Socioeconomic dynamics of tomato trading and the challenges facing small-scale traders in Chinsali District, Zambia

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Socioeconomic dynamics of tomato trading and the challenges facing small-scale traders in Chinsali District, Zambia

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Tomato (*Lycopersicon esculentum* Mill.) trading plays a vital role in supporting rural livelihoods and contributing to household food security. This study examined the socioeconomic opportunities and challenges faced by tomato traders in the district. Primary data were collected through semi-structured questionnaires administered to traders, and descriptive and inferential statistics were used to analyse the data. The majority of traders were women (77.5%), predominantly aged between 20 and 30 years, and more than half (57.5%) had attained primary education. Women were found to be earning more on average than men through tomato trading. Income generation was the primary motivation for engaging in tomato trading (45%), with most traders (70%) relying on personal savings as their main source of start-up capital. The main opportunities identified were high consumer demand (35.4%) and access to new markets (29.2%), whereas poor market infrastructure (28.8%) and high transportation costs (21.2%) were the major challenges. Traders highlighted the need for financial support (53.3%) and improved infrastructure (33.3%) to enhance operations. The results indicated a statistically significant association between education level and weekly income (χ^2 (6) = 37.638, $p < 0.001$). Similarly, a statistically significant association was observed between gender and weekly income (χ^2 (3) = 22.456, $p < 0.001$). Given that tomato traders are predominantly young women with low levels of formal education, the findings suggest that access to credit and vocational capacity-building interventions should be specifically targeted at young and female traders to improve incomes and enhance the sustainability of tomato trading in rural Zambia.

KEYWORDS
food security, *Lycopersicon esculentum*, rural markets, small-scale traders, tomato trading

1 Introduction

Tomato (*Lycopersicon esculentum* Mill.) is the second most consumed fruit globally and one of the most economically significant horticultural crops (Iqbal et al., 2019). It belongs to the Solanaceae family (Zewdie et al., 2022) and serves as a vital source of income, employment, and nutrition for millions of small-scale farmers and traders worldwide. The crop's relatively short growth cycle, high yield potential, and wide range of culinary uses make it a key component of both rural and urban food systems (Salunkhe et al., 1987; Akand et al., 2015). Tomato fruits are rich in essential nutrients, including carotenoids, amino acids, minerals, sugars, vitamins, and dietary fibre, contributing to their high dietary and commercial value (Tolasa et al., 2021). While tomatoes are often considered a high-value crop in developed economies, they form an essential part of the daily diet and income base in developing countries (Meniga, 2014; Mwamba et al., 2025). The horticulture sector, including tomato production and marketing, offers substantial opportunities for women and youth, particularly in rural areas where it generates employment and supports household livelihoods (Bekele et al., 2016). Moreover, the production and marketing of fruits and vegetables are estimated to be twice as labor-intensive per hectare as cereal crops, providing valuable opportunities for smallholder farmers, rural laborers, and the urban poor (Hichaambwa and Tschirley, 2006).

The increasing global demand for food, driven by population growth, places additional pressure on agricultural systems to produce more efficiently and sustainably (Akand et al., 2015; Siankwilimba et al., 2025). The tomato industry forms part of a complex global network involving production, distribution, and trade, where countries with favorable climates and strong agricultural infrastructures dominate. In Africa, the tomato sector has significant potential to boost export earnings and reduce poverty by creating employment and stimulating local economies (Anang et al., 2013). For example, in Ghana, the tomato industry has been recognized as a key driver of poverty reduction and income diversification (Anang et al., 2013). Despite these opportunities, tomato trading faces persistent challenges, including market price fluctuations, inadequate storage and transport systems, and trade barriers that affect smallholder profitability (Hichaambwa and Tschirley, 2010; Shula, 2020).

With rising unemployment in many developing countries, Zambia's abundance of arable and pastoral land presents agriculture as a viable avenue to accelerate economic growth and improve living standards. The economy of Chinsali District remains predominantly agrarian, characterized by limited industrial development and heavy reliance on traditional smallholder farming (Mwamba et al., 2025). Within this context, tomato trading plays a vital role in the local economy by providing income and employment opportunities, particularly for women and youth, supporting household livelihoods, enabling income diversification, and sustaining market activity throughout the year (Fick et al., 2020; Phiri et al., 2020).

Tomatoes are among Zambia's most important horticultural commodities, contributing significantly to both rural livelihoods and urban food supply chains (Musonda and Mwila, 2024; Mwamba et al., 2025). However, despite their economic importance, limited research has examined the socioeconomic dynamics of tomato trading and the challenges faced by small-scale traders, especially in rural districts such as Chinsali. Understanding these dynamics is crucial for developing policies and interventions that strengthen local market systems and promote inclusive rural development. Consequently, this study assessed the socioeconomic opportunities and challenges of tomato trading in Chinsali District, with the aim of generating insights to inform strategies for enhancing market participation, profitability, and sustainability among small-scale traders.

