Economic Contribution of Spice Farming to Household Income on the Slopes of the Uluguru Mountains, Morogoro Region, Tanzania

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Abstract

Spice farming is a crucial agricultural activity for smallholder farmers in the Uluguru Mountains, Morogoro Region, Tanzania. However, the extent to which it contributes to household income compared to other livelihood activities remains unclear. This study assesses the economic significance of spice farming, identifies the main types of spices cultivated, and examines key challenges affecting spice production and market access. As such, a cross-sectional research design was employed, utilizing simple random sampling (a probability technique) to select 120 farmers from a sampling frame of 617 organic spice farmers, and purposive sampling (a non-probability technique) to select key informants and study villages. Data collection involved household surveys, key informant interviews, and direct field observations conducted between June and July 2020 in four wards: Kinole, Mkuyuni, Mtombozi, and Tawa. The findings reveal that black pepper, vanilla, and cinnamon are the predominant spices cultivated. Income derived from these spices was significantly higher than that from other crops ($p<0.007$, $t=2.727$), underscoring their economic importance. However, fungal diseases affecting black pepper and weak market linkages present major challenges to farmers. The study concludes that the agro-climatic conditions on the slopes of the Uluguru Mountains are highly suitable for spice farming but require improved support systems. It is recommended that farmers increase investment in spice production, while local government authorities and extension officers should enhance training on best agricultural practices and establish stronger market linkages to boost productivity and economic returns.

Keywords: Spices farming, Household's income, economic contribution, smallholder farmers, Morogoro, Tanzania.

Introduction

Spices are plant-based products valued for their pungent flavor, aroma, color, and preservative properties, enhancing both culinary and medicinal applications (Hirasa & Takemasa, 1998). They can be derived from various plant parts, including buds, fruits, seeds, flowers, bark, rhizomes, and bulbs. Many individuals consume spices such as turmeric and coriander for their health benefits, as recognized in the Ayurveda system of medicine (Rathore & Shekhawat, 2008). Moreover, spices play a crucial role in pharmaceuticals and cosmetic industries, where they are widely used in the production of medicinal and beauty products (Gupta, 2010).

Spice farming is a significant component of the horticultural industry, contributing to food security, employment, and income generation for smallholder farmers in developing countries (Garu, 2017). The Food and Agriculture Organization (FAO, 2019) classifies spices as a niche agricultural product, advising farmers to integrate them into their farming systems to enhance income diversification and resilience against economic shocks. Globally, India dominates spice production, contributing 86% of the total global output, followed by China

(3%), Bangladesh (3%), Sri Lanka (2%), Pakistan (2%), Turkey (2%), Nepal (1%), and other regions, including Africa (Garu, 2017). In Africa, significant spice-producing countries include Ethiopia, Nigeria, Uganda, Egypt, and Tanzania (Muyengi, 2012).Tanzania, in particular, has a long history of spice farming, with Zanzibar historically known as the "Spice Islands." Between 2006 and 2011, Tanzania exported 5,500 tons of spices valued at USD 38.2 million (ITC, 2014). Spice farming is widely practiced in Zanzibar, Tanga, Morogoro, Kagera, Mbeya, Iringa, Kilimanjaro, and the Coastal Region (BET, 2002). Morogoro Region, with its favorable agro-climatic conditions, supports the production of various spices, including lemongrass, chilies, black pepper, cloves, cinnamon, cardamom, ginger, turmeric, and vanilla. Certain wards specialize in specific spices: Mtombozi in turmeric, Mkuyuni in ginger, and Kinole and Tawa in cinnamon and black pepper production. High-value spices such as black pepper, cloves, cinnamon, cardamom, ginger, turmeric, and vanilla serve both domestic markets and exports, significantly influencing rural household economies (ITC, 2014).

Several studies highlight the economic significance of spice farming in improving rural livelihoods. For instance, Zhu (2018) found that vanilla farming in Madagascar significantly alleviates poverty among smallholder farmers by increasing household revenues. Similarly, a study in India by Kumari & Sharma (2020) revealed that cardamom and black pepper farming provided stable income sources and enhanced resilience against agricultural shocks. In East Africa, Senko *et al*. (2005), Hassan (2014), and Garu (2017) document the role of spices in enhancing farmers' incomes and economic stability.

In Tanzania, Kajembe *et al*., (2024) assessed livelihood strategy choices among spice farmers in the Eastern Arc Mountains of Tanzania while Kinyau (2018) examined the profitability, investment opportunities, and challenges in spice production in Matombo and Mkuyuni Divisions, Morogoro District. However, the study primarily focused on spice farming's potential as a business venture, without analyzing its direct contribution to household income relative to other sources. This gap is crucial, as understanding the proportion of income derived from spices compared to alternative livelihood activities can inform policy decisions, extension services, and investment strategies for smallholder farmers.

While existing studies emphasize the economic potential of spice farming (FAO, 2019; Garu, 2017; Zhu, 2018), there is limited empirical evidence on how spice farming directly contributes to household income on the slopes of Uluguru Mountains in Morogoro Region, Tanzania. Previous studies, such as Kinyau (2018) and Hassan (2014), have explored the profitability, opportunities, and investment challenges in spice production but have not comprehensively quantified spice-related income against other household income sources. This leaves a critical knowledge gap in understanding the extent to which spice farming enhances household economic well-being.

