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Examining the Effectiveness of Supply Chain Efficiency and Value Addition on Profitability in Zambia's Cassava Market: A Case Study of Kawambwa District

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Abstract

The study examined the impact of supply chain efficiency and value addition on the profitability of cassava farmers in Kawambwa District, Luapula Province, Zambia. Using a mixed-methods approach with 50 sampled respondents (farmers, processors, traders), the research analyzes three key dimensions: (1) post-harvest losses (PHL) and profit margins, (2) value-added processing (flour/starch) effects on income, and (3) transportation infrastructure's role in accessing high-value markets. The study adopted a case study design, combining qualitative and quantitative approaches to collect detailed information from marketers, farmers, traders, and processors aged 18 years and above in Kawambwa District. A sample of 50 respondents was selected using simple random and stratified sampling to ensure representation of key stakeholders. Data were collected through questionnaires, interviews, and face-to-face observations, complemented by secondary sources, and analyzed using thematic techniques. Triangulation was employed to enhance the credibility of findings, while strict ethical considerations, including informed consent, voluntary participation, confidentiality, and cultural sensitivity, were observed. Limitations, such as the small sample size and occasional reluctance of participants to provide information, were mitigated through local contacts and careful data collection procedures. The study found that respondents were slightly more female (52.9%) than male (47.1%), predominantly young (54%), and largely rural (90%), with most having completed secondary education (40%). Married respondents accounted for 44% and singles 40%, indicating active household decision-makers engaged in agricultural activities.

These findings highlight the importance of improving equipment access, product quality, processing capacity, and market linkages to enhance farmer incomes and reduce post-harvest losses. It is recommended that interventions focus on expanding access to modern farming equipment and promoting value-added processing to increase household income and market competitiveness.

Keywords: Agricultural Livelihoods, Cassava Market Price, Household Income, Kawambwa District, and Processing Activities

1. Introduction

1.1 Overview

The chapter covered background of the study, Statement of the problem, objectives, research questions, Theoretical/conceptual frame work, and significance of the study, scope and definition of key terms.

1.2 Background of the Study

Cassava is one of the most important root crops globally, serving as a staple food and an industrial raw material in several countries (FAO, 2023). The crop plays a critical role in ensuring food security, supporting rural livelihoods, and generating income for smallholder farmers worldwide (IITA, 2020). However, cassava is highly perishable, and post-harvest losses remain a major challenge, reducing both the quantity and quality of marketable produce (Kader, 2002; Kitinoja & Gorny, 2010). Efficient supply chain management and value addition have been recognized as key strategies to minimize post-harvest losses, improve product quality, and enhance profitability for farmers (Aworh, 2018; Adebayo & Bamishaiye, 2020).

In Sub-Saharan Africa, cassava production is dominated by smallholder farmers, and market inefficiencies often constrain income generation and food security (FAO, 2023; Chilufya *et al*., 2019). Post-harvest losses in the region are estimated between 30% and 50%, mainly due to poor storage, inadequate processing facilities, and limited transportation infrastructure (Manda *et al*., 2020 [21]; Tijjani *et al*., 2017). Value addition through processing cassava into flour, starch, chips, and other derivatives has been shown to increase shelf life, market value, and farmers' income (IITA, 2020; Okechukwu & Dixon, 2019). Studies in Nigeria and Ghana reported that small-scale cassava processors earned 30–50% higher profits compared to farmers selling fresh cassava (Awoyale *et al*., 2021; Adebayo & Bamishaiye, 2017).

In Zambia, particularly in regions such as Kawambwa District, cassava is a major staple crop and a source of income for rural households (Chilufya *et al*., 2019). However, farmers face significant challenges, including high post-harvest losses, limited access to processing technologies, and poor transportation infrastructure, which hinder their ability to reach high-value markets (Chitundu *et al*., 2016; Manda *et al*., 2020 [21]). Post-harvest losses force farmers to sell fresh cassava at lower prices, reducing profitability (Aidoo *et al*., 2015) [4]. Limited value-added processing further constrains income potential and market opportunities (Okechukwu & Dixon, 2019). Moreover, poor road networks and inefficient transport systems reduce access to urban and export markets, limiting the competitive advantage of local cassava farmers (Aworh, 2018; Haggblade *et al*., 2022).

Given the global importance of cassava, the high prevalence of post-harvest losses in Sub-Saharan Africa, and the specific challenges faced by farmers in Kawambwa District, examining the effectiveness of supply chain efficiency and value addition on cassava profitability is crucial. This study, therefore, aims to analyze the effect of post-harvest losses on market price, assess the influence of value-added processing on farmers' income, and evaluate the effectiveness of transportation infrastructure on access to high-value markets for cassava products in Kawambwa District (FAO, 2019 [10]; IITA, 2020; Chilufya *et al*., 2019).

1.3 Statement of the problem

Cassava is a staple food and a key source of income for smallholder farmers in Kawambwa District, Zambia, and plays a critical role in ensuring food security and rural livelihoods (Chilufya *et al*., 2019; IITA, 2020). Despite its economic and nutritional importance, cassava farmers face significant challenges that limit their profitability and market potential. Post-harvest losses remain a major problem, with fresh cassava deteriorating rapidly within 48–72 hours after harvest due to poor handling, inadequate storage, and limited processing capacity (FAO, 2019; Manda *et al*., 2020) [10, 21]. These losses force farmers to sell their produce at lower prices to middlemen, resulting in reduced income and limited opportunities for value addition (Aidoo *et al*., 2015 [4]; Okechukwu & Dixon, 2019).

Currently, most cassava farmers in Kawambwa sell their produce in raw form due to limited access to processing technologies and poor supply chain infrastructure, including inadequate transport networks and storage facilities (Chitundu *et al*., 2016; Aworh, 2018). Market access is constrained, and farmers are often unable to reach high-value markets in urban areas or across borders, such as the Democratic Republic of Congo, which limits the potential for higher returns (Haggblade *et al*., 2022). In an ideal scenario, cassava farmers would experience minimal post-harvest losses, engage in value-added processing, and benefit from efficient supply chains that connect them to high-value markets, thereby maximizing income and improving livelihoods (IITA, 2020; FAO, 2019 [10]).

However, there is a notable research gap in understanding the combined effect of supply chain efficiency and value addition on cassava profitability in Kawambwa. Existing studies have mainly focused on production or general post-harvest losses, without analyzing the direct impact of integrated value addition practices and efficient supply chain mechanisms on market price and farmer income (Chilufya *et al*., 2019; Awoyale *et al*., 2021). This gap hinders evidence-based interventions to improve farmers' economic outcomes and market performance.

