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Assessment of Vegetable Gardening and Its Contribution to Household Income in Tabora Municipality, Tanzania

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Authors 'contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study investigated the contribution of vegetable gardening to household income among vegetable growers in Tabora Municipality, Tanzania. Despite the potential of vegetable cultivation to improve livelihoods, many households remained reliant on limited income sources.

This study aimed at ascertaining the contribution of vegetable gardening to the household income in Tabora Municipality, Tanzania. Specifically, the study identified the major vegetables grown in the area and examined the relative contribution of income from vegetable sales compared to other income sources. This study employed a cross-sectional design with a mixed-methods approach during data collection, where qualitative and quantitative data were collected. A structured questionnaire was administered to 120 respondents purposively selected from three wards: Ndevelwa, Mlisha, and Kabila. Qualitative data were gathered through focus group discussions and key informant interviews. The findings revealed that in the 2021/2022 and 2022/2023 cropping seasons, slightly more than half of the respondents (N=55.3% and N- 55.5%), recognized the significant contribution of vegetable gardening to their household income. This percentage increased significantly to 80.5% in the 2023/2024 season. Notably, the income generated from vegetable gardening surpassed other household income-generating activities. However, the study also highlighted substantial constraints: most respondents operated on small plots of land (<0.6 acres) and frequently failed to implement recommended agronomic practices effectively. These factors limited the overall productivity and profitability of vegetable production. To enhance yields and improve household income. Furthermore, it is recommended that the Tabora Municipality, through local authorities, should provide targeted capacity-building training on best agronomic practices to vegetable growers.

Keywords: Vegetable Gardening, Household Income, Tabora Municipality, Agronomic Practices, Livelihood Improvement

1.0 INTRODUCTION

Globally, vegetable gardening is recognized as a significant practice involving the cultivation of a diverse range of horticultural crops, primarily leafy greens, root vegetables, and fruits, in various controlled environments such as backyard gardens, raised beds, or containers [1, 2]. This practice is crucial for ensuring food and nutrition security worldwide [3]. Literature review indicates that vegetable gardening represents one of the earliest and most widespread food production systems across the globe [4]. Empirical studies have underscored the role of vegetable production in addressing food insecurity and malnutrition in developing countries, highlighting its importance as a key component of farm diversification strategies[5][6]. Furthermore, the economic benefits of vegetable gardening extend beyond mere food and nutritional security, especially for resource-poor families. Research indicates that the production of vegetables such as tomatoes, onions, eggplants, okra, spinach, cabbage, carrots, green beans, radishes, coriander, mint, green chillies, and amaranth leaves—not only enhances income and food security for farmers but also supports input suppliers, traders, and various actors within the value chain[7].

In Australia, vegetable production significantly contributed to agricultural income in 2020-2021, contributing AUD 4.04 billion, equivalent to $2.95 billion [8].In Africa, for centuries, vegetable gardening has been an integral component of family farming and local food systems [3]. It is an ancient and widespread practice all over African countries. In Nigeria, for example, it has been a longstanding practice, providing income and employment opportunities, particularly in dry cropping season [9]. Drawing on the study in Nigeria, vegetable farming emerges as a longstanding and economically significant practice, offering income and employment opportunities, particularly during dry cropping seasons [10]. The respondents from the said study reported an average monthly income of N28, 745.43 (USD 69.94), with vegetable production contributing over 80% to their overall income. Likewise, vegetable gardening is widely used as a remedy to alleviate hunger and malnutrition in the face of a global food crisis in most parts of Kenya, Rwanda, Tanzania and Ghana because outcomes from vegetable gardening are mankind's most affordable source of vitamins and minerals requirement for good health, also provides high returns on

land labour, thus creating employment opportunities and income for rural households. According to [11], vegetable production serves a significant and varied role in the diets of impoverished people in Sub-Saharan Africa.
The realization of the potential of vegetable production to meet up with the necessities of life has made farmers embark on its production, not just for immediate consumption, but also for economic benefits and poverty alleviation [6]. Studies show that many households engaged in vegetable gardening have higher incomes than those who solely rely on cereal crop production [12]. Under favorable climatic conditions, vegetable production can play a significant role in the food economy, social issues, and the environment [13; 14]. However, [5] emphasizes that to tap these economic benefits of vegetable gardening, the growers, governments and development partners should give vegetable gardening greater priority.

In Tanzania, vegetable gardening is an important agricultural sub-sector, contributing to the country's food security and economic growth. In most cases, farmers use a combination of traditional and modern techniques, including irrigation systems and improved seeds [15]. Tomatoes, onions, green peppers, carrots, cabbage, eggplant and okra are the most important vegetables grown in Tanzania. Evidence shows that vegetables provide food for domestic consumption and also improve people's living standards by generating income for farmers [16]. The study conducted by [17], on an overview of Vegetable Farming in Tanzania, revealed that vegetable production contributed significantly to household income, with over 60% contribution. According to [18], the vegetables' value chain encompasses various stages: production, marketing, and consumption. Each stage within the value chain offers income-generating opportunities for different actors such as input suppliers, farmers, transporters, traders, and retailers. Vegetable gardening serves as a diversified source of income, reducing dependency on a single income stream. It also creates employment opportunities in farm activities, transportation, packaging, and marketing, thus contributing to the local economy [6], [19]

In Tabora region, where this study was conducted, smallholder farmers play a crucial role in vegetable production to meet local market demands and generate household income [20]. The impact of climate change has led many smallholder farmers to shift from rain-fed agriculture to irrigated vegetable production, and from subsistence towards commercialization [21]. While most of the previous studies like.[22] and [23] have based on prospective, ecological aspects, and the significant importance of vegetable gardening to human health and income generations, yet have neglected discussion on how much gardening contributes to entire household income. Despite the widespread practice of vegetable gardening as a way of supporting nutrition and health [24], there is lack of studies to examine the contribution of household income. Likewise, while vegetable gardening has sprouted across the landscape of Tabora Municipality, the extent of its contribution to household income has been overlooked.

Knowledge is also scant on the common vegetables grown in the region, the associated costs of production, and how easy or difficult it is to access extension and input services. The general objective of this study was to investigate the contribution of vegetable gardening to household income among vegetable growers in the study area. Specific objectives of this study were: a) to explore the major vegetables grown in the study area; b) to analyze the income generated from vegetables compared to other sources of household income; and c) to quantify the contribution of income from vegetables to household income. This article, therefore, intends to fill some of the aforementioned research gaps, exploring the contribution of vegetable gardening to the entire annual household income compared to other income sources. The findings of this paper inform policymakers, researchers, farmers, and local government authorities on the economic significance of vegetable production and actions to take to increase production and subsequently improve food and incomes of farmers.