2 Methodology

2.1 Study site

The study was conducted in Chinsali District, located in Muchinga Province, Zambia. Chinsali covers an estimated area of 11,150 km^2 and has a population of 148,997 people, with farming serving as the primary economic activity (Zambia statistic agency (ZAMSTAT), 2022). Tomato production is practiced throughout the year, with the highest production typically occurring during the hot dry season and the rainy season, when warm temperatures and improved water availability support crop growth. Most tomato producers in the district are small-scale farmers, and they are predominantly based in rural areas outside Chinsali town. Chinsali District was selected for this study because it is a major tomato-producing and trading area in the region, with well-established rural markets that support both small- and medium-scale traders. The district's tomato value chain reflects the typical socioeconomic characteristics of tomato trading in the northern part of Zambia, making it suitable for examining trader opportunities and challenges. In addition, the district's accessibility and proximity to the researcher's study site facilitated efficient data collection within the available undergraduate project timeframe (see Figure 1).

2.2 Data collection

In Chinsali District, as in other parts of Zambia, tomato is farmed throughout the year, although the number of individuals participating in tomato farming and trading varies across seasons. Therefore, this study was conducted between June and October 2024, which coincided with the timeframe available for data collection as part of the undergraduate project. This period falls within the dry season in Chinsali, when tomato production is generally lower due to limited water availability and cooler temperatures. Collecting data during this period allowed the study to focus on traders who operate consistently throughout the year, rather than opportunistic traders who engage in tomato trading only during the peak production period in the rainy season. Despite the timing constraints, this approach enabled the researcher to capture a representative sample of active tomato traders and obtain valid insights into their socioeconomic opportunities and challenges. Primary data were obtained through the administration of structured questionnaires to tomato traders, while relevant secondary

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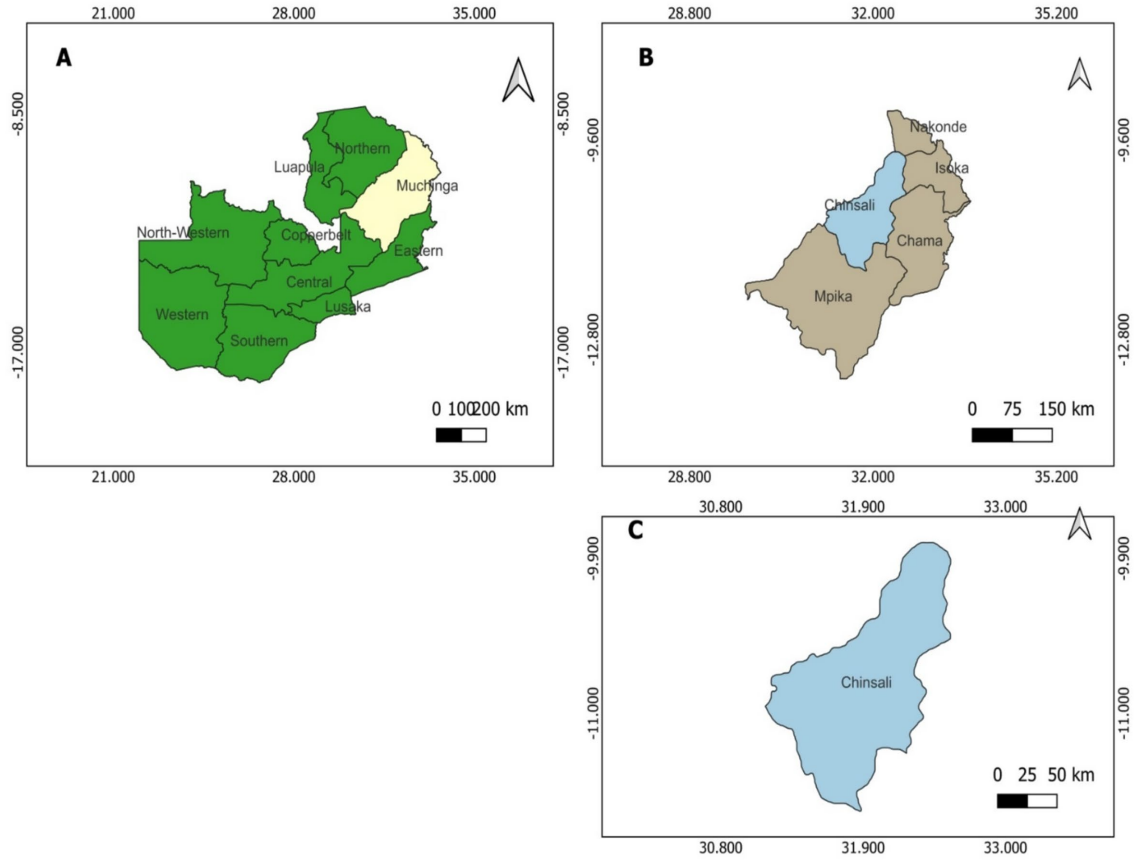

FIGURE 1
Map of Zambia, showing the geographical location of Chinsali district of Muchinga Province. **(A)** Map of Zambia showing Muchinga province (light yellow). **(B)** Map of Muchinga showing Chinsali district (light blue). **(C)** Map of Chinsali district where the study was carried out.