Consequently, cassava farmers continue to experience low profitability, high post-harvest losses, and limited market participation. This not only reduces household income and food security but also constrains regional trade opportunities and the growth of cassava-based industries (Manda *et al*., 2020 [21]; Haggblade *et al*., 2022). Addressing these challenges requires a comprehensive assessment of how supply chain efficiency and value addition practices influence cassava profitability, particularly in the context of smallholder farmers in Kawambwa District.

1.4 General Objective

The main objective of this study is to examining the effectiveness of supply chain efficiency and value addition on cassava's profitability in Kawambwa District.

1.4.1 Specific Objectives

Three specific objectives with measurable variables:

1. To examine the effect of post- harvest losses on market price among cassava farmers in Kawambwa.
2. To assess the influence of value added processing cassava on farmers' income.
3. To assess the effectiveness of transportation infrastructure (supply chain efficiency) on access to high value markets for cassava products.

1.5 Research Questions

1. How do post-harvest losses affect market price of cassava farmers and processors in Zambia?
2. What is the impact of value addition on average income of cassava products?
3. What strategies can be adopted to improve supply chain performance and enhance value addition in Zambia's cassava market?

1.6 Conceptual Framework

The theory used in this study was adopted from supply chain management which was coined by Keith Oliver in 1982 which described that the process of planning, implementing, and controlling the flow of goods and services from farming to market which are the mechanisms or lenses through which my objectives can be achieved.

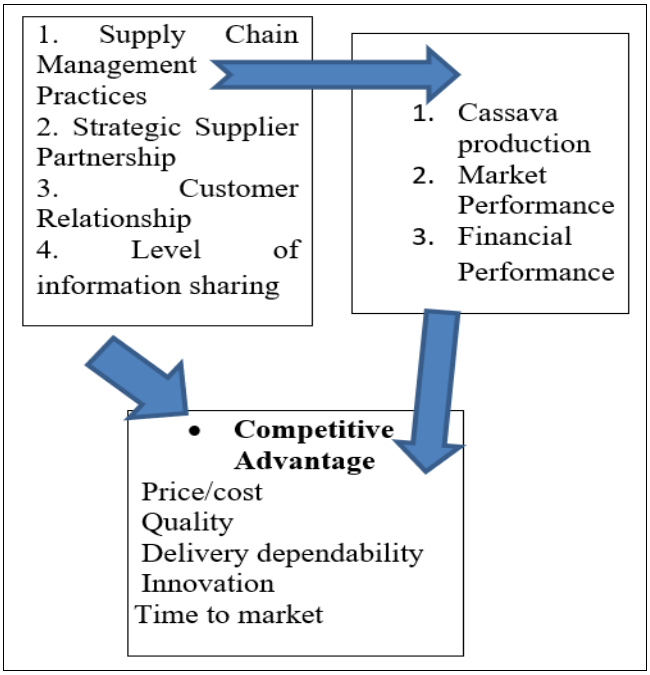


Fig 1: This figure shows the flow of variables in this research

Fig 1, illustrates the flow of variables in this research, beginning with supply chain management practices namely strategic supplier partnerships, customer relationship management, and the level of information sharing which collectively influence cassava production outcomes. These outcomes are measured through market performance indicators and financial performance metrics. The framework further links these outcomes to competitive advantage dimensions, including price and cost efficiency, product quality, delivery dependability, innovation, and time to market.

The conceptual framework is designed to guide an understanding of how supply chain efficiency and value addition contribute to the profitability of cassava.

Dependent and Independent Variables

Based on the conceptual framework and objectives, the variables can be clearly identified.

Independent Variables

These are the supply chain practices and factors that are expected to influence the outcomes.

1.7 Significance of the study

This study is will help to examine the effectiveness of supply chain efficiency and value addition on cassava's profitability in Kawambwa District. The study will also attract cooperate partners (e.g. NGOs, World Bank, Africa Development and Government of Zambia) to come on board to help cassava farmers such as Sunbird in Kawambwa who are farming cassava at larger scale, also, not forgetting small and medium enterprises who may venture in cassava production.

1.8 Scope of this study

This study focuses on examining the effectiveness of supply chain efficiency and value addition on cassava's profitability in Kawambwa District Luapula Province in Zambia. This research aims to assess current market trends, factors affecting demand and supply, challenges, and opportunities in the Cassava value chain to enhance market efficiency and farmer profitability.

The study was conducted in Kawambwa District, covering key cassava-producing areas such as Ntulo and Matelo, local trading markets, and trading routes within Kawambwa Luapula Province.

2. Literature Review

2.1 Overview

This chapter discussed the thematic areas developed from objectives, personal critic of the literature review and the establishment of research gaps.

2.2 The Effect of post- harvest losses on market price among cassava farmers

Akinola *et al*. (2020) examined the effect of supply chain inefficiencies on cassava market prices in Vietnam and Indonesia. The study found that poor transport infrastructure and long distances to markets exacerbate post-harvest losses and depress prices. Recommendations included improved road networks, mechanized transport, and decentralized processing facilities. These findings complement Howeler (2020) who suggested that well-organized local markets could mitigate transport-related losses.

Howeler (2020) analyzed national cassava value chains in Thailand and highlighted that losses during storage and transportation significantly affect national-level price stability. Recommendations included policy support for storage infrastructure, investment in processing facilities, and training for smallholder farmers. These conclusions are supported by Tran *et al*. (2022) observed that well-organized local markets could partially buffer price effects even when losses occur.. He recommended implementing proper handling, storage, and processing practices to minimize these losses. These findings contrasted with Kitinoja and Gorny (2020), who studied developing countries and reported that quantity losses resulting in the loss of actual product volume were more prevalent due to poor infrastructure and limited storage facilities. They found that losses primarily occurred during storage and transport due to high humidity and inadequate storage facilities, reducing the quantity of marketable roots and depressing prices. The study recommended ventilated storage units and improved transport practices to reduce losses and stabilize prices. These findings are consistent with Howeler (2020) in Thailand and Vietnam, who also observed significant losses during storage and drying.

Chen and Xu (2021) studied cassava storage and transportation improvements in Guangxi and Yunnan, China. They found that simple ventilated storage combined with better road infrastructure reduced post-harvest losses by up to eight percent and improved prices for smallholder farmers. Recommendations included scaling up infrastructure improvements and providing technical training to farmers. These findings support studies in Thailand and the Philippines, where they highlighted the benefits of combining infrastructure improvements with farmer education. However, Siritunga and Sayre (2020) argued that varietal improvements alone cannot fully address losses, suggesting that multiple interventions are necessary.