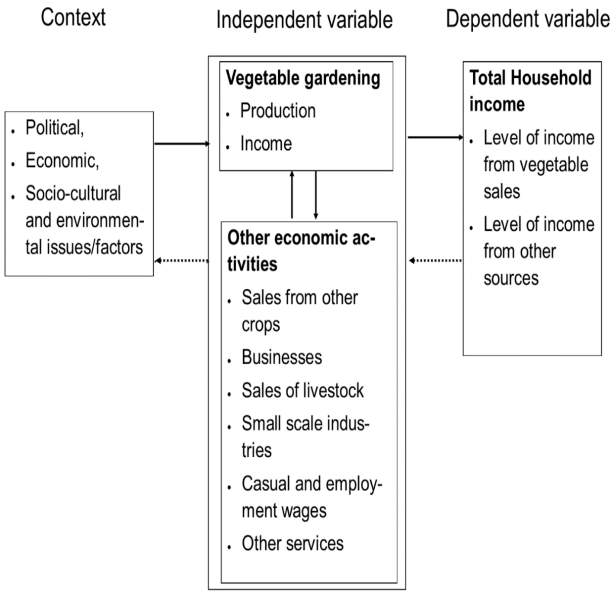
2.0 Conceptual Framework

The conceptual framework of this study was derived from Chambers' livelihood theory,

which analyzed how individuals and households utilized various assets and strategies to secure their well-being and income. According to this framework, the total household income comes from various sources, such as vegetable farming, selling other crops, off-farm activities. Contextual factors like political, socio-cultural, economic, and environmental circumstances significantly influence these income-generating activities. The framework views the overall household income as the dependent variable and various revenue sources as independent variables. With an emphasis on the many revenue sources and the variables affecting them, this research seeks to provide a thorough grasp of how households sustain their livelihoods.

The framework makes a distinction between variables examined using quantitative and qualitative approaches in order to account for the mixed-methods approach used in the research. The study's quantitative methods center on estimating household income from a variety of sources and computing net income, which is arrived at by deducting production costs from revenues. Examining these factors' direct and indirect impacts on total family income is best done using multilevel approaches. The research qualitatively examines contextual variables, such as political pressures or socio-cultural norms that affect how families decide to allocate resources and develop livelihood strategies. These are more context-specific and dynamic aspects that are investigated via focus groups and interviews to provide more in-depth understanding of household motives and obstacles.

Additionally, the framework shows how these two methods merge to improve comprehension. In a step-by-step manner, the creation of quantitative survey instruments is guided by qualitative insights into contextual elements, guaranteeing that all relevant variables are included in the research. The outcomes of the two approaches are combined, and the qualitative information offers a more thorough justification for the differences in household income shown in the quantitative data. With the use of this mixed-method approach, the research is able to examine both the financial results of family activities and the larger socio-political context in which they are entrenched, producing more comprehensive findings on the sustainability of livelihoods.



Key: ⟶ Represent a direct influence of intermediary/factor

⇠ Represent indirect influence of intermediary/factor

Fig. 1: Conceptual Framework for the Study

3.0 RESEARCH METHODOLOGY

3.1 Profile of the Study Area

The study was conducted in Tabora Municipal Council located in Tabora region, central-western zone of Tanzania between October 2023 and March 2024. An elevation of the Council is 1200m a.s.l and lies between latitudes 4° and 7° south of the Equator and longitudes 31° to 34° east of the Greenwich Meridian. The Council was purposively selected among six districts in Tabora region because most farmers had shifted their livelihood strategies from depending on a rain-fed crops production to irrigated vegetable production as a result of the effects of climate change (prolonged drought and unreliable rainfall patterns). In the council, vegetable production is a widespread practice because of its adaptability to changing climatic

conditions, shorter growing periods and minimal water requirements. The selected study area generally has hot temperatures ranging from 20°C to 33°C and relative humidity ranges from 25 to 65% with the mean annual rainfall ranging from 650 to 850 mm [25]. Tabora Municipal has a total population of 308 741 (150 416 are males and 158 325 females) and the average household size is 4.2 people [26]. Administratively, the Council has two divisions and 29 wards. This study involved three wards namely Ndevelwa, Misha and Kabila (Figure 2). Generally, the Council covers 109 226 hectares (ha). Out of them, 70 498.25 ha were for farming and livestock keeping, and 4 892 ha were suitable for irrigation [25]. The majority of the people were heavily reliant on agriculture; contributing 74% of the region's Gross Domestic Product (GDP), the remaining (26%) did trading and small-scale industries [26]. Maize, sweet potatoes, cassava, and paddy are the main food crops, while tobacco, cotton, vegetables - eggplant, spinach, tomato, chinese cabbage, carrot, onion, okra and amaranths are common cash crops [52].

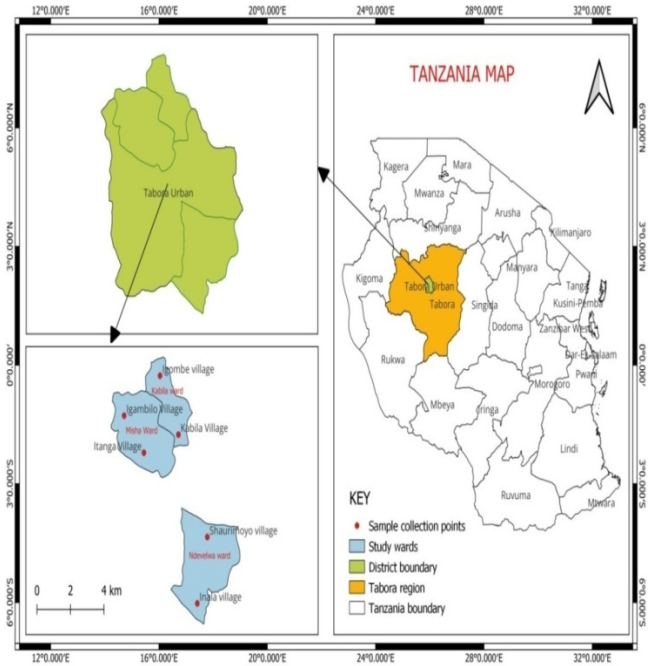


Fig. 2: Maps of Tanzania and Tabora Region showing the location of the study area (Tabora Municipality)

3.2 Research Design

The study used a cross-sectional research design, which allowed primary data to be gathered at one point in time using different methods and from different sources. The design was selected because it was efficient in determining the relationship between variables at a time.

3.3 Sampling Procedure and Sample Size

In this study, a multistage sampling method was used. A purposive sampling method was used in the first stage for selection of divisions and wards with a high number of farmers producing vegetables. In the second stage, random sampling was used to select respondents who engaged in vegetable growing and sold their products at local and central marketplaces. A total of 120 households were obtained by selecting six villages, each with 20 respondents. Drawing an equal number of families from each village guaranteed a representative sample of households actively engaged in vegetable production, minimizing bias and improving the generalizability of results across the research region.

Tabora Municipal Council comprises large, medium and smallholder farmers, and other people who engage in different economic activities. Therefore, the sample size for the vegetable growers was computed using the Kothari (2006), formula as recommended by [27] as appropriate for the sample size determination of a finite population.

This is expressed as: $$n = \frac{Z^2.p.q.N}{e^2(N-1)+Z^2.p.q}$$

Where n is the sample size, Z is the confidence level, 95% score, which is 1.96, p is a sample proportion = 0.1, q = 1-p, where q is equal to 0.9, and e is the sampling tolerable error, which is 0.05, and N is the size of the sampling population. The sampling population was 900 when computing the above formula, given the sample size (n) = 119.9945, approximation of it = 120. A population of 900 individuals was a record of vegetable growers in Tabora Municipality

$$n = \frac{1.96\ x\ 1.96\ x\ 0.1\ x\ 0.9\ x\ 900}{0.05\ x\ 0.05(900\ -1)\ +1.96\ x\ 1.96\ x\ 0.1\ x\ 0.9}$$

$$n = \frac{311.1696}{2.5932}$$

n= 120

Furthermore, a distinct sampling strategy was used for the FGDs and KIIs due to the unique characteristics of the participants. Purposive sampling was used to choose 24 participants in vegetable growing villages for the focus group discussions (FGDs) who had a range of experiences in vegetable growing. These individuals were chosen based on their involvement in vegetable gardening and their readiness to provide in-depth information. Similarly, purposive sampling was used to select the key informants of 12 people, based on their jobs and areas of expertise. These included Ward Agriculture Extension Officers, representatives from the Municipal Agriculture, Livestock, and Fisheries Officer.

