantly. According to NBS (2018), agriculture employs up to 63.0% of the labour force in Tanzania. Mobile phones are observed to be important in connecting farmers to markets, bridging the information gap, and helping farmers acquire enough information before they make decisions. With less information, farmers sell their bananas to few markets, these markets become congested leading to low prices and a higher risk of fruit perishability while there may be some potential markets that could clear the bananas.

The average banana harvest is very low in Tanzania, banana yield for smallholder farmers is reported to be as low as 2.5 tons per acre as opposed to the required 32 tons per acre (FAO, 2012; Lucas & Jomanga, 2021), the reported findings match the findings of this study. Additionally, a small sample of observations with credit shows that credit is not freely available. There are many obstacles to farmers in most of the developing countries which hinder access to credits because they are perceived as unable to provide collateral for formal credits. This makes it hard and costly for farmers to borrow money.

Probit results show that working outside agriculture enables the farmer to participate in the banana value chain than working in agriculture constantly. This may be because outside agriculture there is higher and more stable income, health insurance, and retirement benefits and therefore people who are working outside agriculture find less time to engage in banana value chain activities. Similar results were reported by Kiwanuka & Machethe (2016). An increase in the number of banana plants (plant density) to a required level increases banana productivity. An increase in banana productivity triggers the ability of farmers to participate in the value chain because they produce enough bananas to consume at home and are left with some amount to sell. The findings resemble those found by Mustaffa & Kumar (2012).

The quantity of bananas harvested influences smallholders' participation in the banana value chain through horizontal coordination. The results are similar to those of Warsanga & Evans (2018). This is plausible because for a farmer to participate in the crop value chain, there is a need to increase productivity and produce beyond subsistence. The application of organic fertilizer influences participation in the banana value chain as it ensures higher yields; this allows the farmer to have a surplus to sell and earn income. These results resemble those found by Cen et al. (2020).

Time-fixed effects show a reduction in household banana value chain participation yearly. The reduction is largely associated with yearly changes in environmental variables like rainfall and drought and macroeconomic variables like inflation and interest rates. Inflation erodes household's purchasing power, which exacerbates household food insecurity, hunger, and low banana harvests especially for the farming households that are perceived to be more prone to hunger. On the other hand, an increase in the interest rate on deposits may reduce households' value chain participation as households' propensity to save expecting higher returns increases, leaving less income for value chain activities. Similar findings were reported by Diallo (2023), Etang et al. (2022), Kapoor & Ravi (2009), Khalili et al. (2021), and Masih et al. (2014).

Banana value chain participation is linked to higher welfare. The increased welfare may be in terms of increased household income, improved banana production efficiency, reduced rural poverty, and ensuring household food and nutrition security. Similar findings were found by Islam (2018), Ndlovu et al. (2022), and Warsanga & Evans (2018). Working outside agriculture was found to enhance welfare through non-agricultural income, which offers additional finance that enables farmers to smooth fluctuations in banana income.

Similar findings were reported by Demeke et al. (2011) and Muriithi & Matz (2015).

Owning a mobile phone enables a farmer to have greater access to information. The information received includes banana prices, farm labor markets, and connections to farmers' networks. All these enable the farmer to raise household disposable income and generate welfare gains. The findings of this study are similar to those of Kikulwe et al. (2014) and Ngwilizi et al. (2024). In addition, household size has an influence on household welfare in that, if the number of people in a household is high, more income is expected for consumption. It is also possible that an increase in household size leads to a higher number of people who are working in agriculture and outside agriculture; this would lead to aggregate higher earnings for the household and; therefore, higher household welfare. The increase in household welfare can also be explained by the presence of economies of scale in the household through shared household public goods which can make households with a large number of members better off at the same level of per capita household resources. Similar results were reported by Bellemare (2012) and Demeke et al. (2011).

Years fixed effects show changes with time. Yearly consumption changes are due to macroeconomic factors such as inflation, consumer income, interest rates, commodity prices, and tastes and preferences of consumers. On the other hand, yearly household welfare changes can also be explained by environmental factors such as drought, pollution, floods, and geographical factors. The study's results corroborate those of Dilanchiev & Taktakishvili (2022) and the European Environment Agency (2005).

For self-selection bias, the findings of this study show that banana value chain participation is significant and positively associated with household welfare. These findings are consistent with the fixed effects results found earlier. The findings match those of Islam (2018), Ndlovu et al. (2022) and Warsanga & Evans (2018).