Given that agriculture remains the main economic activity in Morogoro (Gwasa, 2007; Muyengi, 2012), assessing the role of spice farming in household income generation is essential for designing effective policies and support programs that enhance farmer profitability and market linkages. Studies in Madagascar (Zhu, 2018) and India (Rathore & Shekhawat, 2008) highlight that spices contribute significantly to smallholder farmer revenues, yet similar evidence is scarce for Tanzania. Therefore, this study aimed to address this gap by identifying the types of spices produced, determining the income accrued from spice sales, and evaluating the importance of spice farming in household income compared to other economic activities. This is due to the fact that, understanding these aspects provide empirical evidence on the economic significance of spice farming, informing policy decisions and interventions to enhance the livelihoods of smallholder spice farmers in Tanzania. Therefore, by generating data on income contributions, this study helps to improve market access strategies and guide the implementation of policies that strengthen the spice sector for sustainable rural development.

Material and Methods

Theoretical Review

This study was informed by the Subjective Equilibrium Theory of the Farm Household developed by Nakajima (1986). The theory conceptualizes the farm household as the central unit of decision-making concerning agricultural production, resource allocation, and income diversification. It emphasizes that farmers make rational choices on yield maximization, technology adoption, and market engagement based on their subjective preferences, resource endowments, and economic environment. According to Nakajima, farm households operate within different farming structures categorized into three types: Type I farms, which hire labor while household members engage in non-farm activities; Type II farms, which are self-sufficient in labor and do not hire external workers; and Type III farms, which depend on hired labor, particularly during peak seasons. The theory further posits that total household income is a composite of multiple income streams, including earnings from farming, non-farm activities, salaries, pensions, and other passive incomes (Yamane *et al*., 2018).

This theory was selected for this study because of its relevance in explaining how smallholder farmers balance agricultural income with other sources of earnings. Unlike classical agricultural economic theories that focus solely on farm output and productivity, the Subjective Equilibrium Theory of the Farm Household considers the dynamic and adaptive strategies farmers employ to sustain their livelihoods. In the context of spice farming on the slopes of the Uluguru Mountains, this theory provides a useful lens for examining how farmers integrate spice production with other income-generating activities to achieve household economic stability. Additionally, it aligns with the study's objective of assessing the contribution of spice farming to household income by recognizing that agricultural decisions are influenced by both market conditions and household livelihood strategies.

The Subjective Equilibrium Theory has been applied in various contexts, particularly in analyzing farm household behaviors in Asia, Africa, and Latin America. Studies in Japan and China (Nakajima, 1986; Yamane *et al*., 2018) have used the theory to understand how farm households make investment decisions in response to labor availability, market conditions, and economic policies. Similarly, in East Africa, researchers have employed the theory to investigate income diversification strategies among smallholder farmers engaged in cash crop production, including coffee, tea, and horticulture (Hassan, 2014; Zhu, 2018).

However, while the theory provides a conceptual framework for understanding household income diversification, it has some limitations. One major criticism is that it assumes farm households are rational decision-makers with complete information about markets and production technologies, which is often not the case in developing economies. Additionally, the theory does not adequately account for external factors such as climate variability, price fluctuations, and institutional constraints, which significantly influence farmers' income and decision-making processes (Muyengi, 2012).

Methodology

Description of the study area

The study was conducted in Morogoro District, which is part of Morogoro Region in Tanzania, located in the southeastern part of the country. Morogoro region is located in the Mid – Eastern part of Tanzania mainland and it lies between latitudes 5° 58' and 10' south of the equator and between longitude 35° 25' and 38° 30' East Greenwich. It is bordered by seven other Regions. To the north Morogoro region shares boarders with Arusha and Tanga regions. To the east and southeast, it shares boarders with Ruvuma and Lindi regions respectively. To the west and southwest, it shares borders with Dodoma and Iringa regions respectively(URT, 2020). Morogoro region can broadly be divided into three broad Agro-Ecological Zones which include the mountain zone, the intermediate zone, and the river valleys and basins zone. The slopes of the uluguru mountains are located on the river valleys and basins zone which is constituted by the valleys of rivers including Mgeta, Ruvu, Wami, Msongozi, Mbulumi and Ngerengere(URT, 2020). The topography of these areas is predominantly plain with rainfall

ranging between 900mm and 1400mm annually. Temperatures in this zone are high with an average of 300 c due to its lowland nature. The zone is densely populated in the upper parts of the valleys and sparse in the inner parts of the valleys. Major food crops grown in this zone include maize, paddy, sorghum, beans, cassava, fruits and vegetables. Cash crops grown are cotton, sisal, oil seeds, sugarcane, coconuts and spices (URT, 2020; Msanya et al.,2001). Morogoro district was selected for this study due to its significant role in the cultivation of various spice crops, such as cloves, cardamom, and black pepper.

The mean annual rainfall ranges from 1065 mm to 2450 mm, which significantly supports spice production. The rainfall distribution is seasonal, typically from December to May, with peak rainfall occurring in April (Msanya et al., 2001). The communities in the study area largely depend on agriculture for their livelihoods, with the majority of the population engaged in both crop farming and livestock rearing (Yamane *et al*., 2018).

The district features a mix of urban and rural areas, with urban centers such as Morogoro Town benefiting from better infrastructure and access to markets, while rural areas face more challenges related to resource access, infrastructure, and market connectivity. Income sources vary between urban and rural areas. In urban areas, income is more diverse, with opportunities in trade, services, and remittances, whereas rural areas predominantly rely on agriculture, with a focus on crop farming, livestock, and, to a lesser extent, forest products.