3.4 Data Collection Methods

The study adopted a mixed method approach for data collection whereby quantitative and qualitative data were collected. Since mixed method approach combines the best features of both quantitative and qualitative research methodologies, it allows for richer, more verified results and offers a more thorough knowledge of a study problem. In this study, the quantitative data were collected using household questionnaires which were constructed and designed purposely to gather information toanswer the study questions. The questions asked included demographic and socio-economic characteristics of the households, income sources, experience in farming, assets owned, type of vegetable and other crop production, amount harvested, earning from sales of vegetables, and earning from other major sources of income such as sales of crops other than vegetables.

Qualitative data were gathered using a checklist of questions using in-depth key informant interviews (KIIs) and focus group discussions (FGDs) approaches. A total of 24 vegetable growers were involved in FGD. Each FGD involved 12 respondents. This made a total of two FGDs with 12 individuals in Itagavillage and 12 individuals in Inala village. The FGD comprised of 6 youth, and 18 elders, with 11 women and 13 men. Further, the KII comprised four extension officers, two wards' leaders, two village leaders, two traders, and two buyers in the market. The qualitative data collected included Agricultural practices, socio-economic factors, and access to agricultural extension services. In addition, the review was done on published materials, which included books, journal papers, organizational reports, and academic dissertations, to identify and bridge the research gaps based on the study's objective. The net income from vegetable and other crop production was computed by subtracting production costs incurred in production from the total income generated from vegetable production.

3.5 Data Processing and Analysis

In this study, quantitative data were coded, entered, cleaned, and analyzed using Statistical Package for Social Sciences (SPSS). Descriptive statistics and cross-tabulation were conducted to generate tables and percentages, allowing for the examination of relationships and associations between variables. SPSS has a Quantitative Analysis Technique in Means Comparison (QATMC) where a comparison of means for different groups was performed. In QATMC, vegetable production, other crop production and non-farm activities were treated as groups and were assigned discrete values and incomes from the groups were assigned as continuous variables. In using QATMC, average incomes for vegetable production, other crop production and non-farm activities for the growing seasons 2021/2022, 2022/2023 and 2023/2024 were computed. For the purpose of assessing the contribution of vegetables to household income, results from QATMC in the SPSS were then summarized in tables and charts using Excel.

Thematic analysis was used to analyze qualitative data because it offers a thoroughly qualitative and complete explanation of data [28]. For this study, qualitative data from in-depth interviews and focus group discussions were read for familiarization, coded, organized into themes, reviewed, defined, named, and then written up. Content analysis was also employed to analyze the data. In order to

provide a thorough picture of family income sources and the significance of vegetable production, the integration of both quantitative and qualitative data was crucial in this study.

To ensure the reliability and validity of the results, data triangulation was used. The cross-study verified its findings by using a variety of techniques (such as surveys, and focus groups) and key informants (agricultural extension workers), which decreased possible biases and boosted trust in the conclusions made. The qualitative accounts corroborated and strengthened the quantitative findings. The triangulated method improved the study's overall validity by offering a comprehensive view of how contextual variables influence livelihood options and how vegetable production affects family income.

4.0 RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of Vegetable Growers

4.1.1 Demographic characteristics

The demographic analysis of vegetable growers in Tabora Municipality revealed that a significant majority, 64.2%, were male, while 35.8% were female (Table 1). This disparity indicates a higher male participation in vegetable gardening, aligning with the findings of [29], which suggested that men tend to be more engaged in vegetable production and related value chains than their female counterparts. This may be explained by the cultural and socioeconomic norms prevalent in the area, where women are more likely to take on caregiving responsibilities or perform less physically demanding jobs. In contrast, males are more likely to do the more labor-intensive duties associated with agriculture. The low female participation rate may also be related to women's time and ability being diverted from producing vegetables to other income-generating activities or household duties. The age distribution among respondents indicated that 40.83% fell within the 36–45 age group, 22.5% aged 26–35, and 21.7% in the 46–55 age range. The observation that most of farmer had age between 36-40 may be explained as during this age, farmers are at the age of their physical and financial potential and thereby engage more in productive ventures. Compared to younger or older farmers who may not have the financial stability to engage in farming, these farmers are likely to have more farming experience and are more open to implementing new agricultural technology. The literature supports this observation, asserting that farmers in this age bracket are generally more responsive to agricultural practices than younger farmers under 30 or older farmers above 60 years [30].

Regarding educational attainment, the majority (83.3%) of the vegetable growers possessed primary school education, whereas a smaller proportion had secondary (8.3%), college (5.8%), or university education (2.5%). The large number of respondents with primary school education is due to the fact that primary school education is compulsory in Tanzania, and the government enacts laws against those who ignore primary school education. Previous studies have highlighted the importance of education, noting that educated farmers have greater access to essential resources such as markets, technology, information, and finance [31], [32], [33].

Additionally, the marital status of respondents revealed that 82.5% were married, indicating that most vegetable farmers in Tabora Municipality bear family responsibilities that motivate their engagement in vegetable production. The findings of [34] emphasized that married individuals often benefit from collaborative efforts with their partners, which can enhance their success in agricultural endeavors. In terms of farming experience, nearly half (55.0%) of the respondents reported having over 10 years of experience, which underscores their familiarity and competency in vegetable production.

Table 1: Respondents' demographic data (N = 120),

	Ward							
	Ndevelwa		Misha		Kabila		Overall	
Demographic data	N	%	N	%	N	%	N	%
1. Respondent Sex								
Male	24	60.0	21	52.5	32	80.0	77	64.2
Female	16	40.0	19	47.5	8	20.0	43	35.8
2. Respondent Age Groups								
<26	4	10.0	2	5.0	3	7.5	9	7.5
26 – 35	8	20.0	8	20.0	11	27.5	27	22.5
36 – 45	18	45.0	13	32.5	18	45.0	49	40.8
46 – 55	8	20.0	13	32.5	5	12.5	26	21.7
> 55	2	5.0	4	10.0	3	7.5	9	7.5
3. Respondent Education								
Primary	31	77.5	32	80.0	37	92.5	100	83.3
Secondary	5	12.5	3	7.5	2	5.0	10	8.3
College Education	3	7.5	3	7.5	1	2.5	7	5.8
University level	1	2.5	2	5.0	0	0.0	3	2.5
4. Respondent Marital Status								
Married	28	70.0	35	87.5	36	90.0	99	82.5
Single	3	7.5	3	7.5	2	5.0	8	6.7
Widow	1	2.5	2	5.0	0	0.0	3	2.5
Divorced	2	5.0	0	0.0	2	5.0	4	3.3
Separated	6	15.0	0	0.0	0	0.0	6	5.0
5. Experience in Farming in Years								
2 – 5	6	15.0	6	15.0	14	35.0	26	21.7
6 – 10	15	37.5	8	20.0	5	12.5	28	23.3
> 10	19	47.5	26	65.0	21	52.5	66	55.0

Source: Field Survey 2024

4.1.2 Distribution of respondents by land size ownership

The land size owned by respondents participating in this study exhibited significant variability across the wards, as presented in Table 2. The average land size owned by farmers across the surveyed areas was 6.4 acres. When broken down by wards, farmers in Ndevelwa owned an average of 7.0 acres, while those in Misha and Kabila reported average land sizes of 6.7 acres and 5.4 acres, respectively. Notably, N=45 % of the respondents in both Ndevelwa and Misha wards indicated owning between 3 and 5 acres of land, whereas 37.5% in Kabila ward possessed less than 2 acres. These findings suggest that less than half of the respondents (N= 40.0%) in the surveyed area owned between 3 and 5 acres of land. The differences in land ownership across wards could indicate the geographical and economic differences, but farmers in Ndevelwa and Misha wards, on average, have larger plots of land.