information was sourced from local records and previous studies. Printed hard copies of the questionnaires were used to ensure clarity and inclusiveness for respondents with limited digital literacy. The questionnaires were administered face-to-face to ensure clarity and inclusivity for respondents with limited digital literacy. The questionnaire comprised four distinct sections: Section A captured demographic characteristics, Section B covered business-related information, Section C explored perceived opportunities in the tomato trade, and Section D examined the challenges experienced by traders. Prior to full deployment, the questionnaire was pre-tested among a small group of farmers to assess clarity, relevance, and reliability of the survey items. Content validity was established by evaluating whether the questions adequately covered the study objectives and key indicators identified from the literature. Feedback from the pre-test was used to refine question wording, improve clarity, and ensure consistency of responses. This approach follows established procedures used in similar studies (Muhala et al., 2021; Mphande et al., 2023; Hasimuna et al., 2025a,b). At the time of the study, there were 140 registered tomato traders in the area. Based on this population size, a minimum sample size of 103 was determined using the Equation 1 developed by Krejcie and Morgan (1970), which was also applied by Tonga et al. (2025). To account for potential non-responses or incomplete submissions, the final sample size was increased to 110 farmers. The formula is presented below:

$$s = X^2 NP\frac{1-P}{D^2(N-1)} + X^2 P(1-P) \quad (1)$$

where: s: required sample size; X^2 = the value of chi-square for one degree of freedom at the desired confidence level; N: the population size, P: population proportion (assumed to be 0.50 to maximize sample size); $D^{2:}$ degree of accuracy expressed as a proportion (0.05).

Respondents were initially selected using purposive sampling, targeting traders who were actively engaged in tomato trading and represented different market locations. Snowball sampling was then employed, whereby the purposively recruited traders recommended additional eligible traders for inclusion in the study. Four enumerators, familiar with local languages and the tomato trading context, conducted the interviews. They received 2 days of training covering ethical conduct, questionnaire administration, accurate recording of responses, and handling respondents' queries. Each interview lasted approximately 30 to 40 min, depending on the respondent's availability and depth of information provided. To address non-response bias, enumerators revisited traders who were initially unavailable and no significant patterns of non-response were observed, and the collected data are considered representative of the tomato trading population in Chinsali District, providing a reliable basis for analysis.

2.3 Data analysis

The data collected were entered into Microsoft Excel (Version 16.0) for data management and standardization and then imported into the Statistical Package for the Social Sciences (IBM SPSS, Version 27.0) for statistical analysis. Descriptive statistics,

including frequencies, percentages, charts, and graphs, were generated for variables such as weekly income to summarize the overall distribution of earnings among tomato traders. For examining associations, reported monthly income was used to reduce short-term fluctuations. Monthly income values were categorized into four brackets (ZMK 800, 1,000, 1,500, 2000), and the distribution across these categories was analyzed by gender and age using the Pearson Chi-square test of independence. Where expected counts were small, the Fisher–Freeman–Halton exact test was applied. Statistical significance was determined at $p < 0.05$.

3 Results

3.1 Demographic information

Table 1 presents the demographic characteristics of the respondents, including gender, age distribution, educational attainment, and experience in tomato trading. The majority of respondents were female (77.5%), while male participants accounted for 22.5%. In terms of age distribution, 35% of the traders were aged between 20 and 30 years, followed closely by 32.5% in the 31–40-year age group. Respondents aged 51 years and above constituted 17.5%, while 10% were aged between 41 and 50 years. The youngest group, under 20 years of age, represented 5% of the sample.

Regarding educational background, most respondents (57.5%) had completed primary education, followed by 27.5% who had attained secondary education. A smaller proportion (15%) reported having no formal education. In terms of trading experience, 42.5% of the respondents had been engaged in tomato trading for 1–3 years, whereas 27.5% had 4–6 years of experience. Those with less than 1 year of experience comprised 22.5% of the sample, while only 7.5% reported having traded tomatoes for 7–10 years.

TABLE 1 Demographic information of respondents.

Variables	Category	Percentage (%)
Gender of respondent	Female	77.5
	Male	22.5
Age of respondent	20–30 years	35
	31–40 years	32.5
	41–50 years	10.0
	51 and above	17.5
	under 20	5.0
Level of education	No formal education	15
	primary education	57.5
	secondary education	27.5
Years of tomato trading	1–3 years	42.5
	4–6 years	27.5
	7–10 years	7.5
	less than a year	22.5

3.2 Reasons for tomato trading

The present study explored the motivations behind respondents' involvement in tomato trading (Figure 2). Income generation was the most frequently reported reason, accounting for 45 percent of responses. This was followed by other unspecified reasons at 20 percent. Market availability and market demand were each reported by 17.5 percent of the respondents.

3.3 Sources of capital for tomato traders

Figure 3 presents the sources of capital utilized by tomato traders. A majority of the respondents (70.0 percent) indicated that their capital originated from personal income. This was followed by 17.5 percent of traders who reported receiving grants as their primary source of capital, while the smallest proportion, accounting for 12.5 percent, acquired capital through loans.

3.4 Weekly income distribution of tomato traders

The weekly income levels among tomato traders showed considerable variation (Figure 4). The highest proportion of respondents (30.0 percent) reported earnings between ZMW 101 and 150 per week. This was followed by 27.5 percent who earned less than ZMW 50, and 25.0 percent who reported income within the range of ZMW 151 to 200. The smallest proportion of traders (17.5 percent) earned between ZMW 50 and 100 per week.