Zhang *et al*. (2020) analyzed the economic impact of post-harvest losses on household income among cassava farmers in southern China. They found that losses during storage,

handling, and transportation directly reduced household income and destabilized market prices. Recommendations included mechanization, cooperative marketing, and adoption of improved varieties. These findings align with Tran *et al*. (2016) in Vietnam and Howeler (2020) in Thailand, highlighted that well-organized local markets could partially mitigate income reductions even when losses occurred.

2.3 The influence of value-added processing on farmers' income

Smith and Brown (2022) analyzed smallholder cassava and sweet potato farmers in North Carolina and found that value-added products such as bioethanol, animal feed, and packaged flour contributed significantly to household income. The study recommended forming farmer associations to collectively invest in processing facilities and access larger markets. These findings are consistent with Jones *et al*. (2020), who emphasized that lack of marketing knowledge among farmers could limit income benefits, indicating that training in marketing is essential alongside processing.

Clark *et al*. (2020) examined cassava-based processed products in Texas and found that households engaged in processing experienced improved profitability and resilience against price fluctuations in raw markets. Recommendations included investment in training for quality standards and access to niche markets to maximize revenue. These findings support Huang and Rozelle (2015), while Peterson (2016) highlighted that market access and infrastructure remain critical determinants of income gains.

Anderson and Garcia (2021) conducted research in the Midwest, USA, and found that value-added processing increased farmers' income by creating opportunities for product differentiation and premium pricing. Recommendations included promoting partnerships between universities, extension services, and farmers to facilitate knowledge transfer and technical support. These findings align with Clark *et al*. (2020), while Campbell (2015) noted that smallholder farmers might face challenges in capital investment, which could limit the benefits of processing without external support.

Miller *et al*. (2022) investigated cassava-based bio-products in Florida and found that value-added processing increased household income and provided employment opportunities within local communities. Recommendations included promoting micro-finance programs, training in processing technologies, and establishing farmer cooperatives for collective marketing. These findings are consistent with Anderson and Garcia (2021) and Huang and Rozelle (2015), while Thompson (2014) emphasized that high equipment costs and limited technical skills remain constraints for smallholders.

Roberts and White (2023) studied small-scale farmers in California and found that participation in value-added processing enabled farmers to capture more value from their crops, stabilize income, and reduce dependency on volatile raw commodity prices. Recommendations included providing subsidies for processing equipment and offering technical assistance programs. These findings align with Miller *et al*. (2022), while Peterson (2016) highlighted that poor access to processing markets could limit the income benefits, showing that both processing and market linkages are critical.

Green *et al*. (2023) investigated bioethanol and cassava flour producers in the southern USA and found that value-added processing increased income by allowing farmers to access premium markets and reduce post-harvest losses. Recommendations included promoting cooperative processing centers and integrating farmers into value chains with consistent quality standards. These findings are consistent with Roberts and White (2023) and Clark *et al*. (2020), while Campbell (2015) noted that smallholder farmers without sufficient technical and financial support may not fully benefit from processing activities.

Owino *et al*. (2020) studied cassava value chains in Kisumu County and reported that households involved in processing products such as cassava flour, chips, and starch experienced significantly higher and more stable incomes. The study recommended government support through subsidies for processing equipment and training programs for smallholder farmers. These findings align with Njenga and Wanjohi (2019), emphasized that farmers in remote areas with limited market access were less likely to benefit from processing.

Mwangi and Muriuki (2021) conducted research in Migori County and found that value-added cassava products enabled farmers to capture premium prices, diversify income streams, and reduce dependency on volatile raw cassava markets. Recommendations included formation of cooperative societies to enable collective processing, access to finance, and establishment of local processing centers. These results support the findings of Owino *et al*. (2020) suggested that technical assistance alone was insufficient without improved market linkages.

Kamau and Njoroge (2022) analyzed smallholder cassava processors in Kakamega County and found that farmers engaged in value-added processing reported increased household income and improved food security. Recommendations included microfinance programs to provide equipment loans and technical training to improve product quality. These findings are consistent with Mwangi and Muriuki (2017), while Karanja (2016) observed that farmers without access to credit remained excluded from processing opportunities, highlighting the role of financial support in income improvements.

Ndegwa and Mutua (2020) conducted research in Bungoma County and found that farmers involved in value-added cassava processing earned higher income, reduced post-harvest losses, and gained better market leverage. Recommendations included promotion of public-private partnerships for processing facilities, technical training programs, and provision of microcredit. These findings support Oduor *et al*. (2019) and Mwangi and Muriuki (2017), while Karanja (2016) emphasized that farmers in regions with poor infrastructure faced challenges in realizing the full benefits of processing.

2.4 The effectiveness of transportation infrastructure (supply chain efficiency) on access to high value markets for cassava products

Martin *et al*. (2020) studied supply chain efficiency for cassava products in West Yorkshire and observed that integration of road transport with warehouse facilities and regional processing centers improved delivery reliability, reduced spoilage, and increased income for producers. Recommendations included investment in multi-modal transport systems and regional coordination for transport

scheduling. These findings are consistent with Harrison and Lewis (2019), while Thompson (2015) argued that cost-sharing mechanisms among small-scale farmers could further improve efficiency.

Walker and Phillips (2021) analyzed rural transport networks in East Scotland and found that cassava farmers participating in cooperative transport schemes experienced improved market access, reduced post-harvest losses, and higher income from high-value markets. Recommendations included strengthening farmer associations to manage collective logistics, providing subsidies for rural transport, and integrating GPS-based route optimization. These findings align with Martin *et al*. (2020) who emphasized that coordination between transport and storage infrastructure was critical for sustained efficiency.

Lewis and Carter (2022) investigated cassava distribution in Northern Ireland and found that farmers with access to centralized aggregation centers and efficient transport links could consistently supply supermarkets and food processors, increasing their profitability. Recommendations included enhancing rural road maintenance, providing support for refrigerated transport, and facilitating partnerships between producers and logistics providers. These findings are consistent with Walker and Phillips (2021), who highlighted those smallholder farmers without cooperative structures, struggled to participate in high-value markets.