The implications of these findings are profound, as they show that most smallholder farmers in the study had limited access to and ownership of land, which was crucial to production. This aligns with the assertions of [35], who noted that land is a fundamental resource for vegetable production. Furthermore, the study by [36] highlights the correlation between farm size and agricultural productivity, indicating that smaller and fragmented land holdings can limit the potential for increased agricultural output. Smallholder farmers are often constrained by their land size, impacting their ability to invest in better farming practices, technology, and crop diversification. As illustrated in the study, smaller landholdings may hinder farmers' potential to maximize productivity, leading to lower incomes and increased vulnerability to market fluctuations and environmental

changes. Given that land ownership is closely linked to food security and rural livelihoods, it is crucial to explore interventions that can enhance access to land and promote efficient land use practices among smallholder farmers in the villages.

Table 1: Respondent's farm size in acres in the vegetable producing Wards in Tabora MC (N= 120)

	Ndevelwa		Misha		Kabila		Total	
	N	%	n	%	N	%	N	%
≤ 2	4	10.0	7	17.5	15	37.5	26	21.7
3 – 5	18	45.0	18	45.0	12	30.0	48	40.0
6 – 10	15	37.5	10	25.0	9	22.5	34	28.3
11 – 15	1	2.5	2	5.0	2	5.0	5	4.2
> 15	2	5.0	3	7.5	2	5.0	7	5.8
Average land size in acres	7.0		6.7		5.4		6.4	

Source: Field Survey 2024

4.2 Area Allocated for Vegetable Production Ward-wide

Results in Figure.3 illustrate the trend of land allocated for vegetable production over three consecutive growing seasons, (2021/2022 to 2023/2024). The overall area dedicated to vegetable production in the study area showed a modest increase, starting from 0.44 acres to 0.48 acres. This could have been due to a growing consumer demand for vegetables, advantageous market conditions, and access to agricultural inputs among many others. Respondents in the study area progressively increased their commitment to vegetable growing, as seen in acreage allotted for vegetable production over the course of the three growing seasons. Notably, in Kabila ward, where 37.5% of the respondents owned less than 2 acres of land, the area allocated for vegetable production declined from 0.57 acres to 0.50 acres which indicated a reduction in the intensity of land use for vegetable production.

In contrast, Misha and Ndevelwa wards experienced increased (figure. 3) in the sizes of land allocated to vegetable production, The mixed trends observed across the wards implied that some respondents adopted more efficient land-use practices, while others ma faced challenges that hindered their ability to allocate adequate land for vegetable growing. The overall findings underscore a limited proportion of land being allocated for vegetable production, highlighting the necessity for strategies aimed at increasing land use efficiency. Expanding land area for vegetable production is critical for achieving economies of scale, as noted by [37], who argued that plot expansion can lead to increased agricultural economies of scale, thereby enabling smallholder farmers to enhance their profitability while simultaneously reducing production costs.

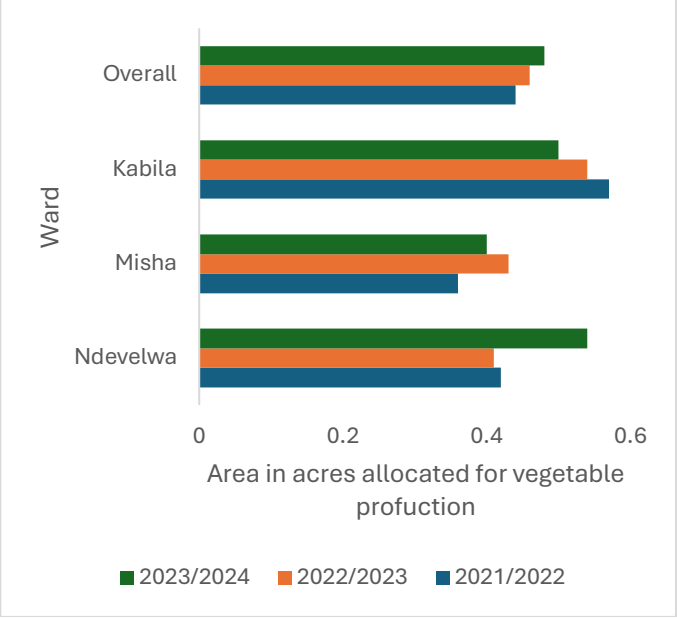


Fig. 3: Area allocated for vegetable production in three wards

4.3 Major Vegetable Types

The primary vegetables cultivated in the study area included tomatoes, cabbage, green peppers, green tomatoes, Chinese vegetables, and cucumbers. Figure. 4 show that the area allocated for tomato production significantly surpassed that of other crops during the 2023/2024 growing season. The significant expansion of agricultural acreage devoted to tomato cultivation in the 2023–2024 growing season indicated the crop's significance as a cash crop. The reason for this tendency was high demand for tomatoes in the market. Hence, the land allocated for tomatoes increased compared to the previous two growing seasons (2021/2022 and 2022/2023), which underscored its growing importance in the local economy.

In contrast, the area allocated to Chinese, Amaranths, and Green pepper production fluctuated in the 2022/2023 growing season. Additionally, cabbage production saw the largest allocation of land in the 2021/2022 season, with subsequent years showing reduced areas. The land allocated to green pepper production also fluctuated, being more intensive in 2022/2023 season compared to the other two seasons. The decreasing amount of land devoted to Green pepper, Amaranth, and Chinese vegetables in the 2023–2024 growing season pointed to a change in farmer priorities, as well as shifting customer tastes. Respondents may have overestimated the viability of these crops due to their early success in 2022–2023 season. Farmers must adjust to market signals and consumer preferences, as seen by the finding of the 2021–2022 season with land allocation to cabbage production, which declined in subsequent years. This variation could be the result of difficulties in preserving crop quality or the competitiveness of cabbage in relation to others profitable vegetables such as tomatoes.