Research design

This study employs a cross-sectional research design, chosen for its ability to capture data from the population at a specific point in time. This design is appropriate for this study as it allows for the examination of the contribution of spice farming to household income based on the production year of 2020 (Thomas (2020) and Bryan, (2012)). Cross-sectional designs are effective in providing insights into current trends, enabling researchers to examine the relationship between different variables, such as spice farming income and other livelihood sources. Moreover, it is a practical design given the time constraints of the study and the need for immediate data collection. The cross-sectional approach ensures that a snapshot of the impact of spice farming on household income is obtained, which is essential for informing policy decisions and agricultural interventions.

Sampling procedures and sample size

The study population consisted of farmers engaged in the Uluguru Spice Project (USP) under the auspices of Sustainable Agriculture Tanzania (SAT). The sampling process was carried out in two stages. In the first stage, four wards - Kinole, Mkuyuni, Mtombozi, and Tawa were purposively selected due to their prominence in spice production according to SAT data. The second stage involved the selection of villages, where five villages—Kibwaya, Kisarawe, Mfumbwe, Lungeni, and Tandai were randomly selected from the list of 33 villages and 120 farmers were also randomly selected from the list of 617 farmers involved in the project. The sampling frame was obtained from SAT's register, ensuring that all farmers were given an equal chance of being included in the study.

In total, 120 farmers were selected, representing about 19% of the total population of farmers under the SAT program. According to Gray (2014), a sample size of at least 30 respondents per village is recommended for statistical analysis, which was achieved in most villages. The distribution of respondents across villages was as follows:

Table 1: Number of respondents per village

Villages	Number of Spice farmers	Number of Respondents
Tandai	180	36
Mfumbwe	95	23
Kibwaya	120	27
Lungeni	92	21
Kisarawe	60	15
Total	**617**	**120**

Source: SAT, (2020)

The decision to include fewer than 30 respondents in some villages (Kisarawe,

Lungeni, Kibwaya, and Mfumbwe) was based on practical constraints, such as the availability of farmers who are cultivating all types of spices and who were willing to participate during data collection. Despite this, the study maintains statistical validity with a total of 120 respondents, which is sufficient for the objectives of the study.

Data collection methods and tools

Data were collected through a household survey using pre-structured questionnaires, as well as through interviews and observations. The questionnaire focused on the incomes derived from spice farming and other agricultural activities, such as food crop sales. Key informant interviews were conducted with extension officers, farmers, and SAT staff to provide further insight into the economic role of spice farming in the area. Additionally, observations were made on the production, marketing, and harvesting practices related to spice cultivation in the study area.

Data analysis

Statistical Package for Social Sciences (SPSS) version 20.0 was used for data analysis. Both descriptive and inferential statistics were employed to summarize and analyze the data. Descriptive statistics, including frequencies and percentages, were used to characterize the study sample. Inferential statistics, specifically a paired-samples t-test, were used to test the hypothesis that incomes from spice farming and other agricultural activities do not differ significantly. This test is appropriate as it compares the means of two related groups and is commonly used when the data follows a normal distribution (Wooldridge, 2005). Therefore, the paired-samples t-test was chosen because it is a robust statistical tool for comparing the means of two related samples, in this case, incomes from spice farming and other agricultural sources. This test is particularly useful in agricultural studies where interventions, such as the introduction of new farming practices, may impact income sources over time.

The data for income distribution from both spice and other crops were initially examined for normality. Histograms were used to visually assess the distribution of income data, revealing that the incomes were right-skewed. To correct for this, a Log10 transformation was applied to the income data, allowing for a more accurate statistical analysis. Therefore, regarding normality testing, the study used histograms as a visual tool to assess the distribution of income data. While more rigorous methods such as the Shapiro-Wilk test or Levene's test are often recommended, the use of histograms was justified in this study due to the exploratory nature of the data and the right-skewed income distribution observed. Future studies may benefit from more advanced statistical tests for normality, especially if the data warrants more precise examination.2.4 Limitations of the study. It was difficult to get 30 respondents in Kisarawe, Lungeni, Kibwaya, and Mfumbwe villages selected for the study. The reason was based on practical constraints, such as inadequate number of farmers who are cultivating all types of spices and who were willing to participate during data collection.

Results and Discussion

Socio-economic characteristics of respondents

Age and Sex of respondents

The age of respondents in the study ranged from 18 to 73 years, with the majority falling within the age groups of 31-43 years (26.7%) and 44-56 years (30.0%) (Table 2). This indicates that the most active group in spice farming is middle-aged individuals, which aligns with the labor-intensive nature of the agricultural activities involved. Spice farming, particularly for crops like black pepper, requires significant physical labor, including the climbing of trees for harvesting. These activities necessitate the involvement of younger, more physically capable individuals or the use of hired labor, especially among older farmers. This finding is consistent with Komarek (2010), who highlighted the labor-intensive nature of spice farming despite its high returns. As such, older farmers are often supported by the younger generation or external labor to ensure the continuity of spice production.

Regarding gender, the results show that 69.2% of respondents were male-headed households, while 30.8% were female-headed

(Table 2). Male dominance in spice farming is consistent with the broader trend observed in many African societies, where cash crops like spices are typically managed by men, while women are more often involved in food crop cultivation (Mhando, 2005). This gender disparity is also reflected in market access; Hill and Vigneri (2014) noted that men often have better access to agricultural networks and markets, giving them an advantage in obtaining valuable market information and resources.