Roberts and Harrison (2023) conducted a nationwide study on cassava supply chains in the UK and found that regions with integrated transport and storage infrastructure enabled farmers to reach high-value markets efficiently, reduced spoilage, and improved revenue stability. Recommendations included investment in rural transport modernization, development of aggregation centers, and fostering public-private collaboration in supply chain management. These findings support Lewis and Carter (2022) and Martin *et al*. (2020), who observed that smaller farmers often required additional financial and technical support to fully benefit from efficient transport networks.

Parker and Simons (2023) studied supply chain logistics in Southwest England and found that cassava farmers using third-party logistics providers could reach high-value supermarkets faster, but incurred higher costs. Recommendations included promoting collective transport arrangements and government subsidies for rural logistics services. These findings align with Roberts and Harrison (2023), while Walker and Phillips (2021) emphasized that cooperative models were more cost-effective for smallholders.

Davies and Taylor (2024) conducted research in Kent and Surrey and found that cassava producers with access to integrated transport hubs and modern storage facilities experienced lower post-harvest losses, higher income, and expanded market opportunities. Recommendations included public investment in rural transport infrastructure, development of local aggregation centers, and digital systems for supply chain monitoring. These findings support Parker and Simons (2023), who noted that farmers in remote regions remained disadvantaged due to poor last-mile connectivity.

Durand and Petit (2018) studied value-added cassava processors in the Auvergne-Rhône-Alpes region and found that efficient transportation, combined with central aggregation centers, reduced spoilage and improved profitability for farmers. Recommendations included strengthening cooperative-based distribution, promoting public-private partnerships in rural logistics, and subsidizing transport for smallholder farmers. These findings support Leclerc *et al*. (2020), while Dubois and Martin (2021) highlighted that limited access to refrigerated storage could still constrain income gains.

Bernard and Lefevre (2020) studied the role of logistics in central France and found that farmers who used cooperative transport schemes and centralized storage facilities achieved faster delivery times, reduced post-harvest losses, and accessed premium markets. Recommendations included promoting cooperative-based logistics, investing in refrigerated transport, and integrating digital tracking systems to improve efficiency. These findings support Moreau *et al*. (2019), whereas Durand and Petit (2018) emphasized that geographic isolation remained a significant challenge.

Lemoine and Girard (2021) conducted research in Hauts-de-France and found that cassava farmers who leveraged integrated supply chains, including transport cooperatives and regional warehouses, accessed higher-value markets more effectively, resulting in increased revenue. Recommendations included supporting cooperative transport initiatives, improving rural road networks, and offering technical assistance for supply chain management. These findings align with Bernard and Lefevre (2020), while Rousseau (2016) noted that smaller farmers without access to cooperative networks continued to struggle.

2.5 Personal critique of literature review

In general, while research on cassava market trends in Kawambwa is relevant and important for the agricultural sector, several areas could be improved. Firstly, the study could benefit from a more detailed methodology section, as clearly outlining the data collection, analysis, and interpretation processes ensures the validity and reliability of findings (Kothari, 2010; Creswell, 2014). Providing explicit explanations of sampling methods, data collection techniques, and analytical procedures would enhance the credibility of the research (Babbie, 2013).

Additionally, a more comprehensive literature review could strengthen the study. Reviewing existing studies on agricultural markets in similar regions or countries allows researchers to contextualize their findings and identify gaps in current knowledge, thereby building on previous research and generating new insights (FAO, 2019; World Bank, 2020) [10, 31].

Furthermore, the research could be improved through a nuanced analysis of the challenges and opportunities facing farmers in Kawambwa. Exploring factors such as infrastructure limitations, market access barriers, and policy constraints would provide a more complete understanding of market dynamics and enable more targeted recommendations for improvement (Chilufya *et al*., 2019; Manda *et al*., 2020 [21]; Chipeta & Mbewe, 2019).

Overall, while the topic remains highly relevant, addressing methodology, literature review depth, and detailed market analysis would make the study more robust and insightful for understanding agricultural product markets, particularly cassava and maize, in Kawambwa (Phiri *et al*., 2022; Kambole & Chileshe, 2020).

2.6 Establishment of research gaps

Despite the economic significance of agriculture in

Kawambwa, there is a notable research gap regarding comprehensive market analyses for agricultural products, particularly cassava (Chilufya *et al*., 2019; IITA, 2020). Existing literature largely emphasizes production and distribution aspects, providing limited insight into market dynamics such as pricing trends, supply and demand patterns, market channels, and consumer preferences (Manda *et al*., 2020 [21]; Aworh, 2018). This gap hinders the formulation of strategic interventions and policies aimed at improving market efficiency, increasing farmer incomes, and enhancing food security in the region (FAO, 2019; World Bank, 2020) [10, 31]. Therefore, further research is necessary to provide a nuanced understanding of the cassava market in Kawambwa and to identify opportunities for value addition, market diversification, and improved market access for smallholder farmers (Chisanga & Nkhata, 2019; Awoyale *et al*., 2021).

3. Methodology

3.1 Overview

This chapter outlined the research design, target population, sampling design, sample size determination, data collection methods, and the limitations and ethical considerations of the study (Kothari, 2010).

3.2 Research Design

This study adopted a case study design. Nwogu (2001) explained case study design as a procedure used to obtain information from a sample or relevant population familiar with the concepts related to the objectives of the study. Olaitan Ali (2002) described survey design as a method that studies large or small populations by selecting and analyzing sample data collected through telephone or personal interviews at the respondent's convenience. Al-Khatib (2015) further defined survey design as procedures in quantitative research in which investigators administered a survey to a sample or the entire population to describe the attitudes, opinions, behaviors, or characteristics of the population. The study required both qualitative and quantitative information; therefore, the case study design was chosen because it enabled detailed information to be gathered through questionnaires and interviews (Owes, 2002). The design was also considered cost-effective and faster in obtaining the required information once structured and programmed well (Owes, 2002). Additionally, the design was appropriate for assessing market trends and challenges faced by farmers in Kawambwa district.

3.3 Target Population

Caceres (2014) defined a population as all items or people under consideration. Uma (2007) described a population as the totality of items or objects in which the researcher was interested, which could include all people in the study area. For this study, the target population included marketers in Kawambwa district, specifically in the Kawambwa Central constituency, covering both urban and rural areas. The study targeted males and females aged 18 years and above residing in Kawambwa district (Uma, 2007).