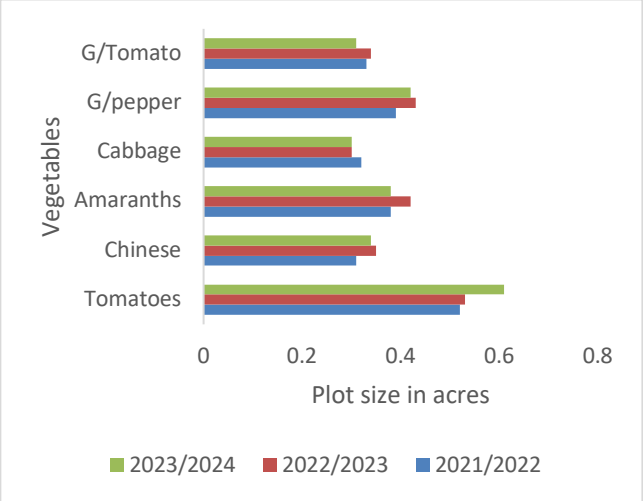


Fig. 4: Areas allocated for cultivation of major vegetable

The observed changes in land distribution for various vegetables over the three years indicated that farmers had made strategic cultivation choices influenced by crop performance, profitability, and market demands. The preference for tomato cultivation over other vegetable crops highlights shifting agricultural priorities and trends. During focus group discussions (FGDs) conducted in selected villages, respondents reported a steady increase in the area under tomato cultivation. This trend is attributed to the crop's rising market value and the adoption of irrigation practices as a climate change adaptation strategy.

These findings align with the study by [38], who documented a surge in tomato production in Tanzania, driven by high market prices in urban areas. On the other hand, the varying growing of Cucumbers, Green pepper, Chinese, and Cabbage suggested a dynamic farming environment, where farmers adjust their crop selections based on market trends and environmental conditions. Such patterns emphasized the importance of monitoring environmental variables and market dynamics to understand and anticipate shifts in crop production strategies effectively.

4.4 Vegetable Production

Figure 5 illustrates the total production of the six major vegetables cultivated in the study

area over three growing seasons. The overall production of vegetables showed a notable increase in the 2023/2024 growing season, reaching a total of 222 tons. This marks a substantial rise compared to 166 tons produced in 2022/2023 season and 148 tons in 2021/2022 growing season. Specifically, the total production from the surveyed area over the three years was recorded as follows: 148 tons in 2021/2022, 166 tons in 2022/2023, and 222 tons in 2023/2024, resulting in a cumulative total of 536 tons.

The notable surge in vegetable output during the 2023/2024 growing season may be attributed to two factors: the adoption of effective farming techniques by farmers and the potential growth in market demand for these products. It is possible that farmers adopted better agricultural methods, accessed to better seeds, and superior resource management strategies since output increased from 148 tons to 222 tons in only two years. This upward trend in local vegetable production mirrors a broader global increase in vegetable output, which rose from 446 million tons over the past two decades to 1.128 billion tons by 2020[39]. Similarly, in Africa, vegetable production expanded from 44.4 million tons to 85.7 million tons during the same period [39]. Despite the increase in local production, it remains relatively small when compared to national, regional, and global levels. For instance, the vegetable production in the study area for the 2021/2022 season, of 148 tons, constituted a mere 0.005% to the national vegetable production, highlighting the limited scale of operations in the region.

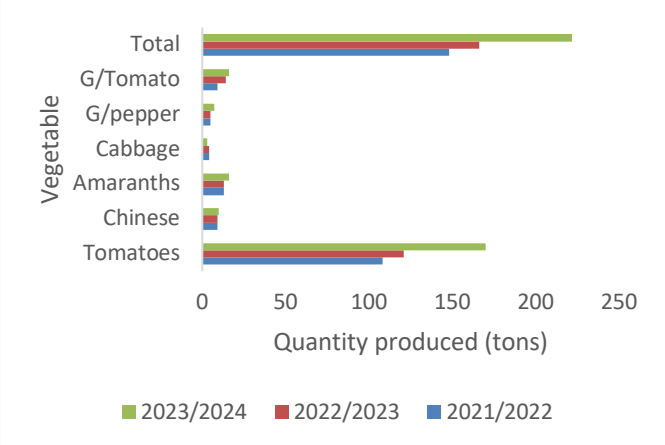


Fig. 5: Quantity of vegetables produced (in tons)

The findings indicate that while local production is on the rise, it still falls significantly short of the potential contributions that smallholder farmers could make to national and regional food security. Factors such as limited access to inputs, market information, and financial resources may contribute to this disparity. To capitalize on the increasing production trends, it is imperative to implement support mechanisms that enhance farmers' capacity to increase their output sustainably.

4.5 Average Vegetable Production Cost in Tanzanian Shillings

The results presented in Figure 6 depict the costs associated with vegetable production in Tanzanian shillings (TZS) for the cultivated plots, encompassing various farming operations and inputs such as cultivation, terrace management, manure, seeds, fertilizers, pesticide application, weeding, and irrigation. Analysis revealed a consistent upward trend in production costs across the growing seasons of 2021/2022, 2022/2023, and 2023/2024 for each ward in the study. Overall, the total production costs increased from 1.04 million TZS in the 2021/2022 growing season to 1.11 million TZS in the 2023/2024 growing season, reflecting a 6.7% increase over three years.

A number of variables, such as inflation, growing costs for labor, fertilizer, seeds, and pesticides, may be attributed for the steady growth in expenditures. The noted rise in production costs emphasized how farmers who cultivated vegetables increasingly invested. The expenses increased from 1.04 million TZS to 1.11 million TZS, indicating that farmers are spent more on operations and necessary supplies to sustain production

Furthermore, data indicate a direct relationship between plot size and production costs. Specifically, a 1% increase in plot size is associated with a 0.74% increase in production costs, alongside a 9% rise in income. This relationship underscores the economic dynamics of land utilization in

vegetable farming, where larger plots may facilitate greater production but also incur higher operational costs.

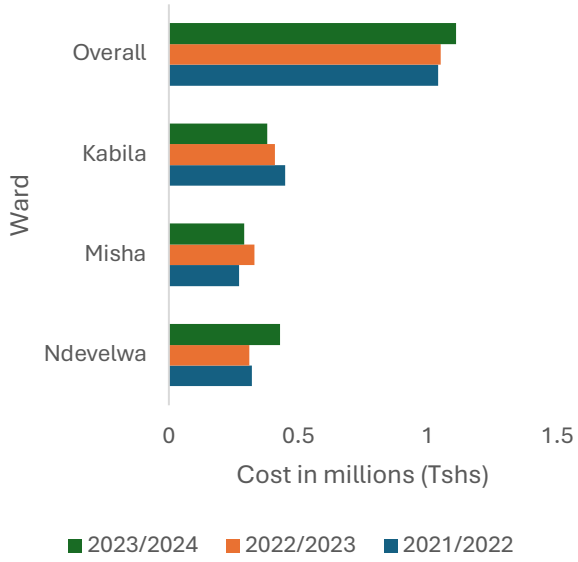


Fig. 6: Vegetable production cost

Qualitative findings from farmers' interviews further highlighted the rising costs of vegetable production, with significant concern regarding the escalating expenses associated with pesticide applications to combat diseases and pests in vegetables. Key informants noted that more than 80% of vegetable growers continued to use traditional ways, which exacerbated their vulnerability to rising costs associated with climate change impacts.

These findings corroborate the withthose by [40], which identified that increases in production costs are closely linked to fluctuations in input prices, labor costs, land prices, energy expenses, and transportation costs. The combination of these factors illustrate the multifaceted challenges that smallholder farmers face in maintaining profitability while striving to enhance production efficiency. As such, the upward trajectory of vegetable production costs in the study area necessitates urgent attention to mitigate their impact on farmers' livelihoods. Strategies to reduce production costs, such as promoting access to affordable inputs, encouraging the adoption of modern agricultural technologies, and improving market access, was vital for enhancing the sustainability and profitability of vegetable farming in study area.