Respondent's Education and Marital status

Education plays a crucial role in determining a farmer's ability to adopt new agricultural practices. In this study, the majority of respondents (61.7%) had attained only primary education, while 29.2% had informal education and 9.2% had completed secondary education (Table 2). The relatively low levels of formal education among spice farmers may limit their ability to understand and implement innovative agricultural practices. This finding aligns with the research by Oluwasola (2010), who suggested that access to information and the adoption of technological innovations in farming are closely linked to education levels. Inadequate education may thus hinder farmers' capacity to improve productivity and adapt to emerging farming techniques.

Marital status also emerged as an important factor influencing agricultural productivity. The study found that 90% of respondents were married (Table 2), suggesting that households with marital partnerships tend to have a more collective approach to agricultural activities. This is in line with Naamwintome and Bagson (2013), who observed in Ghana that married couples are more successful in agricultural ventures due to the teamwork and joint decision-making that often characterizes their households. Consequently, larger and more cooperative households are likely to perform better in spice farming, benefiting from the combined efforts of all family members.

To assess the relationship between socio-economic factors and household income from spice farming, inferential statistics were applied. A regression analysis revealed that the age of the household head ($p=0.032$) and the education level ($p=0.048$) had statistically significant effects on household income. This suggests that older and more educated household heads tend to have higher income from spice farming. The positive correlation between age and income may reflect the accumulation of farming experience, while education facilitates better management practices and market engagement. Gender, however, showed no significant correlation ($p=0.423$), indicating that while men dominate the sector, female-headed households do not differ substantially in terms of income when controlling for other variables.

The socio-economic characteristics of the respondents provide valuable insights into the dynamics of spice farming on the slopes

Table 2: Socio-economic characteristics of respondents (n=120)

Variables		Frequency	Percent
Household head's age	18-30	24	20.7
	31-43	32	26.7
	44-56	36	30.0
	57-69	26	21.7
	70 >	2	1.7
Household head's sex	Male	83	69.2
	Female	37	30.8
Education	Informal education	35	29.2
	Primary education	74	61.7
	Secondary education	11	9.2
Marital status	Married	102	90.0
	Unmarried	12	10.0

of the Uluguru Mountains. The predominance of middle-aged farmers reflects the physical demands of spice cultivation, particularly for labor-intensive crops like black pepper. However, the gender and education disparities highlight broader socio-economic challenges, including unequal access to resources and knowledge. These barriers could be addressed through targeted extension services and gender-sensitive policies that ensure equitable access to farming resources and markets. The inferential statistics underscore the importance of age and education in determining household income from spice farming. Policymakers and extension services should prioritize strategies that enhance the capabilities of older farmers and improve education levels, which could lead to more sustainable and profitable spice farming practices. Moreover, addressing gender imbalances by increasing female farmers' access to market networks and information could further enhance the sector's economic contribution to households.

Table 3: The relationship between socio-economic factors and household income from spice farming

Variable	Coefficient	Standard Error	t-value	p-value
Age of Household Head	0.032	0.014	2.29	0.032*
Education Level	0.052	0.022	2.36	0.048*
Sex of Household Head	0.018	0.015	1.18	0.423

*(*Significant at $p < 0.05$)*

Types of Spices Produced on the Slopes of Uluguru Mountains

Black pepper productivity

Black pepper emerged as the dominant spice, with 32.4% of respondents involved in its production (Table 4). Respondents found black pepper relatively easy to manage compared to other spices, such as vanilla, due to its minimal supervision requirements and ease of storage. The market for black pepper is also accessible, with agents readily collecting the produce from farmers' households. This ease of management and marketability is one of the reasons for its popularity among farmers in the study area. Thangaselvabal *et al*., (2008) noted similar advantages in the management of black pepper, which requires less supervision compared to more demanding spices like vanilla. The quantity of pepper harvested from a well-maintained vine in the study area ranged from 5kg to 15kg, depending on the farm management practices. Well-irrigated vines with proper support and moderate shade were found to produce higher yields, which aligns with findings by Ravindran and Kallupurackal (2012), who reported that farm management practices directly influence black pepper yield.

Cinnamon Productivity

Cinnamon was the second most common spice produced, with 15.2% of respondents cultivating it (Table 3). A significant challenge associated with cinnamon farming is its incompatibility with intercropping. Unlike other crops such as bananas or coconut, cinnamon depletes the soil of nutrients, preventing the cultivation of other crops in the same field (Gwassa, 2017). This necessitates large land areas, which requires significant investment. The production of cinnamon is mostly concentrated in the Tandai and Kisarawe villages, where established markets and easy access to traders from Uganda, Kenya, and Zanzibar offer profitable avenues for sale (Kinyau, 2018). During the study, farmers employed value addition by chopping cinnamon into small chips, which is commonly used in spice blends

Table 4: Types of spices produced in the study area

Spice Name	Frequency	Percent
Black pepper	102	32.4
Cinnamon	48	15.2
Cloves	47	14.9
Ginger	37	11.7
Turmeric	29	9.2
Vanilla	28	8.9
Cardamom	24	7.6

and herbal condiments (Rema *et al*., 2003). The value-added products increase the marketability of cinnamon, enhancing farmers' income.

The inferential statistics analysis provides insights into the relationship between socio-economic characteristics and spice production. Table 5 below shows the results of a Chi-square test to assess the association between household head's education level and involvement in different types of spice production.