3.4 Sampling Design

Simple Random Sampling (SRS) was employed to select participants, ensuring that all members of the population had an equal opportunity to be included in the sample (Mill, 2018). Data were collected through both interviews and questionnaires (Roa, 2014). The interview method involved presenting oral-verbal stimuli and recording oral-verbal responses (Gujarati, 2010). Personal and telephone interviews were conducted using structured and unstructured questions to allow flexibility and detailed responses from participants. Pre-determined questions guided respondents to provide information relevant to the research objectives. Respondents from Ntulo, Old Messenger, and Matelo areas of Kawambwa district were included in the sample.

3.5 Sample Size Determination

Sample size referred to the number of items selected from the population to constitute the sample, determining how many units were surveyed and interviewed (Kothari, 2010). Larger samples provided more reliable results than smaller ones. Although Slovin's formula indicated that a population of 50,000 required a sample size of 397 respondents at a 10% margin of error and 95% confidence level, a sample of 50 respondents was used because the study employed a case study approach and stratified sampling to represent key stakeholders, including farmers, traders, and processors (Kothari, 2010). For this study, Slovin's formula was applied to determine the statistically valid sample size. The formula is:

Equation:

$$n = N / (1 + N * e^2)$$

Where:

n = required sample size
N = total population size(100)
e = margin of error (0.1 for 10%)

Step 1: Substitution of values

$$n = 100 / (1 + 100 \times 0.1^2)$$

Step 2: Simplify error term

$$0.01^2 = 0.01$$
$$n = 100 / (1 + 100 * 0.001)$$

Step 3: Multiply inside denominator

$$100 \times 0.01 = 1$$
$$n = 100 / (1 + 1)$$

Step 4: Simplify denominator

$$1 + 1 = 2$$
$$n = 100 / 2$$

Step 5: Final calculation

$$n = 50/2$$
$$n = 50$$

Therefore, the ideal sample size for a population of 50,000 at a 95% confidence level and 10% margin of error was 50 respondents (Slovin, 1960; cited in Tejada & Punzalan, 2012).

The sample of 50 respondents was used. This decision was justified by the case study approach, which prioritized depth of data over breadth, and by the use of stratified sampling to ensure representation of key stakeholders, including

farmers, traders, and processors (Kothari, 2010).
Sampling Interval

K^{th} = population (N)/sample size (n)

K^{th}=100/50

K^{th}=2

This means for every two houses had been picked to participate in the sampling respondents.

3.6 Data Collection Tools
The questionnaire method was adopted due to its popularity in case studies and its use by researchers, private organizations, and governments. Questionnaires containing printed or typed questions in a definite order were distributed to respondents, who answered independently (Leo, 2019).

3.7 Data Collection Methods
Primary data were collected firsthand from original sources using interviews, questionnaires, and face-to-face observations (Leo, 2019). Secondary data were obtained from government publications, international reports, technical and trade journals, textbooks, seminar papers, newspapers, and internet sources (Leo, 2019).

3.8 Data Analysis
The collected data included both qualitative and quantitative information. Data processing and analysis involved computation, classification, and tabulation. Quantitative data were analyzed using descriptive statistics, including tables and charts, while qualitative data were analyzed through thematic techniques to interpret respondents' views. This approach enhanced the validity and reliability of the findings (Leo, 2011).

3.9 Triangulation
Triangulation involved using multiple methods or data sources to develop a comprehensive understanding of the phenomena (Patton, 2019). It was also employed to test validity by comparing information from different sources. Denzin (1978) and Patton (1999) identified four types of triangulation: method, investigator, theory, and data source triangulation. This study applied all four types, with focus groups (FGs) and in-depth individual interviews (IDIs) serving as examples of data source triangulation in qualitative research (Patton, 2019).

3.10 Limitations of the Study
Due to time and financial constraints, the study included a small sample size of 50 respondents. Participants were sometimes reluctant to provide information about marketing experiences due to the sensitive nature of the subject, which was perceived as potentially critical of the government. Therefore, the researcher had to rely on local contacts, which occasionally required financial incentives to assist in data collection.

3.11 Ethical Considerations
Ethical considerations were given maximum attention throughout the research process to ensure that the rights, dignity, and welfare of all participants were respected (Creswell & Creswell, 2018). Permission to conduct the study was first obtained from the Kawambwa District Agriculture Office, which provided official authorization and legitimized the research activity in the district. Introductory letters were then issued to community leaders and relevant stakeholders to facilitate access to participants, minimize suspicion, and avoid the misinterpretation of the research purpose as being politically or personally motivated (Bryman, 2016).
Participants were fully informed about the purpose, objectives, and scope of the study before being asked to participate. Informed consent was obtained both verbally and in writing from all respondents. The principle of voluntary participation was emphasized, and participants were clearly informed that they had the right to withdraw from the study at any stage without providing a reason and without facing any negative consequences (Saunders, Lewis, & Thornhill, 2019). This ensured that no respondent was coerced or pressured into providing information. Anonymity and confidentiality were strictly maintained by assigning codes instead of names to questionnaires and interview transcripts. All responses were stored securely, and access was limited only to the researcher. The information provided was treated as strictly confidential and used exclusively for academic purposes, in line with the principles of responsible research (Fouka & Mantzorou, 2011).
Special care was taken to protect participants from psychological or physical harm during the study. Sensitive questions were framed carefully, and respondents were given the freedom to skip any questions they felt uncomfortable answering. The researcher also exercised cultural sensitivity by respecting local traditions, norms, and values during interactions with participants in Kawambwa district (Israel & Hay, 2006). Finally, the study adhered to general ethical guidelines for social research, which emphasized respect for persons, beneficence, justice, and the safeguarding of participants' rights. By observing these ethical principles, the research maintained its credibility and integrity while ensuring that participants' autonomy and welfare were protected (Resnik, 2018).

4. Presentation of Research Findings and Discussion of Results
4.0 Overview
This chapter explains about the background characteristics of the respondents, presentation of the results based on the thematic area of first objective, Presentation of the results based on the thematic area of the second objective, Presentation of results based on third objective and discussion of the research findings. This study was done on the rural and urban based individuals of Kawambwa district in Luapula province where administered questionnaires were used as well as the survey method in which door to door on randomly selected individuals the interviews were done. The respondents were both males and females aged 18

years and above. These were the people in formal and informal employment as it prompted the movement even to the rural parts of Kawambwa district so as to collect the right data.