3.5 Opportunities perceived by tomato traders

Tomato traders reported various opportunities within the trading environment, including access to storage facilities, improved farming techniques, proximity to production areas, high market demand, access to new markets, and an open market policy facilitating entry. The majority of respondents (35.4 percent) identified high demand for tomatoes as the most significant opportunity (Figure 5). This was followed by 29.2 percent who cited access to new markets, and 15.9 percent who highlighted proximity to tomato farms. Improved farming techniques were mentioned by 9.7 percent of traders, while 6.2 percent noted access to storage facilities. The least cited opportunity, at 3.5 percent, was the presence of an open market policy enabling easier market entry.

3.6 Challenges encountered by tomato traders

Some of the challenges encountered by tomato traders were lack of access to credit, poor market, poor road infrastructure, lack of government support, and price fluctuation as shown in (Figure 6). Poor market infrastructure was the main (28.8%) challenge, this was seconded by 21.2% which was high transportation costs, this was followed by poor road infrastructure with a share of 19.2%, Price fluctuations were noted by 15.4% of the traders, while 6.7% cited a lack of access to credit. Lack of government support was stated by 4.8% of respondents. Furthermore, the least challenges were competition from other traders and issues with shelf life each represented 1.9%.

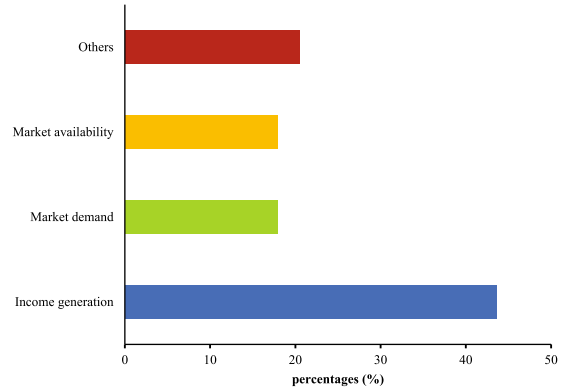

FIGURE 2
Reasons for tomato trading.

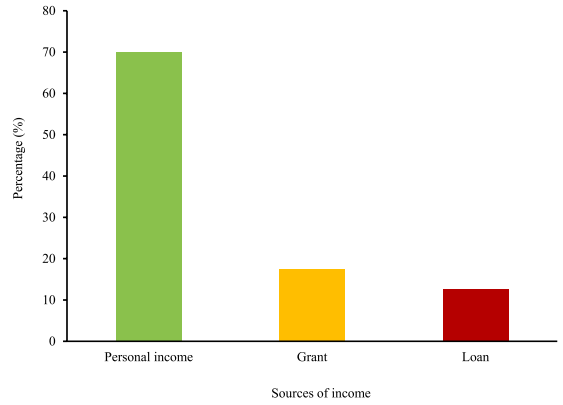

FIGURE 3
Distribution of sources of capital for tomato traders.

3.7 Support needed by tomato traders

Tomato traders identified several areas where support is required to enhance their operations, including financial assistance, improved infrastructure, and access to reliable market information. As indicated in Figure 7, the majority of respondents (53.3 percent) reported a need for financial assistance. This was followed by 33.3 percent who indicated that improvements in infrastructure were necessary. A smaller proportion (13.3 percent) expressed the need for better access to market information.

3.8 The association between education level and estimated monthly income

The association between education level and estimated monthly income among tomato traders in Chinsali District is presented in Table 2. The results show a statistically significant relationship between education level and weekly income χ^2 (6) = 37.638, $p < 0.001$. Overall, tomato traders with primary education accounted for the largest share of estimated monthly income, contributing approximately 57.3 percent of the reported weekly income, which was nearly three times higher than the share attributed to traders with no formal education at 15.5 percent. Tomato traders with secondary education contributed 27.3 percent of the total weekly income.

With respect to income categories, traders with no formal education were largely concentrated in the lower income brackets, with most of their estimated monthly income distributed within the ZMK 800, ZMK 1000, and ZMK 1500 categories, and only a small proportion falling within the ZMK 2000 category. In contrast, traders with primary education contributed substantially across all income levels, with the highest proportion of their estimated monthly income recorded in the ZMK 2000 category. Traders with secondary education were predominantly represented in the highest income category, with the majority of their estimated monthly income concentrated at ZMK 2000 and minimal contribution to the lower income categories.

3.9 The association between gender and estimated monthly income

The association between gender and estimated monthly income among tomato traders in Chinsali District is presented in Table 3. The results indicate a statistically significant relationship between gender and weekly income χ^2 (3) = 22.456, $p < 0.001$. Female traders accounted for a higher proportion of weekly income in the upper income categories, with 45.9 percent of their estimated monthly income concentrated in the ZMK 2000 category, followed by 22.4 percent in the ZMK 1500 category. In contrast, male traders had a greater share of their estimated monthly income in the lower income categories, with 56.0 percent and 28.0 percent of weekly income falling within the ZMK 800 and ZMK 1000 categories, respectively.

Overall, female traders contributed more substantially to higher estimated monthly income levels, whereas male traders were predominantly represented in the lower income brackets. The significance of this association was further supported by the likelihood ratio and the Fisher Freeman Halton exact test, both of which were statistically significant $p < 0.05$. These results demonstrate that the distribution of estimated monthly income differs significantly by gender among tomato traders in Chinsali District.