4.6 Income from Vegetable Production

Figure 7 shows the average income generated from the production of different vegetables during the 2021/2022, 2022/2023, and 2023/2024 growing seasons. The income generated from tomato production was far higher than the income generated from other vegetables in both 2021/2022, 2022/2023, and 2023/2024 seasons. With exceptional G/Tomato and eggplant, the income generated from each specific vegetable showed an increasing trend, with higher income being generated in the 2023/2024 growing season as compared to the other growing seasons (2021/2022, and 2022/2023) (Figure 7).

A number of reasons, such as enhanced market accessibility, enhanced farming methods, and rising consumer demands for vegetables, contributed to the observed expansion of profitability. Respondents seemed to benefit from their investments in growing vegetables. The findings are in line with those by [41] who emphasized that, despite the challenges facing tomato growers, significant profit can be generated from tomato production which attracted more.

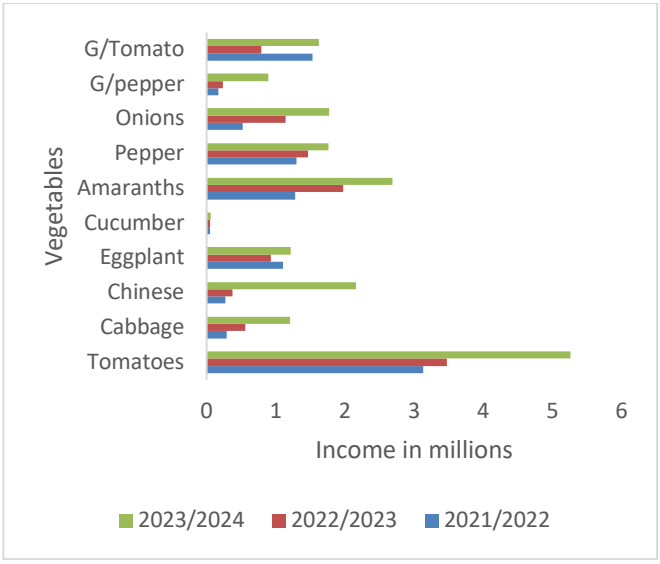


Fig. 7: Income earned from vegetable production

The study findings indicated that the overall income grew from TZS 6.64 million in 2021/2022 to TZS 12.03 million in the 2023/24 growing season per household. This was a 81.2% increase in income from vegetable

production over the three years. While vegetable income increased from TZS 6.64 million in 2021/2022 to TZS 12.0 million in 2023/2024 growing seasons, plot size increased (in acres) from 0.44 to 0.48 equivalent to an increase of 9.81%. These results implied that an increase in plot size by 1% yielded a rise of 9% in the income from vegetable production. This increase of income is an incentive to farmers that encourages and motivates them to pay more attention to vegetable production [42].

The study findings from qualitative data highlighted that increasing income from vegetable production was mainly associated with the availability of inputs and improved farming methods. Furthermore, instead of depending exclusively on increasing plot size, respondents said they could optimize productivity if training in modern techniques was offered. Agricultural extension officers confirmed that focused interventions and ongoing technical support were critical to increase yields. Equally, [43] highlighted that vegetable production is an important source of livelihood and household income for smallholder farmers and surrounding communities.

Furthermore, the results in Table 3 indicate that net income rose from TZS 5.60 million in the 2021/2022 growing season to TZS 10.93 million in the 2023/2024 growing season, an increase of 95%. This implied that in Tabora Municipality, a unit increase of 1% of plot size allocated for vegetable production increased 10.5% of net income from vegetable production. For example, one respondent stated, *"Expanding my plot by just a small margin has made a big difference in my earnings, especially now that I know how to get the most out of my land."* The other commented, *"With the knowledge we've gained on better farming techniques, even a slight increase in land area results in a much higher income."*

Furthermore, extension officers who participated as key informants said that *"farmers who slightly expanded their plots and improved their farming methods saw their net incomes rise."* These revelations demonstrated how the village's net earnings had increased as a result of improved farming methods and plot increases.

Table 2: Income from vegetable production (in million TZS)

		Growing Seasons		
Ward	Variable	2021/22	2022/23	2023/24
Ndevelwa	Income	3.29	3.48	7.28
	Production cost	0.32	0.31	0.43
	Net income	2.97	3.17	6.85
Misha	Income	1.8	1.84	2.97
	Production cost	0.27	0.33	0.29
	Net income	1.53	1.51	2.68
Kabila	Income	1.55	2.1	1.78
	Production cost	0.45	0.41	0.38
	Net income	1.1	1.69	1.40
Total	Income	6.64	7.42	12.03
	Production cost	1.04	1.05	1.10
	Net income	5.6	6.37	10.93

Source: Field Survey 2024

The increase of net income from vegetable production created an opportunity for more farmers to engage in vegetable production. Given that vegetable crops provide faster returns than other agricultural goods, their attractive profit margins and increased market demand were probably the main reasons for the 95% rise in net revenue from vegetable production. This notable increase in profit may also have been attributed to enhanced market channels, improved input availability, and improved agricultural practices, which in turn attracted more farmers to vegetable production. A study by [44], found that smallholder farmers engaged in vegetable gardening had a significant increase in income. Vegetable gardening helps to provide jobs and reduce poverty, especially for women and young people [45], [46]. Furthermore, [47], claimed that smallholder farmers used vegetable gardening as their main business if they had easy access to resources including land, credit and inputs. The sector presents opportunities for attracting the young and educated unemployed if cultivable lands, inputs, credit and social overheads can be provided [47].

On the contrary, [48], discovered that high input costs and restricted market access can make vegetable gardening less profitable, which may discourage young, educated jobless people from pursuing the industry. Furthermore, [49] contended that there are substantial hazards associated with the price volatility of vegetables and their susceptibility to climate change, which may reduce the appeal of vegetable growing as a sustainable livelihood approach.

4.7 Other Livelihood Strategies

Apart from vegetables, other livelihood strategies contribute to household income encompassing the production of other crops and non-farm activities. Crops such as groundnuts, maize, beans, cassava, and sunflower were grown by the interviewed farmers. Furthermore, vegetable farmers in the study are did other non-farm activities such as trading, entrepreneurship and sewing. This implied that, respondents had diversified sources of income which had helped them during the off-season.

4.7.1 Production of Other Crops

The findings in Table 4 show notable differences in land allocation, gross revenue, production cost, and net income in the three wards. However, data for income in the 2023/2024 growing season is missing because when the study was conducted there was no harvest yet.The land allocated for the production of crops other than vegetables was1.96 acres higher in Kabila ward followed by Misha ward (1.44 acres), and Ndevelwa

ward (1.30 acres), respectively. The gross income from the production of other crops for Kabila (1.80 million) and Ndevelwa (1.79 million) was nearly similar despite the differences in land allocation, while for Misha ward (0.82 million) was low. The disparities in net income, gross revenue, and land distribution among the three wards demonstrated different agricultural practices, which have important ramifications for resource allocation and policy formation.

Kabila ward may benefit from more diverse and maybe more effective farming practices, as evidenced by the ward's increased land allotment for non-vegetable crops and its comparatively high gross income. However, Misha ward's lower gross income despite having a considerable amount of land allocated to it suggests that there may be inefficiencies or less viable crop selections, which emphasizes the need for focused improvements in input access or agricultural practices. Further, the observed disparity in income implies that variables outside the extent of land, such as crop productivity or market values, have a noteworthy influence on the revenue generated from agriculture [50]. These results imply that, to enhance agricultural output and income generation in each ward and guarantee that every area may realize its full agricultural potential, specific interventions and resource allocation plans are required.