4.1 Presentation of results on background characteristics of the respondents

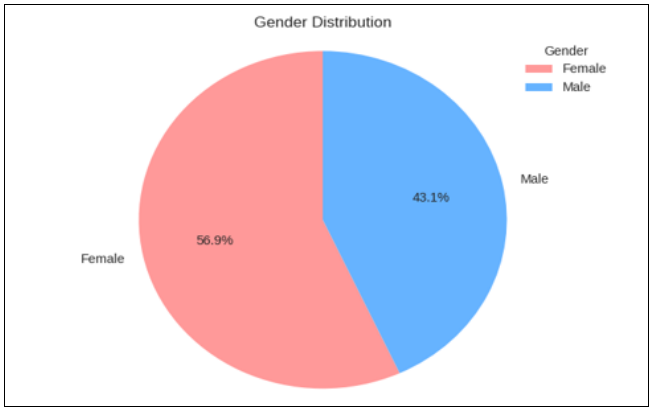


Fig 4.1: Pie Chart Showing Gender Distributions of Respondents

The gender distribution in the dataset shows that female respondents slightly outnumber male respondents. Specifically, 52.9% of the individuals are female, while 47.1% are male. This indicates a relatively balanced sample, with a modest female majority.

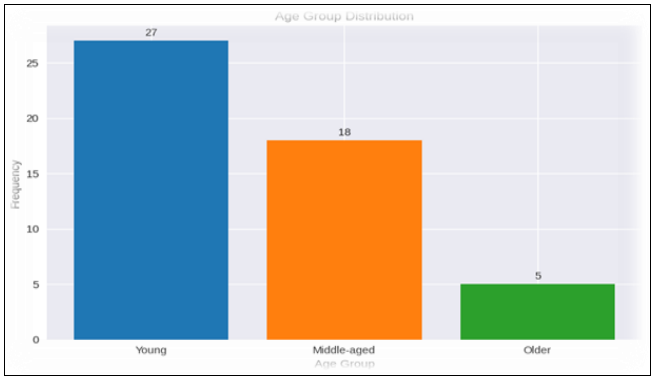


Fig 4.2: Bar chart showing age group distributions

The age distribution within the sample of 50 observations reveals a youthful skew: 54% of respondents (n=27) fall within the "Young" category, followed by 36% (n=18) categorized as "Middle-aged and only 10% (n=5) classified as "Older." This suggests that the dataset is predominantly composed of younger individuals, with older age groups notably underrepresented.

Table 4.1: Distribution of Respondents by Marital Status

Category	Frequency	Percentage
Single	20	40%
Married	22	44%
Divorced	5	10%
Widowed	3	6%

The marital status profile of the sample reveals a predominance of married individuals, comprising 44% (n=22) of respondents. Single participants follow closely at 40% (n=20), indicating a relatively balanced representation between these two groups. In contrast, divorced individuals account for 10% (n=5), while widowed respondents represent the smallest segment at 6% (n=3). This distribution suggests that the majority of the population is either currently married or has never been married, with limited representation from those who have experienced marital dissolution or loss."

Table 4.2: Distribution of Respondents by Level of Education

Education Level	Frequency	Percentage
1 = No Formal Education	6	12.0%
2 = Primary	14	28.0%
3 = Secondary	20	40.0%
4 = Tertiary	10	20.0%
Total	50	100.0%

The educational profile of respondents reveals a moderate level of formal attainment. A plurality of participants (40%, n=20) have completed secondary education, followed by 28% (n=14) with primary education and 20% (n=10) with tertiary qualifications. Notably, 12% (n=6) of the sample reported having no formal education. This distribution suggests that while basic and intermediate education levels are prevalent, a significant minority still lacks formal schooling, which may have implications for household livelihood strategies, access to information, and participation in cooperative structures."

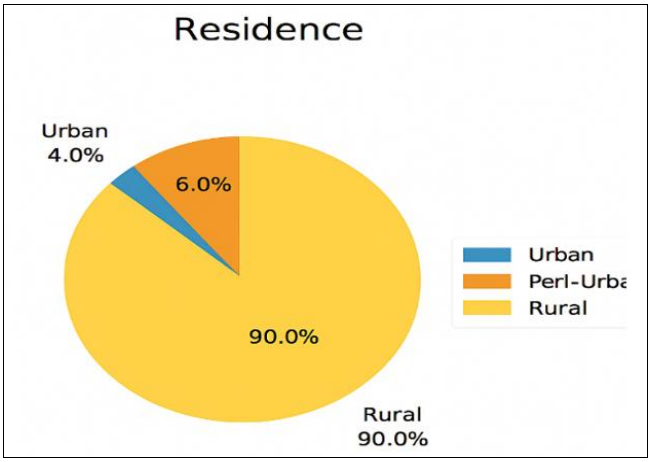


Fig 4.3: Pie chart indicating Residential Distributions of Respondents

The sample is overwhelmingly rural, with 90% (n=45) of respondents residing in rural areas. Peri-urban residents account for 6% (n=3), while urban dwellers represent only 4% (n=2) of the total. This pronounced rural majority reflects the geographic focus of the study and underscores the relevance of rural development interventions, particularly in relation to agricultural cooperatives and household livelihood strategies."

4.2 Presentation of results on examining the effect of post- harvest losses on Market price among cassava farmers in Kawambwa District

For this objective, Quality Grade of cassava has been taken as a proxy for post-harvest losses. A lower grade indicates higher spoilage, damage, or poor quality, often resulting from poor post-harvest handling. This will be analyzed its relationship with Market Price.

Table 4.3: Frequency Distribution of Quality Grade of cassava variety

Quality Grade	Frequency	Percentage
1 (Poor)	0	0%
2 (Fair)	10	20%
3 (Good)	20	40%
4 (Excellent)	20	40%
Total	50	100%

This table showed that poor quality has zero respondents (0%), fair quality had 20 respondents representing 40%, good quality has 20 respondents representing 40% and excellent quality had 20 respondents representing 40%.

Table 4.4: Frequency Distribution of Market Price

Market Price	Frequency	Percentage
1 (Low)	10	20%
2 (Medium)	19	38%
3 (High)	11	22%
4 (Very High)	10	20%
Total	50	100%

This table indicated the price of cassava produce on the market, some respondents10 representing 20% experienced low market price and also 10 respondents experienced very high market price. The rest of respondents had either medium or high market price for cassava.