Spices Selling Price Trends and Market Dynamics

Table 6 presents the selling price trends of the spices cultivated in the study area between 2017 and 2019. Among the seven types of spices, vanilla stands out as the highest-priced spice, followed by cardamom and black pepper. These high prices, especially for vanilla, are primarily attributed to the ready market created by Natural Extract Industries LTD (NEI) and

Table 5: The Relationship between Socio-Economic Characteristics and Spice Production

Variable	Black Pepper (χ^2)	Cinnamon (χ^2)	Cloves (χ^2)	Ginger (χ^2)	Turmeric (χ^2)
Household head's Age	0.154	0.232	0.056	0.189	0.305
Household head's Sex	0.042**	0.051	0.091	0.031**	0.120
Education Level	0.125	0.250	0.350	0.174	0.421
Marital Status	0.088	0.074	0.119	0.065	0.212

Significant at $p<0.05$

The results indicate that the household head's sex had a significant association with the production of black pepper and ginger, suggesting that male-headed households were more likely to engage in the production of these spices. However, education and marital status did not show significant associations with spice production, implying that while education influences agricultural practices, other factors such as land availability, market access, and physical capacity may play more substantial roles in determining which spices are produced. The production of spices, particularly black pepper and cinnamon, plays a vital role in the livelihood of farmers on the slopes of the Uluguru Mountains. The socio-economic factors influencing spice farming, such as age, sex, and education, are crucial for understanding farmers' participation in spice production. Although productivity challenges exist in African agriculture, including Tanzania, the focus of this study on production is due to its direct impact on household income, market access, and the broader agricultural economy. Addressing productivity issues, however, remains critical for the long-term sustainability of spice farming, as low productivity limits economic growth and household income.

other traders who buy the produce directly from farmers. Vanilla's relatively high selling price is consistent with findings by Kamarek (2010), who observed that vanilla production is labor-intensive but rewarding due to its guaranteed market access. Vanilla, however, has unique agronomic requirements compared to other spices. It is grown under shade and requires mulching to protect it from soil run-off and direct sunlight, which increases the labor demand and makes it more complex to manage. These findings align with those of Kamarek (2010), who emphasized the labor-intensive nature of vanilla farming, requiring farmers to invest time and effort into managing the plants for three to five years before they begin to bear fruit.

Interestingly, the study showed that turmeric consistently had the lowest prices among the spices, with a significant price decline observed over the years. In 2017, turmeric fetched 400 TZS per kilogram, rising slightly to 500 TZS in 2018 and 700 TZS in 2019 (Table 4). However, turmeric's profitability has become increasingly unappealing to farmers in Lungeni village, where turmeric production is dominant. The market for turmeric has been constrained by both low prices and the requirement that turmeric be free from Salmonella bacteria, a

pathogen responsible for typhoid fever and other foodborne diseases. According to local respondents, the limited willingness of traders to purchase turmeric, coupled with declining prices, has led farmers to explore more lucrative alternatives, such as cloves and vanilla. This trend is similar to the findings of other studies Nguyan *et al*., (2024), where economic viability and market access were key drivers for farmers switching from low-value to higher-value crops. involvement of traders such as NEI guarantees a steady demand, ensuring farmers do not struggle to sell their produce. However, for spices like turmeric, farmers in Lungeni village face more significant challenges in securing buyers, thereby reducing the profitability of the crop. This scenario underscores the importance of establishing robust local markets that connect farmers to reliable buyers, enhancing the economic contribution of spice farming to

Table 6: Spices selling price trend (Year 2017 - Year 2019)

Spice	Price (TZS per Kg)		
	2017	**2018**	**2019**
Black pepper	3,000	3,200	3,500
Cinnamon	2,200	2,500	2,700
Cloves	18,000	14,000	14,000
Ginger	1,000	1,000	1,500
Turmeric	400	500	700
Vanilla	80,000	90,000	100,000
Cardamom	16,000	24,000	27,000

The price trends observed in Table 6 can be interpreted in relation to both the local and global markets. The selling prices presented in the table are based on market trends from the local area, which tend to follow broader global market fluctuations, but there are notable distinctions between the local and world markets for these spices. For instance, vanilla consistently commanded high prices in both the local and global markets. As the spice is in demand for products like flavoring agents and natural extracts, the price stability and growth over the years in both markets reflect its sustained commercial value. On the other hand, turmeric, despite its relatively low price, faces competition from both local and international markets where it is produced in large quantities, particularly in India and Southeast Asia. The local market price, therefore, is influenced by these broader trends, affecting farmers' willingness to continue production when the prices remain low.

The local market, unlike the world market, may also be influenced by intermediaries or traders who collect the spices directly from farmers. For example, in the case of vanilla, the household incomes.

Price variations among the spices are also strongly influenced by the agronomic practices employed by farmers. As noted, vanilla requires more complex and labor-intensive management practices compared to other spices, such as turmeric and ginger, which are less demanding. This increased labor demand for vanilla production results in its higher selling price, reflecting the costs incurred by farmers for its cultivation (Sujath and Bath (2010). In contrast, turmeric is an annual crop with simpler agronomic practices, yet the lack of market demand and the need for stringent quality control (e.g., free from Salmonella) reduce its profitability. This finding suggests that while simpler crops like turmeric may be easier to cultivate, they may not always be economically viable if market conditions do not support their prices. Inferential statistics was used to explore relationships between spice prices and various socio-economic factors. The analysis helps provide insight into how socio-economic variables, such as farmers' education and access to market information, influence pricing decisions and production choices.

