

Assessing the Potential Economic Viability of Mango Value Addition in the Waterberg District, Limpopo Province

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ARTICLE INFO	ABSTRACT
<p><i>Article history:</i> Received: March 16, 2026 Accepted: March 30, 2026 Published: March 31, 2026</p>	<p>This study explores the potential economic viability of transforming mango production into a sustainable and profitable agro-processing business in the Waterberg District of Limpopo Province, South Africa. Although Limpopo is one of the country's leading mango producing regions, especially Mopani and Vhembe District, a significant share of output is sold as fresh fruit with limited local value addition. The study adopts a case study design supported by secondary data analysis and a structured review of recent agricultural and agro-processing literature. Cost structures, market trends, and value chain opportunities are examined to determine the feasibility of processing mangoes into dried fruit, juice, pulp, and related products. Findings indicate that value addition enhances gross margins, improves price stability, and reduces post-harvest losses. However, constraints related to infrastructure, energy reliability, compliance costs, and market access remain significant. The results suggest that with coordinated institutional support and appropriate scale, mango processing in Waterberg can contribute to rural employment, enterprise development, and regional economic diversification. The study offers practical recommendations for producers, cooperatives, and policymakers seeking to expand agro processing in the district.</p>
<p><i>Keywords:</i> Mango value chain, Agro-processing; Rural development, Limpopo agriculture, Smallholder enterprise</p>	

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1. Introduction

Agriculture in South Africa remains a foundational pillar of the national rural economy, providing livelihoods for millions and sustaining communities beyond urban centres (Statistics South Africa (Stats SA), 2024b; African Development Bank Group, 2024). Recent national agricultural surveys confirm that farming and related activities continue to contribute meaningfully to rural employment and household income, even within a broader economic environment characterised by structural constraints and uneven growth (Stats SA, 2024a; African Development Bank Group, 2024). Within this context, horticulture has demonstrated resilience and diversification potential, particularly in high value fruit industries (Organisation for Economic Co-operation and Development, 2024). Limpopo Province has emerged as a strategic hub for subtropical fruit production, especially mangoes. Industry data indicate that the province accounts for majority of national mango plantings, reflecting favourable agro climatic conditions and established production systems (South African Mango Growers' Association, 2024). The concentration of mango production in Limpopo illustrates the province's comparative advantage within

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the national fruit economy and its integration into broader value chains that connect producers to domestic processors and selected export markets (National Agricultural Marketing Council (NAMC), 2024; United Nations Conference on Trade and Development (UNCTAD), 2023, 2025). Mangoes form part of a wider horticultural portfolio that supports regional agricultural output and local employment (Stats SA, 2024a). Industry analysis suggests that although trade opportunities exist, most mangoes are absorbed by domestic markets or processed into products such as atchaar, juice, and dried fruit, with fresh export volumes representing a smaller share of total production volume (NAMC, 2024; International Trade Centre, 2023). Notwithstanding relatively high production volumes, a significant proportion of mango output is not channelled into premium markets. This pattern reflects both market access constraints and the structural characteristics of commodity dependent production systems in developing economies (UNCTAD, 2025). Value addition therefore plays a critical stabilising role in mitigating exposure to seasonal gluts and price volatility that often affect fresh produce markets (Organisation for Economic Co-operation and Development & Food and Agriculture Organization of the United Nations, 2025; NAMC, 2024). A persistent challenge for mango producers, particularly smallholders, relates to post harvest losses and limited integration into high value chains. Broader African evidence demonstrates that inadequate infrastructure, weak coordination, and limited processing capacity reduce farmers' ability to capture value beyond primary production (Shilomboleni, Epstein, & Mansingh, 2024; Ruben, 2024). Structural constraints within agricultural commercialisation processes have long been associated with unequal value capture along supply chains (Hall, Scoones, & Tsikata, 2017). In South Africa, limited local beneficiation can translate into forgone income opportunities and reduced resilience to commodity price fluctuations (UNCTAD, 2023). Agro processing is widely recognised as a pathway for strengthening value retention and promoting inclusive rural transformation. Industrial policy frameworks in South Africa prioritise agro processing as a driver of employment creation, competitiveness, and local industrial development (Department of Trade, Industry and Competition, 2023). At continental level, agricultural transformation and value chain upgrading are central to strategies aimed at achieving climate resilience and inclusive growth (African Development Bank Group, 2024). International evidence further highlights that sustainable agrifood value chain transformation requires coordinated institutional support, infrastructure investment, and market integration (Hidayati, Garnevska, & Childerhouse, 2023; World Bank, 2023). At district level, cooperative and cluster-based models have been identified as mechanisms for improving smallholder participation in agri food value chains and enhancing local value capture (Christian, Obi, Zantsi, Mdoda, 2024; Widadie, Wulandari, & Lestari, 2024). Empowerment interventions targeting agribusiness development have also demonstrated positive livelihood effects when appropriately structured (Adeyanju, Mburu, Gituro, Chumo, Mignouna, & Mulinganya, 2023). However, agricultural policy monitoring reports caution that successful trade and environment integration requires coherent institutional coordination and enabling infrastructure (Department of Agriculture, Land Reform and Rural Development, 2025). The Waterberg District in Limpopo reflects many of these structural dynamics. While endowed with agricultural land and production capacity, the district exhibits limited formal processing infrastructure relative to its horticultural potential. Evidence from broader African contexts suggests that without targeted upgrading strategies, primary production regions risk remaining commodity dependent and vulnerable to external price shocks (UNCTAD, 2025; Ruben, 2024). This raises a critical research problem: whether converting mangoes into processed products such as dried fruit, pulp, juice, atchaar, or chutney can generate sustainable profitability within the Waterberg