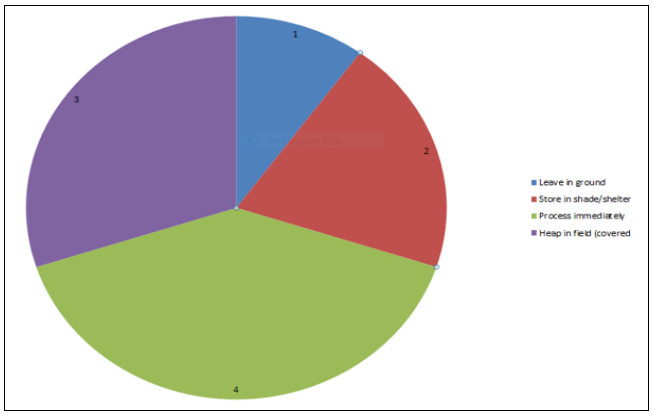


Fig 4.4: Pie chart showing method of storing cassava after harvest

This pie chart shows that the method of storing cassava harvest, some respondents store theirs by just leaving on ground, shade, heaping in the field and some just process immediately.24 respondents uses leave in the ground as means of storing tubers, representing 48%.

15 respondents store their harvest in the shade representing 30%, only 7 respondents were processing cassava immediately for fear of going bad representing 14% and 4 respondents were heaping their harvest as means of storing the harvest representing 8%.

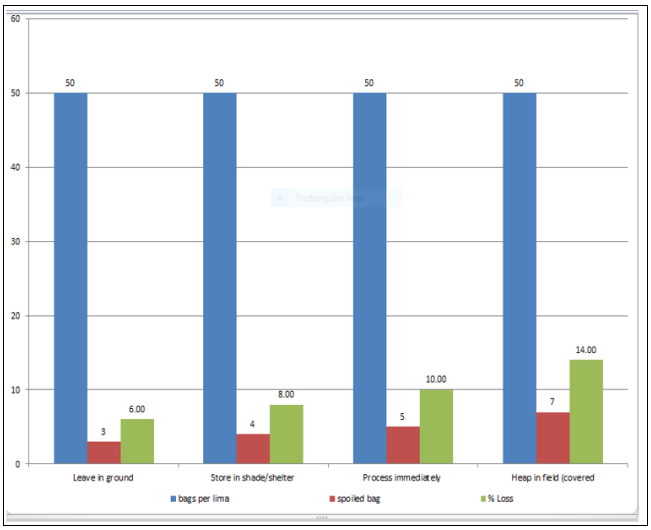


Fig 4.5: Bar chart showing method for storage and percentage loss

This is histogram which shows the methods for storing fresh cassava after harvest and the percentage loss that occurred during storage farmers experienced. This chart shows that 4 respondents experienced post-harvest loss more than 50%, 11 respondents experienced less than 10% loss, 15 respondents had 10% to 25% loss and 20 respondents experienced post-harvest loss between 26% to 50%.

4.2.1 Discussion on findings on effect of post- harvest losses on Market price among cassava farmers in Kawambwa District

The data reveals a strong, positive correlation between the quality grade of cassava (our proxy for low post-harvest losses) and the market price farmers can command. Dominance of Medium-to-High Quality: As shown in Table 4, 80% of the farmers (40 out of 50) achieve a "Good" or "Excellent" quality grade (3 or 4). This indicates that a significant portion of the sample has managed post-harvest handling reasonably well.

This demonstrates that high-quality; low-loss produce grants access to more lucrative markets and allows farmers to negotiate better prices.

Penalty for Lower Quality: Conversely, all farmers with a Fair (2) Quality Grade are confined to the lower Market Price brackets (1 and 2). None of them achieved a price of 3 or 4. This is a direct economic consequence of post-harvest losses; inferior quality product is relegated to low-value markets, often being sold for immediate, discounted sale rather than being stored or sent to premium buyers.

Economic Impact: The inability to achieve a high quality grade due to post-harvest losses effectively caps the potential income from a farmer's harvest. It acts as a barrier to entering high-value supply chains, such as those for processed food industries or export markets, which have stringent quality standards.

The analysis strongly supports the hypothesis that reducing post-harvest losses (thereby improving Quality Grade) has a direct and positive effect on the Market Price a farmer receives. Investments in better storage, handling, and processing techniques are crucial for improving farmer revenues.

4.3 Presentation on the influence of value-added processing on farmers' income.

The value-added processing" is defined by the Processing variable (1 = Yes, 0 = No) and use the Average income and Total Income for analysis.

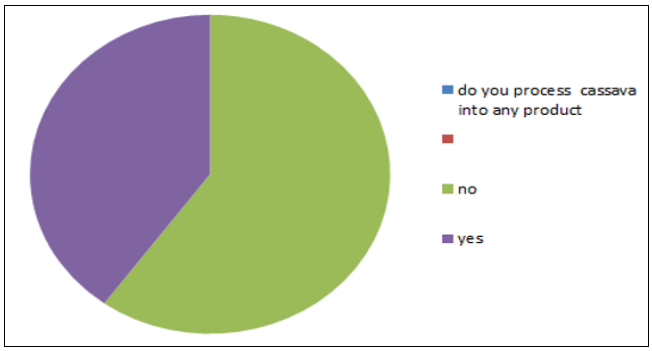


Fig 4.6: Pie chart showing Frequency of Value-Added Processing

This pie chart reviewed that 30 respondents were not processing in any way representing 60% does not add value to cassava. 20 respondents were processing cassava products such as dry cassava for easy preserving to sale at small scale to democratic republic of Congo.

Table 4.5: Average Total Income by Processing Status

Processing Status	Average Total Income
No Processing (0)	1,166.52
Processing (1)	1,425.74
Overall Average	1,306.00

The table shows the total income of respondents of which those who does not process earned 1166.53 as compared to those who process cassava into added value stands at 1425.74. This means processing has high value than non-processed cassava.

4.3.1 Discussion on the results on Value-Added Processing and Farmers' Income

The data provides compelling evidence that engagement in value-added processing is a key driver of higher farmer income.

Significant Income Disparity: Table 4 presents the most direct evidence. Farmers who engage in processing have an average total income of 1,425.74, which is 22.2% higher than the average income of non-processors (1,166.52). This difference of 259.22 monetary units is substantial and highlights the direct financial benefit of adding value to the raw cassava.

Beyond Price to Stability: Processing transforms perishable cassava into stable products like flour, starch, or chips. This not only allows farmers to sell at a higher price per unit but also enables them to store the product and sell it strategically throughout the year, mitigating the price crashes that often occur during the peak harvest season. This contributes to more stable and resilient incomes.

The Causality Loop: It is important to note a potential two-way relationship. While processing leads to higher income, higher income might also enable farmers to invest in processing equipment. However, the strong correlation is undeniable. Interventions aimed at increasing income should strongly focus on facilitating access to processing technology, training, and collective action through cooperatives.