Table 7: Relationships Between Spice Prices and Various Socio-Economic Factors

Variable	Black Pepper (χ^2)	Cinnamon (χ^2)	Vanilla (χ^2)	Ginger (χ^2)	Turmeric (χ^2)
Household Head's Age	0.132	0.236	0.185	0.222	0.143
Household Head's Gender	0.048**	0.063	0.011**	0.072	0.095
Education Level	0.210	0.152	0.085	0.192	0.127
Market Access	0.300	0.265	0.412	0.132	0.503

Significant at $p<0.05$

The results from the Chi-square test indicate that the household head's gender has a significant association with the prices of black pepper and vanilla, with male-headed households typically securing better prices. Market access also played a role, as farmers with better access to markets were able to sell their products at higher prices, particularly vanilla and cardamom. The findings from this study highlight the significant role that spice farming plays in the livelihoods of farmers on the slopes of the Uluguru Mountains. Despite the price volatility observed in some spices, such as turmeric, high-value spices like vanilla and cardamom offer considerable income potential, provided that farmers have access to markets and adopt the appropriate agronomic practices. The relationship between spice prices, market access, and socio-economic factors underscores the need for targeted interventions that enhance farmers' access to markets, improve their agronomic practices, and ensure fair pricing to increase the overall economic contribution of spice farming to household incomes.

This research emphasizes the need for policymakers and agricultural extension services to consider both local and global market dynamics when crafting strategies to support spice farming in Morogoro and other spice-growing regions in Tanzania.

Income earned from Spices and other Crops

Other crops produced by respondents

As shown in Table 8, over half of the respondents (66.7%) cultivate bananas, which are identified as the main food crop in the study area. Bananas are a crucial crop due to their dual function as both a food and cash crop. The study area sees banana cultivation year-round, which allows farmers to sell bananas periodically, generating income for household needs. In addition to bananas, respondents grow other crops such as cassava (43.3%), coconut (43.0%), and cereals like rice (39.2%) and maize (33.3%).

Table.8: Other crops cultivated by spice growing farmers (n=120)

Name of crops	Frequency	Percent	Unit	Price (TZS)
Banana	98	66.7	1 (banana Bunch)	3 500
Cassava	52	43.3	Bag of 20 kg	15 000
Coconut	51	43.0	1	400
Rice Paddy	47	39.2	Kg 100	50 000
Maize	40	33.3	Kg 100	100 000
Vegetable	13	10.8	Bag of 20 kg	15 000
Sweet potatoes	10	8.3	Bag of 20 kg	15 000
Sesame	9	7.5	1kg	5000

During informal interviews, local leaders and extension officers confirmed that bananas are frequently sold to purchase maize flour, a staple food, especially during the rainy season. The farmers mentioned that despite the steady supply of bananas, the income generated from banana sales remains relatively low. These findings are consistent with those of Yamane et al. (2018), who found that banana farming in the Uluguru Mountains contributes significantly to

food security due to the diversity of food crops grown.

Income from spices

Table 9 results show that, 45% of respondents reported earning between TZS 400,001 to TZS 600,000 annually from spice farming. The income from spices is significantly higher than income from other crops due to the high market prices of spices, such as black pepper, cinnamon, and vanilla, which have higher profit margins compared to the food crops mentioned in Table 5. Respondents also noted that income from spices tends to be received in lump sums, making it easier to track.

Income from other crops

Income generated from other crops, as seen in Table 9, was lower than that from spices. The majority of respondents (60%) reported earnings below TZS 400,001 per year from the sale of food crops like bananas, cassava, and vegetables. While bananas serve as both a food and cash crop, their income-generating capacity is limited due to low market prices.

($p<0.007$, $t=2.727$), confirming that income from spices is higher than that from other crops. This result aligns with previous studies, such as Zhu (2018), which reported that spice farming, especially vanilla, generates higher income in similar contexts.

Income contribution from each spice

Income from spice farming, as shown in Figure 1, contributes significantly to household incomes. Black pepper, cultivated by 104 households, generates TZS 25,446,000, making it the highest contributor among spices. Cinnamon, grown by 70 households, contributes TZS 11,569,900. Despite its high returns, vanilla,

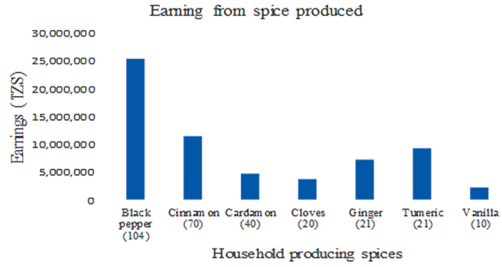

Figure 1: Earnings from each spice produced

Table 9: Income from spices selling and from other crops per season (n=120)

Income from spices			Income from other sources		
Income (TZS)	**Frequency**	**Percent**	**Income (TZS)**	**Frequency**	**Percent**
< 400 000	32	26.7	< 400 000	72	60.0
400 001 – 600 000	54	45.0	400 001–600 000	24	20.0
600 001 – 800 000	15	12.5	600 001–800 000	17	14.2
> 800 000	19	15.8	> 800 000	7	5.8

Income gained from spices and other crops in 2019

Table 10 compares the mean income earned from spices and other crops. The results indicate that the mean income from spices was TZS 568,365, while income from other crops was lower at TZS 428,287.50. A t-test revealed a significant difference between the incomes

cultivated by only 10 households, generates TZS 2,240,000 due to its high production costs and management requirements. The high income from black pepper and cinnamon indicates their economic importance, consistent with findings by Haque *et al*. (2017), who reported similar trends in Bangladesh.