6. Conclusion and policy implications

This study explores the relationships between banana value chain participation among banana-growing households and their welfare using consumption as an indicator of welfare. This study contributes to the ongoing debate of whether agricultural value chain participation is a feasible way to promote household welfare enhancement through reducing poverty and increasing food availability in developing countries, particularly in Sub-Saharan Africa (SSA). The study used the first three wave panel datasets collected during the 2008/2009, 2010/2011, and 2012/2013 periods to systematically address the effects.

The study measured the welfare effects of banana value chain participation by employing several methods like pooled probit, standard fixed effects model, and Heckit model to take care of possible selection bias. The study first established the factors of value chain participation by estimating the pooled probit model. Then, we employed a fixed effects model to take care of unobserved heterogeneity and possible endogeneity caused by possible selection bias.

The study found that banana value chain participation is associated positively with household welfare by using consumption per adult equivalent as a proxy for welfare. Overall, the study concludes that banana value chain participation increases the welfare of banana growers in Tanzania. The results also show that working outside agriculture, mobile phone ownership, and household size have positive contributions to the enhancement of household welfare and therefore poverty reduction and food security. Agricultural policies that focus on enabling environments, such as the availability of improved banana seeds and proper markets for banana harvests, may highly enhance increases in household income, ensure food security, and thereby alleviate poverty.

This study opens the door for further studies that apply different welfare measures, like income and household asset holding, in order to examine dynamics in the capital possession of households, especially smallholder banana farmers. Thus, future research that takes into account household income and asset holdings using appropriate economy-wide modelling approaches can further explain the advantages of participating in the banana value chain and its wider effects on the growers.

References

Arias, P., Hallam, D., Krivonos, E., & Morrison, J. (2013). *Smallholder integration in changing food markets*. 48.

Barrett, C. B. (2008). Smallholder market participation: Concepts and evidence from eastern and southern Africa. *Food Policy*, *33*(4), 299–317.

Barrett, C. B., Bachke, M. E., Bellemare, M. F., Michelson, H. C., Narayanan, S., & Walker, T. F. (2010). Smallholder Participation in Agricultural Value Chains: Comparative Evidence from Three Continents. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1733942

Barrett, C. B., Bachke, M. E., Bellemare, M. F., Michelson, H. C., Narayanan, S., & Walker, T. F. (2012). Smallholder Participation in Contract Farming: Comparative Evidence from Five Countries. *World Development*, *40*(4), 715–730. https://doi.org/10.1016/j.worlddev.2011.09.006

Beed, F., Dubois, T., & Markham, R. (2012). *A strategy for banana research and development in Africa. A Synthesis of Results from the Conference Banana 2008, held 5–9 October 2008, Mombasa, Kenya.*

Bellemare, M. F. (2012). As You Sow, So Shall You Reap: The Welfare Impacts of Contract Farming. *World Development*, *40*(7), 1418–1434. https://doi.org/10.1016/j.worlddev.2011.12.008

Berhane, G., & Gardebroek, C. (2011). Does Microfinance Reduce Rural Poverty? Evidence Based on Household Panel Data from Northern Ethiopia. *American Journal of Agricultural Economics*, *93*(1), 43–55. https://doi.org/10.1093/ajae/aaq126

Bezu, S., Kassie, G. T., Shiferaw, B., & Ricker-Gilbert, J. (2014). Impact of Improved Maize Adoption on Welfare of Farm Households in Malawi: A Panel Data Analysis. *World Development*, *59*, 120–131. https://doi.org/10.1016/j.worlddev.2014.01.023

Bezu, S., & Villanger, E. (2019). *Crop market participation among smallholder farmers in Tanzania*. https://open.cmi.no/cmi-xmlui/handle/11250/2643306

Bound, J., Jaeger, D. A., & Baker, R. M. (1995). Problems with Instrumental Variables Estimation When the Correlation Between the Instruments and the Endogeneous Explanatory Variable is Weak. *Journal of the American Statistical Association*, *90*(430), 443. https://doi.org/10.2307/2291055

Calberto, G., Staver, C., & Siles, P. (2015). An assessment of global banana production and suitability under climate change scenarios, In: Climate change and food systems: Global assessments and implications for food security and trade. *Aziz Elbehri (Editor). FAO, Rome, 2015.*

Campa, J. M., & Kedia, S. (2002). Explaining the Diversification Discount. *The Journal of Finance*, *57*(4), 1731–1762. https://doi.org/10.1111/1540-6261.00476