Furthermore, Kabila ward had the highest production cost (1.06 million) followed by Misha ward (0.86 million) and Ndevelwa ward (0.62 million), respectively. In terms of net income, Ndevelwa ward (1.17 million) out performed Misha (-0.04 million) and Kabila (0.74 million). This suggested that the increased profitability of Ndevelwa ward was a result of its effective resource use. The overall plot size, gross income, production cost, and net income from the production of other crops were 4.70 acres, 4.41, 2.54, and 1.91 million respectively. These results emphasize the necessity of production cost control and effective resource use for generating larger net earnings.

The three wards' different net incomes, gross revenues, and land distributions indicated the different farming techniques and resource use. The higher gross revenue of Kabila ward and the larger amount of land set up for non-vegetable crops suggesed varied incomes. In contrast, Misha ward's lower gross revenue highlighted the need for specific interventions to increase input availability and better agricultural methods. The observed inequalities in incomes show how important elements can influence agricultural revenue. Thus, to fully realize each ward's agricultural potential, specialized interventions and resource allocation plans are necessary.

Table 3: Income from other crops production (in million TZS)

		Growing Seasons		
Ward	Variable	2021/22	2022/23	2023/24
Ndevelwa	Plot size in acres	1.30	1.35	1.52
	Income	1.79	2.49	
	Production cost	0.62	0.65	0.81
	Net income	1.17	1.84	
Misha	Plot size in acres	1.44	1.52	1.78
	Income	0.82	1.20	
	Production cost	0.86	0.89	1.08
	Net income	-0.04	0.31	
Kabila	Plot size in acres	1.96	2.03	2.00
	Income	1.80	2.35	
	Production cost	1.06	1.09	1.05
	Net income	0.74	1.26	
Total	Plot size in acres	4.70	4.90	5.30
	Income	4.41	6.04	
	Production cost	2.54	2.63	2.94
	Net income	1.91	3.41	

Source: Field survey 2024

The average income generated from cultivation of crops other than vegetables during the 2021/2022 and 2022/2023 growing seasons is portrayed in Figure 8. High income was generated from tobacco production in both 2021/2022 and 2022/2023 compared to the remaining crops. Furthermore, the income generated from each specific crop (beans, groundnuts, paddy, sunflower, sweet potatoes, tobacco, cassava, maize) showed an increasing trend, with high income being generated in the 2022/2023 growing season as compared to 2021/2022 (Figure 8).

Revenue from other crops such as tobacco, beans, groundnuts, maize, sweet potatoes, cassava, sunflower, and paddy rose, this suggesting that both agricultural production and market conditions had improved. This upward trend indicated that farmers used more farming technologies. The potential for crop production diversification was shown by the high revenue from these crops in the 2022/2023 season as compared to the previous year. This could have improved food security and supported livelihoods.

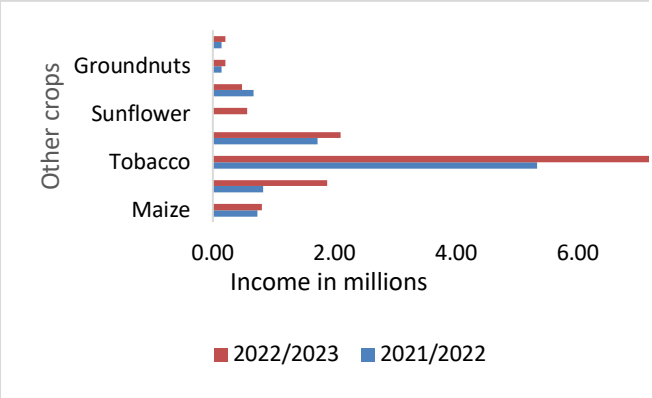


Fig. 8: Income earned from crops other than vegetables

4.7.2 Income from non-farm activities

Results in Figure 10 show that livestock was the most preferred type of non-farm activity in the study area followed by business, salaries and other sources. The average income earned from salary (formal and casual employment) was high as compared to income from businesses and livestock keeping (Figure 9). A variety of sources of income demonstrates the adaptive measures that rural households used to improve their financial stability and reduce the risks that come with being dependent on agriculture. Additionally, the presence of businesses and livestock keeping implied that were vital to the local economy, offering extra sources of income. These findings align with a study conducted by [51] who reported that, while most rural households are involved in agricultural activities as their main source of livelihood, they also engage in other income-generating activities to augment their main source of income.

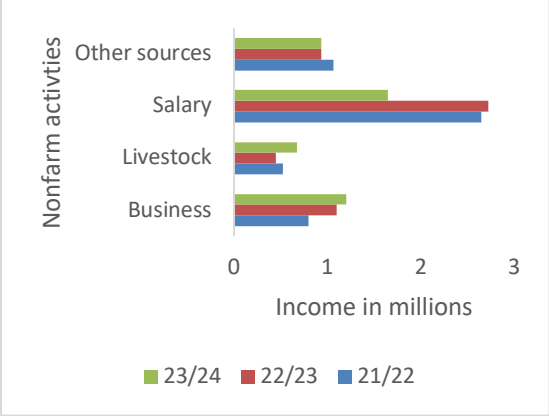


Fig. 9: Respondents' Income earned from nonfarm activities

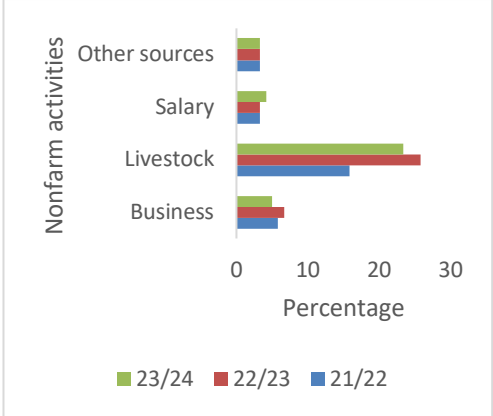


Fig. 10: Respondents' Involvement in nonfarm activities

4.8 Contribution of vegetable production to household income

Results in Table 5 show that, more income from vegetable production compared to other sources. In the 2021/2022 growing season, the overall income from vegetables was TZS 5 595,740 while from other crops was TZS 1,913,100 and TZS 2,675,222 from nonfarm activities. The same trend occurred in the other two vegetable growing seasons. Results further show contribution in percent for each source, location and growing season.

Numerous variables may have contributed to this observation. Firstly, farmers were encouraged to devote more resources to vegetable production due to the growing demand for fresh vegetables. Vegetable growers profited from the growing demand for fresh vegetables brought about by rising urbanization and population growth. Furthermore, farmers achieved returns faster with many vegetables due to their shorter growing cycles than staple crops, which improved cash flow and stabilized family income.

Furthermore, access to improved agricultural inputs like high-quality seeds and fertilizers and advancements in agricultural technologies were responsible for the rise in revenue from vegetable production. It is possible that farmers had adapted more productive farming methods, producing better-quality food with larger yields and higher market prices [53], [54]. The availability of agricultural training programs and extension services also contributed to providing farmers with the information and abilities needed to maximize output. Additionally, by combining vegetable growing with other revenue-generating ventures, families were able to diversify their sources of income, lessening their reliance on volatile markets and bolstered the agricultural economy.