Table 10: Comparison between income from spice selling and other crops (n=120)

Groups compared	n	Mean income TZS	t-value	df	Sig. (2tailed)
Income from spices	120	568 365	2.727	119	0.007
Income from other sources	120	428 287.50	2.727	119	0.007

Conclusions and Recommendations

Conclusions

This study has provided an in-depth analysis of the economic contribution of spice farming to household income in the Uluguru Mountains, located in Morogoro Region. The findings indicate that the agro-climatic conditions in the region are highly conducive to the cultivation of various spices, with black pepper, cinnamon, and vanilla being the most prevalent and economically valuable. Black pepper, in particular, emerges as the primary contributor to household income from spices, followed by cinnamon and vanilla, both of which show considerable potential for income generation.

The study also reveals that income from spices constitutes a significant portion of the total household income, outperforming other crops such as bananas, cassava, and maize. This observation is consistent with the high market value of these spices, which are sold at relatively higher prices than food crops. Interestingly, while farmers also engage in the production of food crops, the income from these crops is lower, underlining the economic significance of spice farming in the region. Moreover, despite the higher income generated from spices, some challenges related to investment in and management of vanilla cultivation persist due to its high demands.

In terms of theoretical perspectives, the findings challenge the assumptions of the subjective equilibrium theory of farm households, which posits that passive income and non-farm income contribute significantly to household income. In contrast, the results from this study demonstrate that agricultural income particularly from spice farming is the dominant source of income for households in the study area.

Recommendations

Based on the findings and conclusions of this study, the following recommendations are proposed to enhance the economic contribution of spice farming to household incomes on the slopes of Uluguru Mountains:

i. Increase Spice Productivity: Farmers should be encouraged to expand the production of high-value spices, particularly black pepper, cinnamon, and vanilla. Given the favorable agro-climatic conditions and the existing demand for these spices, increasing their production would help boost household incomes. Targeted efforts to improve the quality and quantity of spice productivity should be prioritized.

ii. Promotion of Good Agricultural Practices (GAPs): Local government authorities, in collaboration with extension officers, should provide training and support to farmers on modern farming practices that enhance productivity. This includes the use of improved planting materials, soil management techniques, pest control, and post-harvest handling practices. Effective training programs should also focus on crop rotation and agroforestry to maintain soil fertility and improve the long-term sustainability of spice farming.

iii. Investment in Vanilla Cultivation: While vanilla offers high returns, its cultivation remains limited due to its complex management requirements. Therefore, it is essential to invest in training programs that equip farmers with the knowledge and skills needed for successful vanilla cultivation. Financial support in the form of subsidies or loans could also be provided to help farmers overcome the initial capital-intensive nature of vanilla farming.

iv. Market Linkages and Value Addition: Farmers should be linked to reliable and profitable markets for their spices. This can be achieved through the establishment of cooperatives or farmer groups that can collectively negotiate better prices, as well as through the promotion of value-added products, such as processed and packaged spices, which would increase the income derived from spice farming.

v. Research and Extension Support: Continuous research should be conducted to identify high-yielding and disease-resistant spice varieties suitable for the region. Extension services should also be strengthened to ensure farmers have access to the latest information on spice farming practices and market trends. This would

help farmers make informed decisions and improve their productivity and profitability.

vi. Climate Smart Practices: Considering the potential impact of climate change, farmers should be trained in climate-smart agricultural practices that help mitigate environmental risks. This includes water conservation techniques, agroforestry, and diversified farming systems that enhance resilience to climate shocks.

These recommendations aim to strengthen the spice farming sector, ensuring that it remains a viable and sustainable source of income for smallholder farmers on the slopes of the Uluguru Mountains.

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Competing interests

The authors declare that they have no competing interests.

References

FAO (Food and Agriculture Organization) (2012). Gender Inequalities in Rural Employment in Ghana: An Overview Prepared by the Gender, Equity and Rural Employment Division. Food and Agricultural Organization, Rome, Italy. 58 pp.

Garu, F.A. (2017). Organic spices farming in West Districts, Zanzibar: Its contribution to livelihood outcomes of smallholder farmers. A Dissertation for the Award of a Masters' Degree at Sokoine University of Agriculture Morogoro, Tanzania. 78 pp.

Gray, D.E. (2014). Doing research in the real world. SAGE. London. 124pp.

Gupta, M. (2010). Pharmacological properties and traditional therapeutic uses of important Indian spices: A review. *International Journal of Food Properties,* 13(5):1092-1116.

Gwassa, N.F. (2007) Spices production and household income in Morogoro Rural District. Thesis for award of masters' degree at Sokoine University of agriculture Morogoro Tanzania. 66pp.

Hassan, M. (2015). Factor affecting market access among spice farmers in Zanzibar. Thesis for the award of masters' degree at Sokoine University of Agriculture Morogoro Tanzania 88pp.

Hill, R.V. and Vigneri, M. (2014). Mainstreaming gender sensitivity in cash crop market supply chains. In Gender in agriculture, Springer, Dordrecht. 315-341.

Hirasa, K. and Takemasa, M. (1998). Spice science and technology. Marcel Dekker Inc, New York, 23pp.

Haque, M.I., Uddin, M.K., and Akter, S. (2017). Value Chain Development and Technology Practices of Spice Crop Research and Development in Bangladesh Cardamom (small and large), Ginger, Turmeric, Black Pepper and Cinnamon. Challenges and Opportunities in Value Chain of Spices in South Asia. SAARC Agriculture Centre, 12.