4 Discussion

This study assessed the opportunities and challenges associated with tomato trading in Chinsali District, Zambia, providing critical insights into the socioeconomic and structural dynamics shaping this informal trade. The findings highlight how gender, age, and education influence participation in tomato trading, and how factors such as access to capital, market conditions, and infrastructure determine the sustainability and profitability of this enterprise. Together, these dimensions offer a nuanced understanding of the informal tomato value chain and its role in local livelihoods.

4.1 Gender distribution in tomato trading

The gender distribution in this study showed that a higher proportion of tomato traders were women, confirming the widespread perception that tomato selling is predominantly a women's enterprise, while men are more involved in farming and transportation. This pattern is consistent with findings from Britwum (2013), Hadebe and Msuya (2016), and Mwamba et al. (2025), who observed that women dominate market-based tomato trading groups, whereas men are more visible in logistical roles. In Chinsali, women's participation

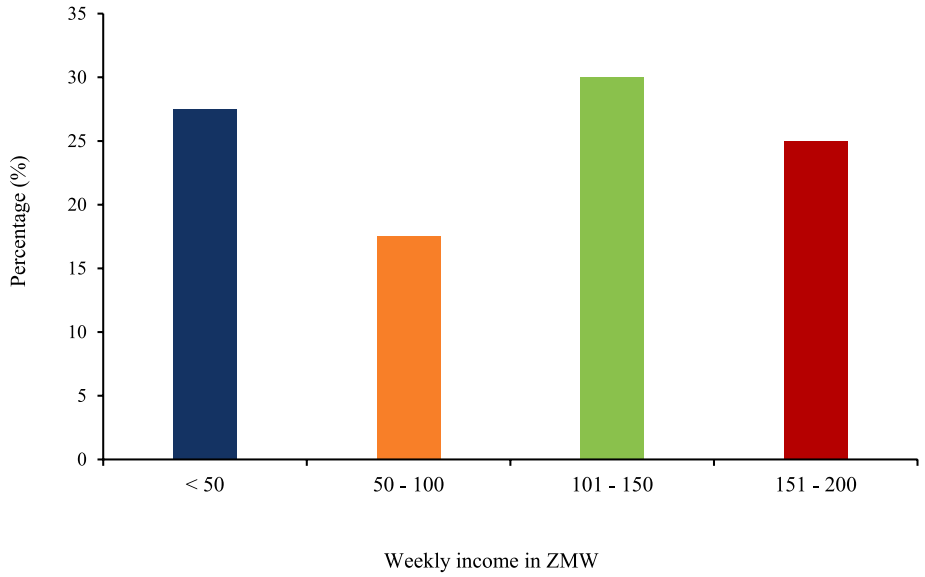

FIGURE 4
Weekly income distribution of tomato traders in Chinsali District.

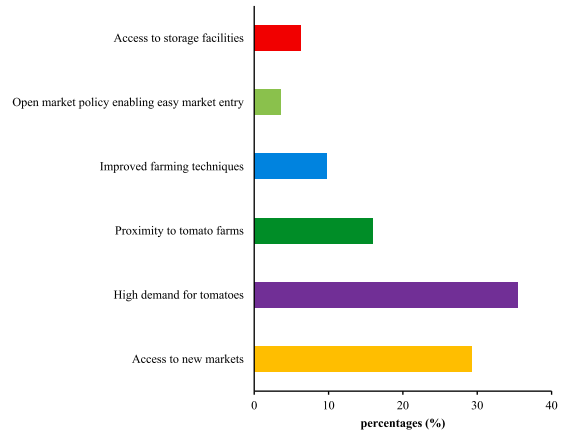

FIGURE 5
Some of the opportunities perceived by tomato traders.

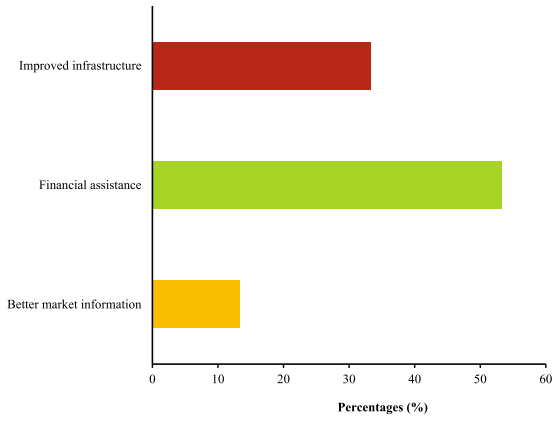

FIGURE 7
Distribution of support needed by tomato traders.

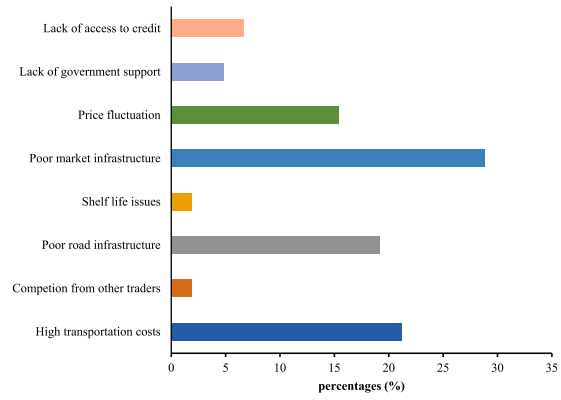

FIGURE 6
Some of the challenges encountered by tomato traders.

TABLE 2 Relationship between the level of education and the estimated monthly income among tomato traders in Chinsali District.