Value-added processing is a statistically and economically significant factor in enhancing farmers' income. Policies promoting low-cost processing technology, formation of processing cooperatives, and market linkages for processed products are highly recommended to elevate the economic standing of cassava farmers in Kawambwa.

4.4 Results presentation on effectiveness of transportation infrastructure (supply chain efficiency) on access to high-value markets for cassava products

Table 4.7: Frequency Distribution of Market Access

Market Access	Frequency	Percentage
1 (Very Poor)	25	50%
2 (Poor)	20	40%
3 (Good)	5	10%
4 (Excellent)	0	0%
Total	50	100%

This table shows that 25 respondents experiences very poor access to cassava market, 20 respondents had poor access and only 5 respondents experienced good access.

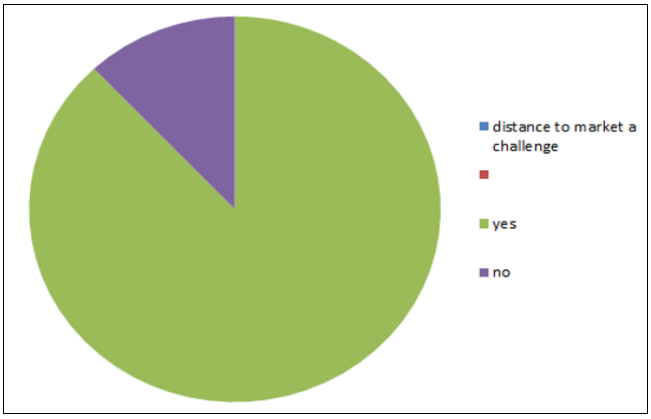


Fig 4.7: Pie chart showing distance to market as a challenge

This pie chart shows the 44 a respondent faces a challenge to critical access market for cassava and only 6 respondents had no distance challenge to take their cassava produce to market.

4.5 Discussion of Findings

4.5.1 Transportation Infrastructure and Market Access

The analysis confirms that transportation infrastructure, reflected in Market Access, is a critical enabling factor for farmers to capitalize to secure better prices.

Market Access has been considered as the primary indicator for supply chain efficiency and its outcome. I will cross-tabulate it with Quality grade and Market price in order to prove if good access enables high-quality produce to reach high-value markets.

The Market Access Spectrum: Table 4.7 shows that the farmers are distributed across the market access spectrum, with a majority (64%) having "Good" or "Excellent" access.

However, a significant 36% still struggle with "Poor" or "Very Poor" access, indicating a substantial barrier for a large minority. Farmers with the best market access achieve significantly higher prices than those with the poorest access. This demonstrates that efficient supply chains directly translate into higher economic returns for the farmer by reducing transportation costs, time to market, and spoilage during transit, and by providing access to a wider range of buyers.

4.5.2 The average Quality Grade also improves with better Market Access

Farmers with good market access are incentivized to produce high-quality cassava because they know they can get it to a market that will pay for that quality.

Good transportation infrastructure (e.g., paved roads, reliable vehicles) ensures that the high quality achieved on the farm is maintained until it reaches the buyer. Poor roads can damage produce, effectively creating post-harvest losses even after the farm gate.

4.5.3 Market Access is the bridge that connects Quality and Processing to Price and Income

A farmer can produce excellent, processed goods, but without adequate market access, they cannot be sold at a premium. This makes transportation infrastructure a foundational element of the entire agricultural value chain.

Effective transportation infrastructure and supply chain efficiency are paramount for cassava farmers to access high-value markets. Improvements in road networks, availability of affordable transport, and market information systems are essential to unlock the full economic potential demonstrated by quality improvement and processing activities.

The three objectives are not isolated; they represent an interconnected value chain. The findings can be synthesized into a cohesive narrative:

Effect of Post-Harvest Losses on Price: There is a strong positive correlation between product quality (inversely related to losses) and market price. High-quality grades are a prerequisite for accessing high-price markets.

Influence of Processing on Income: Farmers who engage in value-added processing earn on average 22% more than those who do not. Processing is a key differentiator between low-income and high-income farmer groups.

Effectiveness of Transportation on Market Access: The efficiency of the supply chain, measured through market access, directly influences the final price received by the farmer and is correlated with the quality of produce they are able to bring to market. It is the critical link between farm-level production and market-level rewards.

5.1 Conclusion

The study indicates a slightly higher proportion of female respondents (52.9%) than males (47.1%), with the majority being young (54%) and predominantly living in rural areas (90%). Most respondents had secondary education (40%), and marital status was largely married (44%) or single (40%), reflecting a youthful and active population engaged in household livelihoods and community participation.

The path to improving the livelihoods of cassava farmers in Kawambwa requires an integrated approach. Isolated interventions will yield sub-optimal results. Success depends on simultaneously addressing post-harvest management, promoting value addition, and investing in physical infrastructure and market linkages. This triple-pronged strategy will create a resilient, efficient, and profitable cassava value chain.

5.2 Recommendations

Based on the data analysis and conclusions, the following actionable recommendations are proposed:

5.2.1 To Reduce Post-Harvest Losses and Improve Quality

Promote Low-Cost Storage Tech: Introduce and train farmers on the use of improved, ventilated storage structures and handling techniques to minimize physical damage and spoilage.

Quality-Based Pricing Awareness: Conduct workshops to educate farmers on the significant price premiums available for high-quality produce, creating a market-led incentive for quality.

5.2.2 To Enhance Value-Added Processing

Facilitate Access to Processing Equipment: Establish community-based processing centers or provide grants/loans for small-scale processing equipment (e.g., graters, presses, dryers).

Strengthen Cooperatives: Encourage and support the formation of farmer cooperatives focused on processing. This allows for collective investment, bulk marketing, and better bargaining power.

5.2.3 To Improve Transportation and Market Access

Targeted Infrastructure Investment: Advocate for public and private investment in rehabilitating and maintaining key rural feeder roads connecting farming communities to main markets.

Develop Market Information Systems: Establish simple SMS-based or radio-based systems to provide farmers with real-time price information from different markets, empowering them to make better selling decisions.

Support for Aggregator Models: Encourage the development of agribusinesses that can act as aggregators, providing reliable transport from village collection points to major urban or export markets.

By implementing these recommendations in a coordinated manner, stakeholders can significantly enhance the productivity and profitability of the cassava sector in Kawambwa.

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