(ITC) International Trade Centre. (2014). Tanzania Spices Sub-Sector Strategy, United republic of Tanzania. 71pp.

Kajembe, J.G., Bostedt G., Ngaga, Y.M and Abdallah J.M(2024). Assessing livelihood strategy choices among spice farmers in the Eastern Arc Mountains of Tanzania. *Journal of Development and Agricultural Economics*. 16(2), pp. 54-68,

Komarek, A.M. (2010). Crop diversification decisions: the case of vanilla in Uganda. *Quarterly Journal of International Agriculture* 1(49):227-242.

Kinyau, M. (2018). Contribution of spice production on the livelihood of small holder farmers: A case of Matombo and Mkuyuni Divisions, East Uluguru Mountains. Thesis for the award of masters' degree at Sokoine University of Agriculture Morogoro Tanzania 78pp.

Msanya, B.M., Kimaro, D.N., Kileo, E.P., Kimbi, G.G. and Mwango, S.B. (2001). Land suitability evaluation for the production of the major crops in the Southwest part of the uluguru mountains, Morogoro Rural districts, Tanzania. Soil and land resources of Morogoro Rural and Urban District (1) 65 pp.

Mhando, D.G. (2005). Farmers Coping Strategies with the Changes of Coffee Marketing System after Economic Liberalization: A case study of Mbinga district. Unpublished PhD thesis Graduate School of Asian and African Area Studies Kyoto University, Kyoto 178pp.

Muyengi, F. and Pro Found. (2012). Organic Spices in Tanzania: Opportunity for Producer of Organic Ginger, Chilli and Vanilla. Belgium Trade Centre Brussels, Belgium. 18pp

Naamwintome, B.A. and Bagson, E. (2013). Youth in agriculture: Prospects and challenges in the Sissala area of Ghana. *Net Journal of Agricultural Science,* 1(2):60-68.

Nakajima, C.(1986). Subjective Equilibrium Theory of the Farm Household. Amsterdam, The Netherlands: Elsevier Publishers B.V., xii + 302 pp.,

Nguyan L., Govindasamy, R and Mentreddy S.R. (2024). Turmeric trends: analyzing consumer preferences and willingness to pay. Frontiers in Sustainable Food Systems. http://dx.doi.org/10.3389/fsufs.2024.1359040

Oluwasola, O. (2010). Stimulating rural employment and income for cassava processing households' in Oyo State, Nigeria through policy initiatives. *Journal of Development and Agricultural Economics* 2(2):18-25.

Rathore, M.S. and Shekhawat, N.S. (2008) Incredible Spices of India: From Traditions to Cuisine. American-Eurasian Journal of Botany, 1, 85-89.

Ravindran, P.N. and Kallupurackal, J.A. (2012). Black pepper. Handbook of Herbs and Spices 3 (3): 86–115.

Rema, J., Krishnamoorthy, B. and Mathew, P.A. (2003). High yielding varieties of cinnamon and nutmeg. Indian Institute of spices research (5): 11.

Reimers, M. and Klasen, S. (2013). Revisiting the role of education for agricultural productivity. *American Journal of Agricultural Economics,* 95(1):131-152.

SAT (Sustainable Agricultural Tanzania) (2019). Uluguru Spice project. [http://www.kilimo.org/ WordPress/ usp-uluguru-spice-project.] Site visited on 14/06/2019.

Sujatha, S. and Bhat, R. (2010). Response of vanilla (*Vanilla planifolia* A.) intercropped in arecanut to irrigation and nutrition in humid tropics of India. Agricultural water management 97(7): 988-994.

SNV (Stichting Nederlandese Vrijwilligers) (2019). "Spice of life " project leveraging the spice sector for poverty reduction amongst ethnic minority communities in Vietnam.

http://www.snv.org/project/spice-life-leveraging-spice-sector-poverty-reduction-northern-vietnam] Site visited on 14/06/2019.

Thangaselvabal, T., Justin, C.G.L. and Leelamathi, M. (2008). Black pepper (Piper nigrum L.) 'The king of spices' - a review.Agri.Rev.29(2):89-98. http://www.indianspices.com

United Republic of Tanzania (2016). Uluguru Nature Forest Reserve Management Plan. 157 pp. available at http://www.tfs.go.tz, www.nature-reserves.go.tz. Site visited 25/04/2019.

United Republic of Tanzania (2020). Morogoro Region Socio -Economic Profile, 2020. A report Prepared Jointly by the National Bureau of Statistics, Ministry of Finance and Planning and Morogoro Regional Secretariat

Udin, N. (2014). Organic Farming Impact on Sustainable Livelihoods of Marginal Farmers in Shimoga District of Karnataka. *American Journal of Rural Development* 2(4):81-88.

Wooldridge, J.M. (2005). Simple solutions to the initial conditions problem in dynamic, nonlinear panel data models with unobserved heterogeneity. J*ournal of applied econometrics,* 20(1):39-54.

Yamane, Y., Kularatne, J., and Ito, K. (2018). Agricultural production and food consumption of mountain farmers in Tanzania: A case study of Kiboguwa village in Uluguru Mountains. Agriculture & Food Security 7 (1): 16.

Zhu, A. (2018). Hot money, cold beer: Navigating the vanilla and rosewood export economies in Northeastern Madagascar. American Ethnologist 45 (2):253-267.