Level of education	ZMK 800	ZMK 1000	ZMK 1500	ZMK 2000	Total
No formal education	2.7%	6.4%	4.5%	1.8%	15.5%
Primary education	7.3%	10.9%	16.4%	22.7%	57.3%
Secondary education	0.0%	0.0%	1.8%	25.5%	27.3%
Pearson Chi square					χ^2 (6) = 37.638, $p < 0.001$
N of valid cases					110

1 Zambian Kwacha (ZMK) is equal to 0.04 $ at the time of the study.

TABLE 3 Relationship between gender and estimated monthly income among traders in Chinsali District.

Gender	ZMK 800	ZMK 1000	ZMK 1500	ZMK 2000	Total
Female	17.6%	14.1%	22.4%	45.9%	100%
Male	56.0%	28.0%	8.0%	8.0%	100%
Pearson Chi square					χ^2 (3) = 22.456, $p < 0.001$
N of valid cases					110

1 Zambian Kwacha (ZMK) is equal to 0.04 $ at the time of the study.

contributes significantly to rural livelihoods, particularly where formal employment opportunities are limited and agriculture remains the main source of income (Mabaya, 2011; Hepplethwaite, 2020). Moreover, cultural norms that emphasize women's responsibility for household food security further reinforce their engagement in the trade (Faso, 2007; Woldie, 2015). However, women's long-term involvement may be constrained by structural barriers, including limited access to credit, poor market infrastructure, and inadequate institutional support. Addressing these challenges is critical to promoting gender equity and sustaining the agricultural value chain, ensuring that women can fully benefit from and contribute to market development.

4.2 Age distribution of tomato traders

The predominance of traders aged between 20 and 30 years indicates an increasing trend of youth participation in informal agribusiness in Chinsali District. This finding reflects the growing importance of agricultural trade as a viable source of income and employment for young people, particularly in rural areas where formal jobs are scarce. Haggblade et al. (2010) observed a similar pattern across sub-Saharan Africa, where youth engagement in informal agricultural trade provides a buffer against unemployment and underemployment. In Zambia, the potential of agriculture to absorb the expanding youth population remains significant, but challenges such as restricted access to capital, land, and market information continue to limit their full participation (Mwamba et al., 2025). The observed youth dominance in tomato trading may also indicate a shift in livelihood strategies, where younger individuals are increasingly drawn to low-entry agribusiness ventures that require minimal investment but offer quick financial returns. With adequate policy support, skills development, and entrepreneurial training, this demographic group could become a driving force in transforming local agri-food systems.

4.3 Educational attainment and its implications

Most tomato traders in this study had attained only primary education, with a smaller proportion having completed secondary school. This may be due to low emphasis on attaining a high education level in rural areas like Chinsali because of poor access to quality education, teacher shortages, and barriers to attending school, such as infrastructure deficits and geographical isolation, poverty, long distances to schools, lack of secondary schools, and fees beyond primary level, which reflect a lack of prioritization of education services in rural contexts as was reported by Lembani (2021). This finding is consistent with Nyamba et al. (2016), who reported that low levels of education are common among informal horticultural traders in rural areas. Limited educational attainment restricts access to formal employment, compelling individuals, particularly women, to rely on informal trade as a primary livelihood strategy (Woldie, 2015; International Fund for Agricultural Development (IFAD), 2016). Low education levels also limit business management skills, financial literacy, and access to market information, all of which are essential for enterprise growth (Ajani, 2008). Nevertheless, informal trade provides opportunities for experiential learning and the development of entrepreneurial skills, particularly when complemented by targeted training programmes (Majgaard and Mingat, 2012).

The demographic characteristics observed in this study reveal that women and youth form the backbone of tomato trading in Chinsali District. Their participation is driven by necessity but also reflects resilience and adaptability within a constrained economic environment (Fink et al., 2020). However, the generally low levels of education and business training highlight the need for capacity-building interventions to enhance productivity, financial management, and market competitiveness.

4.4 Motivations for engaging in tomato trading

Income generation emerged as the principal driver for engaging in tomato trading among respondents, reflecting the crop's strategic role as a source of livelihood diversification in rural Zambia and limited formal employment opportunities in rural areas, the need for household income diversification, and the consistent local demand for tomatoes. Furthermore, this result may be ascribed to the relatively low capital and skill requirements make tomato trading accessible to women, youth, and small-scale entrepreneurs, reinforcing its strategic role in rural livelihoods. This aligns with Kaba (2020) and Issahaku (2012), who reported that informal agricultural traders often enter the market to supplement household income and mitigate seasonal agricultural risks in many African countries. In Chinsali, where formal employment opportunities are limited, tomato trading serves as an accessible income pathway, particularly for women and youth with low start-up capital as was found through the average weekly income of the tomato traders. Market demand was another key motivation, as tomatoes constitute a staple commodity in both urban and rural markets. Similar to Bhandari et al. (2016) and Crawford et al. (2018), the findings underscore that strong consumer demand and year-round marketability create incentives for continuous engagement in tomato trading. The availability of local production further enhances this participation, enabling short supply chains and reduced procurement costs. Thus, tomato trading not only supports household income security but also contributes to local economic resilience by sustaining employment across the value chain.