Cazzuffi, C., McKay, A., & Perge, E. (2020). The impact of agricultural commercialisation on household welfare in rural Vietnam. *Food Policy*, *94*(C). https://ideas.repec.org//a/eee/jfpoli/v94y2020ics0306919219306335.html

Cen, Y., Guo, L., Liu, M., Gu, X., Li, C., & Jiang, G. (2020). Using organic fertilizers to increase crop yield, economic growth, and soil quality in a temperate farmland. *PeerJ*, *8*, e9668. https://doi.org/10.7717/peerj.9668

Chabi, M. C., Dassou, A. G., Dossou-Aminon, I., Ogouchoro, D., Aman, B. O., & Dansi, A. (2018). Banana and plantain production systems in Benin: Ethnobotanical investigation, varietal diversity, pests, and implications for better production. *Journal of Ethnobiology and Ethnomedicine*, *14*(1), 78. https://doi.org/10.1186/s13002-018-0280-1

Coase, R. H. (1937). The Nature of the Firm. *Economica*, *4*(16), 386–405. https://doi.org/10.1111/j.1468-0335.1937.tb00002.x

Demeke, A. B., Keil, A., & Zeller, M. (2011). Using panel data to estimate the effect of rainfall shocks on smallholders' food security and vulnerability in rural Ethiopia. *Climatic Change*, *108*(1–2), 185–206. https://doi.org/10.1007/s10584-010-9994-3

Diallo, Y. (2023). The Effects of Climate and Conflict Shocks on Household Welfare: Niger. *IMF*. https://www.imf.org/en/Publications/selected-issues-papers/Issues/2023/02/27/The-Effects-of-Climate-and-Conflict-Shocks-on-Household-Welfare-Niger-530249

Dilanchiev, A., & Taktakishvili, t. (2022). Macroeconomic determinants of household consumptions in Georgia. *Annals of Financial Economics*. https://doi.org/10.1142/S2010495221500202.

Drakopoulos, S. A. (2021). Theories of Consumption. National and Kapodistrian University of Athens.

Eggert, H., & Lokina, R. B. (2010). Regulatory compliance in Lake Victoria fisheries. *Environment and Development Economics*, *15*(2), 197–217. https://doi.org/10.1017/S1355770X09990106

Etang, A., Hounsa, T., & Pape, U. (2022). *Impact of High Inflation on Household Livelihoods in Urban South Sudan*. The World Bank. https://doi.org/10.1596/1813-9450-10210

European Environment Agency. (2005). *Household consumption and the environment*. Office for Official Publications of the European Communities. https://plus.cobiss.net/cobiss/sr/en/bib/515907

FAO. (2012). *Banana Production Systems at risk: Effectively responding to banana wilt disease in the Great Lakes Region*. FAO. Https://www.fao.org/fileadmin/user_upload/emergencies/docs/FAO%20BANANA%20factsheet%20ENGLISH.pdf

FAOSTAT. (2024). *Food and Agricultural Organisation of the United Nations. FAOSTAT statistical database*. http://www.fao.org/faostat/en/#data/QC

Ferreira, G. F. C., Fuentes, P. A. G., & Ferreira, J. P. C. (2018). *The successes and shortcoming of Costa Rica exports diversification policies*. 56.

Greene, W. H. (2008). *Econometric Analysis* (6th Edition).

Heckman, J. J. (1979). Sample Selection Bias as a Specification Error. *Econometrica*, *47*(1), 153. https://doi.org/10.2307/1912352

Heckman, J. J., & Hotz, V. J. (1989). Choosing among Alternative Nonexperimental Methods for Estimating the Impact of Social Programs: The Case of Manpower Training. *Journal of the American Statistical Association*, *84*(408), 862–874. https://doi.org/10.1080/01621459.1989.10478848

Hill, R. C., Griffiths, W. E., & Lim, G. C. (2011). *Principles of econometrics* (4th ed). Wiley.

IFAD. (2010). *Rural poverty report 2011: New realities, new challenges: new opportunities for tomorrow's generation*. International fund for agricultural development.