Table 4: Net Income from vegetables as compared with income from other sources

Ward	2021/2022		2022/2023		2023/2024	
	Income	Percent	Income	Percent	Income	Percent
Ndevelwa	2 972970	53.1	3 174 300	49.8	6 854 020	62.7
Misha	1 526 590	27.3	1 517 520	23.8	2 675090	24.5
Kabila	1 096 180	19.6	1 688 530	26.5	1 395 310	12.8
Total	5 595 740	100	6 380 350	100	10 924 420	100
2. Net Income from other crops						
Ndevelwa	1 170 000	61.3	1 840 000	54		
Misha	0	0	310 000	9		
Kabila	740 000	38.7	1 260 000	37		
Total	1 910000	100	3 410000	100		
3. Income from non-farm activities						
Ndevelwa	360 000	14.0	354 545	15.9	425 000	15.9
Misha	936364	36.4	661 111	29.7	815 385	30.6
Kabila	1276923	49.6	1 21 111	54.4	1 427 778	53.5
Total	2 573287	100.0	2 226 768	100.0	2 668162	100.0

Source: Field survey, 2024

The results indicated an increasing trend in the income generated from vegetable production during the three consecutive growing seasons. In the 2021/2022, 2022/2023, and 2023/2024 growing seasons, the incomes from vegetables were TZS 5,595,740, 6,380,350, and 10924100, respectively. The increasing trend was also observed in revenue generated from crops other than vegetables. Furthermore, the percentage contribution of vegetables to household income was higher (80.4%) during the 2023/2024 growing season compared to the 2021/2022 and 2022/2023 growing seasons, which were 55.5% and 53.1%, respectively.

The results of this study underscore the significance of vegetable cultivation as a means of augmenting family earnings and strengthening food security within rural communities. These results align with those of [8], who reported that vegetable production significantly contributed to national agricultural income in 2020-2021, contributing AUD 4.04 billion, equivalent to $2.95 billion in Australia. The results are consistent with the study conducted in Nigeria by [10] who pointed out that vegetable production contributes over 80% of the household income. Also, this study aligns with [17], which reported that vegetable production contributed significantly to household income, with over 60%, other crops contributed 20.9%, petty business 8.6%, and livestock production 7.4%.

Table 5: Overall comparison of income from vegetables and other sources

Source	2021/2022		2022/2023		2023/2024	
	Mean	Percentage contribution	Mean	Percentage contribution	Mean	Percentage contribution
Vegetable	5 595 740	55.5	6 370 350	53.1	10 924420	80.4
Other crops	1 910000	19.0	3 410 000	28.4	0	0.0
Nonfarm	2 573 287	25.5	2 226 768	18.5	2 668 162	19.6
Total	10 079 027	100	12 007 118	100	13 592 582	100

Source: Field survey, 2024

Furthermore, Table 7 below shows the t-test statistics of the mean revenue from vegetables and other sources at p=0.05. Mean income from vegetables (1.99±0.35 million) was significantly higher than mean income (0.91±0.26 million) from different sources (p<0.05). This implied that vegetables in the study area provide more income. This was because vegetables have shorter growing periods, high market demands, and superior profit margins [5].

Also, vegetables were harvested several times a year and can react quickly to market demand; their shorter growing seasons might result in higher pricing for fresh food. Vegetables are also often more profitable for farmers to grow than other agricultural goods due to their higher profit margins. Fresh vegetables consistently have high consumer demand, which supports their economic feasibility.

Table 6: Mean comparison of income in million Tzs using the t-test at p > 0.05

Source of income	Mean income	Std. Error	t-statistic	p value
Vegetables	1.99	0.35	2.487	0.032
Other sources	0.91	0.26		

5.0 Conclusion

This study highlighted the significant role of vegetable gardening in enhancing household income in rural wards in Tabora Municipality, where it contributed over 50% to total household income. Despite its importance, the findings indicate that a limited proportion of land is allocated to vegetable production, resulting in suboptimal yields. This situation constrained the potential income from vegetable gardening and diminished its overall contribution to household financial stability.

Increase the area dedicated to vegetable gardening to enhance vegetable yields and, consequently, their impact on household income. Additionally, the adoption of recommended agronomic practices is vital in maximizing production. Expanding and improving irrigation infrastructure is imperative, as it would empower farmers to cultivate larger plots, thus increasing their capacity for vegetable production.

The study has also revealed a predominance of tomato cultivation among farmers, with a significant proportion of household income derived from the crop. However, despite the high level of tomato production, the yields are substantially lower than global averages, indicating a gap to be addressed. This discrepancy underscores the necessity for further research into the factors affecting tomato production in Tabora Municipality.

The implications of these findings are significant for local agricultural policy and support systems. Therefore, by understanding which crops are prioritized and why, stakeholders can tailor their interventions, such as providing access to irrigation, improving market linkages, and offering technical support for crop management to better align with farmers' needs and the evolving agricultural landscape. Strengthening extension services, improving irrigation infrastructure, and providing access to quality seeds and fertilizers could enhance farmers' productivity. Moreover, building market linkages would allow farmers to secure better prices for their produce, encouraging further investment in vegetable farming.

In general, land allocation for vegetable gardening, effective agronomic practices, and improved irrigation systems are needed to boost vegetable yields. Such improvements are essential for increasing the economic benefits of vegetable gardening and ensuring greater financial resilience for households in the study area.

6.0 Recommendations

Based on the findings from this study, the following were the recommendations:

i. The government should implement initiatives to motivate farmers to allocate a larger percentage of their land to vegetable gardening. By promoting the economic benefits of larger plots, the government can help increase vegetable yields, ultimately

enhancing household income and financial stability.

ii. The Government of Tanzania, in collaboration with regional authorities, should prioritize the development and expansion of irrigation infrastructure in rural areas, particularly in Misha, Kabila, and Ndevelwa wards. Improved irrigation systems will enable vegetable growers to cultivate larger areas, thereby increasing productivity and mitigating the risks associated with climate variability.

iii. While farmers currently favour tomato cultivation, extension workers must encourage the cultivation of a broader range of vegetables. Diversifying crop production can enhance household income by reducing dependency on a single crop and spreading financial risk across multiple products. Additionally, the government and agricultural organizations should provide training and resources to support farmers in exploring diverse cropping options.

iv. Further research is warranted to identify and address the factors contributing to the suboptimal production of tomatoes in the region. This research should focus on understanding the underlying causes of low yields and should aim to develop strategies and practices that enable farmers to enhance tomato output to meet international standards.

v. The Government of Tanzania, in collaboration with regional authorities should strengthen agricultural extension services. This is crucial for providing farmers with access to knowledge about best practices in vegetable production. Training programs should be established to educate farmers on modern agricultural techniques, pest management, and sustainable practices that can lead to improved yields and increased profitability.

vi. The government should explore options for providing financial assistance and access to resources for farmers. This may include grants, low-interest loans, and subsidized agricultural inputs, empowering farmers to invest in their operations and adopt new technologies.

7.0 Consent

In compliance with global or academic norms, the author(s) gathered and maintained the written permission of the respondents.

8.0 Disclaimer (Artificial Intelligence)

The author (s) hereby declare that NO generative AI technologies such as Large Language Models (Chat GPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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