4.5 Access to capital and financial challenges

Access to capital remains one of the most significant barriers constraining the growth of tomato trading enterprises in Chinsali District. Most traders relied heavily on personal savings as their primary source of start-up and operating capital, which is indicative of both financial

exclusion and low confidence in formal banking systems. This finding mirrors those of other researchers (e.g., Van Rooyen et al., 2012; Adusei et al., 2019; Fischer et al., 2020; Fink et al., 2020), who noted that rural traders often depend on self-financing due to structural barriers such as stringent collateral requirements, high interest rates, and bureaucratic lending processes. Although microfinance institutions operate in some parts of Zambia, their outreach to informal traders remains limited, as also observed by Beck et al. (2017), Melkani et al. (2025), and Chibbonta and Chishimba (2023). The study further revealed that awareness of grant opportunities and development funds was minimal, and where such funds existed, access was highly competitive, consistent with Mwamba et al. (2025). The lack of affordable financing not only restricts business expansion but also reduces traders' capacity to invest in improved storage, transport, and packaging technologies, perpetuating a cycle of low profitability and vulnerability to market shocks. Enhancing financial inclusion through targeted microcredit schemes and financial literacy training could therefore be transformative for small-scale traders.

4.6 Income and market dynamics

The analysis revealed that traders' incomes were highly variable and closely linked to market fluctuations. Weekly earnings depended largely on supply volume, seasonal price variability, and consumer purchasing power. These results echo findings by Mwiinga (2009) and Hensman (2022), who reported that price instability remains a persistent challenge in informal agricultural markets. The perishability of tomatoes, coupled with inadequate cold storage and poor market infrastructure, compounds these fluctuations. External shocks such as economic downturns, fuel price changes, and climate variability intensify the vulnerability of small-scale traders (Sibomana et al., 2016; Siankwilimba et al., 2023; Mwamba et al., 2025; Melkani et al., 2025). Traders often absorb these risks without formal protection mechanisms, which undermines both profitability and long-term sustainability. Enhancing income stability therefore requires coordinated interventions that improve infrastructure, strengthen market information systems, and promote cooperative marketing strategies that enhance bargaining power and reduce transaction costs.

4.7 Opportunities and challenges in tomato trading

Tomato trading presents both promising opportunities and persistent challenges. The high and consistent demand for tomatoes provides a reliable market outlet, supported by population growth, urbanization, and changing dietary preferences that favor fresh produce (McCluskey, 2015; Amyoony et al., 2024). Additionally, the rising demand for tomatoes may be attributed to population growth and the expansion of Chinsali town, particularly following the establishment of Kapasa Makasa University (KMU), which has created a steady market for tomato traders through its student population. Proximity to production areas also enhances market efficiency by enabling frequent restocking and reducing post-harvest losses (Ndirangu et al., 2017; Abdelrazig et al., 2018). However, traders face several structural challenges, including poor market infrastructure, high transportation costs, and inadequate storage facilities, consistent with the findings from other studies (Ugonna et al., 2015; Salau, 2017; Doku et al., 2020). Additionally, currency fluctuations, limited access to affordable credit, and weak institutional support constrain growth and profitability (Kiplimo et al., 2015; Mutayoba and Ngaruko, 2018; Adusei et al., 2019; Mwamba et al., 2025; Siankwilimba et al., 2025). Addressing these challenges will require an integrated approach that combines infrastructure development, financial inclusion, and institutional capacity building to enhance the efficiency and competitiveness of tomato market.

4.8 The association between education level and estimated monthly income

Regarding the association between education level and estimated monthly income, the present study unraveled a significant association with Traders with higher levels of education, particularly those with secondary education, were disproportionately represented in the highest income category, indicating a potential advantage in accessing more profitable market opportunities. This may suggest that educational attainment plays an important role in shaping income outcomes within informal agricultural markets. Furthermore, this may be attributed improved skills in numeracy, pricing strategies, and negotiation skills associated with higher education, which can enhance business efficiency and profitability. This is not surprise because education level is known to influence the income mainly be raising its level (Fields, 1980). Additionally, the current study revealed that tomato traders with primary education had the largest share of estimated monthly income which may be due to both their numerical dominance in the market and their ability to participate across all income categories and are likely to be the majority participating in the business and the business has their main sources of income. Our findings are consistent with what was reported in Southeast Nigeria by Ibekwe et al. (2010) who found that income was positively related to income in rural households. To add on, the results of this study are in conformity to the findings of Aidoo-Mensah (2018) who reported that income was associated positively to education level among tomato farmers. Moreover, tomato traders with no formal education were largely concentrated in the lower income categories, which may be ascribed to constraints in market engagement, financial management, or access to higher value trading channels. Therefore, strengthening access to basic and secondary education, as well as targeted business training for traders with limited formal education, may contribute to improved income distribution within the tomato trading agricultural market system.