Islam, A. H. M. S. (2018). Impact of Integrated Aquaculture-agriculture Value Chain Participation on Welfare of Marginalized Indigenous Households in Bangladesh: A Panel Data Analysis. *AgEcon Search*. https://doi.org/10.22004/ag.econ.277412

Kapoor, M., & Ravi, S. (2009). *The Effect of Interest Rate on Household Consumption: Evidence from a Natural Experiment in India* (SSRN Scholarly Paper 1346813). https://doi.org/10.2139/ssrn.1346813

Karamura, D. A., Karamura, E., & Tinzaara, W. (2012). *Banana Cultivar Names, Synonyms and their Usage in Eastern Africa*. 132.

Key, N., Sadoulet, E., & Janvry, A. D. (2000). Transactions Costs and Agricultural Household Supply Response. *American Journal of Agricultural Economics*, *82*(2), 245–259.

Khalili, N., Arshad, M., Kächele, H., Farajzadeh, Z., & Müller, K. (2021). Drought shocks and farm household consumption behaviour: Insights from Fars province of Iran. *International Journal of Disaster Risk Reduction*, *66*, 102625. https://doi.org/10.1016/j.ijdrr.2021.102625

Kikulwe, E. M., Fischer, E., & Qaim, M. (2014). Mobile Money, Smallholder Farmers, and Household Welfare in Kenya. *PLoS ONE*, *9*(10), e109804. https://doi.org/10.1371/journal.pone.0109804

Kilimo Trust. (2012). *Banana Value Chain(s) in East Africa: Consumption, productivity and challenges*.

Kilimo Trust. (2015). *Building Blocks of Trade in Food: Kilimo Trust Biennial Report – July 2012 – June 2014*.

Kiwanuka, R. N. L., & Machethe, C. (2016). Determinants of Smallholder Farmers' Participation in Zambian Dairy Sector's Interlocked Contractual Arrangements. *Journal of Sustainable Development*, *9*(2), Article 2. https://doi.org/10.5539/jsd.v9n2p230

Lucas, S. S., & Jomanga, K. E. (2021). The Status of Banana Production in Tanzania; a Review of Threats and Opportunities. *International Journal of Current Science Research and Review*, *04*(10). https://doi.org/10.47191/ijcsrr/V4-i10-10

Maddala, G. S. (1983). Models with self-selectivity. In *Limited-Dependent and Qualitative Variables in Economics*. New York: Cambridge University Press, pp. 257-91.

Marimo, P., Caron, C., Van den Bergh, I., Crichton, R., Weltzien, E., Ortiz, R., & Tumuhimbise, R. (2020). Gender and Trait Preferences for Banana Cultivation and Use in Sub-Saharan Africa: A Literature Review. *Economic Botany*, *74*(2), 226–241. https://doi.org/10.1007/s12231-020-09496-y

Masih, I., Maskey, S., Mussá, F. E. F., & Trambauer, P. (2014). A review of droughts on the African continent: A geospatial and long-term perspective. *Hydrology and Earth System Sciences*, *18*(9), 3635–3649. https://doi.org/10.5194/hess-18-3635-2014

Mgbenka, R. N., & Mbah, E. N. (2016). A Review of Smallholder Farming In Nigeria: Need for Transformation. *International Journal of Agricultural Extension and Rural Development Studies (IJAERDS)*. https://eajournals.org/ijaerds/vol-3-issue-2-may-2016/review-smallholder-farming-nigeria-need-transformation/

Mossie, M., Gerezgiher, A., Ayalew, Z., & Nigussie, Z. (2020). Determinants of small-scale farmers' participation in Ethiopian fruit sector's value chain. *Cogent Food & Agriculture*, *6*(1), 1842132. https://doi.org/10.1080/23311932.2020.1842132

Muriithi, B. W., & Matz, J. A. (2015). Welfare effects of vegetable commercialization: Evidence from smallholder producers in Kenya. *Food Policy*, *50*, 80–91. https://doi.org/10.1016/j.foodpol.2014.11.001

Mustaffa, M. M., & Kumar, V. (2012). Banana Production and Productivity Enhancement through Spatial, Water and Nutrient Management. *Journal of Horticultural Sciences*, *7*(1), 1–28. https://doi.org/10.24154/jhs.v7i1.383

NBS. (2014a). *Basic Information Document: National Panel Survey (NPS 2012-2013)*. NATIONAL BUREAU OF STATISTICS.

NBS. (2014b). *Tanzania National Panel Survey Report (NPS)—Wave 3, 2012—2013*. NBS. https://www.nbs.go.tz/nbs/takwimu/Statistical_Methods_and_Standards/NPS_Wave_3%20_Final%20_Report.pdf

NBS. (2014c). *Tanzania—Household Budget Survey 2011-2012*. https://catalog.ihsn.org/catalog/4846/related-materials

NBS. (2016). *Tanzania National Panel Survey Report (NPS)—Wave 4, 2014—2015*. NBS.

NBS. (2018). *Labour Market Information in Tanzania, 2018: Employment Estimate in Tanzania Mainland 2018 from Integrated Labour Force Survey—2006 and 2014*. NBS.

NBS. (2019). *National Bureau of Statistics—The 2017-18 Household Budget Survey: Key Indicators Report*. https://www.nbs.go.tz/index.php/en/census-surveys/poverty-indicators-statistics/household-budget-survey-hbs/413-the-2017-18-household-budget-survey-key-indicators-report

Ndlovu, P. N., Thamaga-Chitja, J. M., & Ojo, T. O. (2022). Impact of value chain participation on household food insecurity among smallholder vegetable farmers in Swayimane KwaZulu-Natal. *Scientific African*, *16*, e01168. https://doi.org/10.1016/j.sciaf.2022.e01168

Ngwilizi, D., Selejio, O., & Ruhinduka, R. D. (2024). The Effect of Intra-household Mobile Phone Use on Household Food and Nutrition Security in Tanzania. *The African Review* (published online ahead of print 2024). https://doi.org/10.1163/1821889x-bja10128

OEC. (2020). *Bananas in Tanzania | OEC*. OEC - The Observatory of Economic Complexity. https://oec.world/en/profile/bilateral-product/bananas /reporter/tza

OECD. (2013). *OECD Framework for Statistics on the Distribution of Household Income, Consumption and Wealth*. OECD Publishing, Paris.

Olwande, J., Smale, M., Mathenge, M. K., Place, F., & Mithöfer, D. (2015). Agricultural marketing by smallholders in Kenya: A comparison of maize, kale and dairy. *Food Policy*, *52*, 22–32.

https://doi.org/10.1016/j.foodpol.2015.02.002
Ørtenblad, S. B., Larsen, M. N., Bruun, T. B., & Ortiz-Gonzalo, D. (2023). Smallholder Participation in Modernising Agri-Food Value Chains in Thailand: The Role of Traditional Markets. The European Journal of Development Research, 35(6), 1419–1439. https://doi.org/10.1057/s41287-023-00587-9Sexton, R. J. (2008). Perspectives on the Development of the Economic Theory of Co-operatives. *Canadian Journal of Agricultural Economics/Revue Canadienne d'agroeconomie*, *32*(2), 423–436. https://doi.org/10.1111/j.1744-7976.1984.tb02135.x
Shell Foundation. (2023). *East Africa Fruits: Promoting banana farming in Tanzania.* https://shellfoundation.org/app/uploads/2023/03/EA-Fruits-blog.pdf
Sipen, P., Chubo, J. K., King, P. J. H., Huat, O. K., & Davey, M. R. (2011). Genetic Improvement of Banana Using Conventional and In Vitro Technologies. *Journal of Crop Improvement*, *25*(6), 697–727. https://doi.org/10.1080/15427528.2011.603406
Smith, A. (1937). *The Wealth of Nations*. Modern Library Edition.
Söderbom, M. (2009). *Applied Econometrics Lecture 15: Sample Selection Bias Estimation of Nonlinear Models with Panel Data*. 46.
Staiger, D., & Stock, J. H. (1997). Instrumental Variables Regression with Weak Instruments. *Econometrica*, *65*(3), 557. https://doi.org/10.2307/2171753
Stock, J. H., & Yogo, M. (2005). *Testing for Weak Instruments in Linear IV Regression*. 53.
Warsanga, W. B., & Evans, E. A. (2018). Welfare Impact of Wheat Farmers Participation in the Value Chain in Tanzania. *Modern Economy*, *09*(04), 853–887. https://doi.org/10.4236/me.2018.94055
Westlake, M. J. (2005). *Addressing marketing and processing constraints that inhibit agrifood exports: A guide for policy analysts and planners*. Food and Agriculture Organization of the United Nations.
Williamson, O. E. (1985). *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*. New York, Free Press.
Wooldridge, J. M. (2002). *Econometric Analysis of Cross Section and Panel Data*. MIT Press.
Wooldridge, J. M. (2009). On estimating firm-level production functions using proxy variables to control for unobservables. *Economics Letters*, *104*(3), 112–114. https://doi.org/10.1016/j.econlet.2009.04.026