4.9 The association between gender and estimated monthly income

Coming to the association between gender and estimated monthly income, this study demonstrated that gender influenced positively the estimated monthly income with females' traders strongly represented in the higher income categories, particularly in the ZMK 2000 bracket, suggesting greater engagement in higher value trading activities. This pattern may reflect stronger market networks, better product handling practices, or greater consistency in market participation among female traders. This may mean that that women may be more economically resilient or strategic within tomato trading systems than men highlighting the importance of recognizing and supporting the role of women in agricultural marketing through targeted interventions such as access to finance, market infrastructure, and capacity building. In contrast, male traders were predominantly concentrated in the lower income categories, which may indicate limited market stability,

smaller trading volumes, or engagement in more opportunistic or seasonal trading activities. This may be attributed to variations in time commitment and or risk preferences between male and female traders. Our findings agree with Ampaire et al. (2020) who found that in Uganda and Malawi, women traders achieved more income in the market systems than men. Likewise, women's involvement in trading of agriculture commodities can reduce income inequality and have positive effects on income distribution, indicating economic resilience and strategic engagement by women as was reported by Oteng and Gamette (2024). This finding is not consistent with the findings of Maereka et al. (2023) who found that men made more income than women in Malawi bean value chain. This difference may be attributed to differences in the commodities studies and highlights gendered income dynamics in agricultural trade.

4.10 Limitations of the study

This study provided valuable insights into the socioeconomic dynamics of tomato trading in Chinsali District, but several limitations should be noted. First, the research relied on cross-sectional survey data collected from self-reported questionnaires, capturing conditions at a single point in time and potentially influenced by social desirability bias, recall error, or intentional misreporting. Measures such as confidentiality assurances and using average weekly income categories were applied to reduce these biases. Second, respondents were purposively selected and included only those who were available and willing to participate, which may have introduced respondent or selection bias. Third, methodological constraints, including the reliance on structured questionnaires and the absence of longitudinal data, limited the ability to capture dynamic changes in trading behaviors over time. Fourth, seasonal variation and price fluctuations inherent in tomato markets may have affected income and trading patterns observed during the study period, reducing the generalizability of the findings to other seasons. Despite these limitations, the findings provide an important empirical basis for designing targeted interventions to enhance market efficiency, promote inclusive growth, and strengthen the sustainability of rural agri-food systems in Zambia. Moreover, this study provides novel insights into tomato trading in Chinsali District, highlighting the roles of gender, age, and education in shaping market participation and income. The findings underscore the importance of supporting women traders, enhancing rural market infrastructure, and promoting financial inclusion to strengthen livelihoods. By focusing on an under-researched rural context, the study contributes to the evidence base for policy development and horticulture interventions in Zambia. Future research could expand by comparing trader dynamics across districts or examining gendered power relations in markets to further inform inclusive and sustainable agricultural strategies.

5 Conclusion and recommendations

This study demonstrates that tomato trading plays an indispensable role in sustaining rural livelihoods and enhancing food security in Chinsali District, Zambia. The trade provides income and employment, particularly for women and youth, who form the majority of participants. However, the sector continues to face significant structural and socioeconomic challenges that limit its potential contribution to local and national development. Chief among these are poor market infrastructure, high transportation costs, limited access to affordable credit, price instability, and inadequate institutional support. These constraints undermine profitability, weaken resilience to external shocks, and discourage long-term investment in the sector. In order to enhance the sustainability and competitiveness of tomato trading, we recommend improving market infrastructure, including storage facilities, market shelters, and transport networks, is essential to reduce post-harvest losses, and increase trader incomes. Likewise, expanding access to affordable finance through microcredit schemes and financial literacy training would empower traders particularly women and youth to scale operations, invest in value addition, and reduce vulnerability to market fluctuations. Capacity-building initiatives should focus on business and entrepreneurial skills, including numeracy, pricing strategies, record-keeping, and negotiation, to support traders with limited formal education and enhance income distribution across the market. Moreover, gender-responsive interventions are necessary to strengthen women's participation, given their dominance in higher income categories. Likewise, encouraging the formation of trader associations for both women and men can further reduce transaction costs, improve market efficiency, and stabilize incomes. Overall, integrating tomato trading into broader rural development and food systems strategies can maximize socioeconomic benefits by linking infrastructure, finance, and capacity-building initiatives. By prioritizing these targeted, evidence-based interventions, policymakers and development partners can strengthen informal agricultural markets, promote equitable income distribution, and enhance the resilience and competitiveness of tomato trading.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the [patients/participants or patients/participants legal guardian/next of kin] was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

LT: Validation, Data curation, Formal analysis, Project administration, Investigation, Methodology, Writing – original draft, Software. FM: Writing – original draft, Investigation, Formal analysis, Visualization, Validation, Data curation, Methodology. JMp: Supervision, Writing – original draft, Writing – review & editing, Methodology, Validation, Visualization. IN: Methodology,

Writing – original draft, Validation, Visualization, Writing – review & editing. EN: Writing – review & editing, Validation, Writing – original draft, Visualization. ES: Writing – original draft, Methodology, Writing – review & editing, Visualization, Validation. JMu: Writing – review & editing, Visualization, Writing – original draft, Validation. MM: Writing – original draft, Funding acquisition, Visualization, Writing – review & editing, Data curation. SS: Visualization, Writing – original draft, Investigation. MC: Writing – review & editing, Funding acquisition, Writing – original draft, Validation, Visualization. HMM: Validation, Writing – original draft, Writing – review & editing, Visualization. CM: Visualization, Writing – original draft, Validation, Writing – review & editing. IM: Visualization, Writing – original draft, Writing – review & editing, Data curation. OH: Data curation, Visualization, Methodology, Project administration, Conceptualization, Validation, Funding acquisition, Writing – original draft, Supervision, Resources, Writing – review & editing.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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