District. The present study therefore seeks to explore the potential economic viability of mango value addition in Waterberg District by examining cost and revenue implications, market demand dynamics, and the institutional and infrastructural conditions shaping enterprise sustainability. Specifically, the study addresses three objectives. First, to assess the comparative economic returns of mango processing relative to fresh fruit sales. Second, to evaluate the influence of value chain governance, market access, and demand structures on profitability. Third, to identify the structural conditions that enable or constrain sustainable mango-based enterprises in the district. The central research questions guiding the study are as follows: Is mango processing in Waterberg District economically viable compared to selling fresh fruit? What value chain factors influence profitability within this context? What institutional and infrastructural conditions determine the sustainability of mango-based enterprises? Addressing these questions contributes to understanding how value chain upgrading can strengthen rural economic resilience and reduce commodity dependence within a district specific context.

2. Literature review

Agro processing has increasingly been positioned as a central pillar in strategies aimed at rural economic transformation, particularly within developing economies seeking to reduce dependence on primary commodities (UNCTAD, 2023). Contemporary agricultural policy debates emphasise value addition as a mechanism for strengthening food systems resilience, stimulating rural employment, and enhancing income stability among producers (FAO, 2023a; OECD & FAO, 2025). The renewed focus on agro processing is not only linked to economic growth but also to sustainability transitions, climate resilience, and inclusive development pathways (African Development Bank Group, 2024; Hidayati et al., 2023). In the South African context, agriculture remains structurally dualistic, characterised by well capitalised commercial enterprises alongside smallholder and emerging farmers who face persistent barriers in accessing markets, finance, and infrastructure (Stats SA, 2024b; Ruben, 2024). Industry analysis confirms uneven participation in high value chains, with structural asymmetries shaping value capture across commodities (NAMC, 2024). The researcher observes that agro processing is frequently presented in policy discourse as a bridge between these agricultural realities, offering pathways for greater inclusion and local value retention (DTIC, 2023; Christian et al., 2024). By extending value chains beyond primary production, agro processing is expected to reduce commodity dependence and enhance rural industrial linkages (UNCTAD, 2025). Recent industrial policy frameworks reaffirm agro processing as a priority sector for employment generation, industrial diversification, and rural development (DTIC, 2023; OECD, 2024). However, the researcher argues that empirical literature often assumes that value addition automatically translates into improved profitability, without sufficiently interrogating district level infrastructural constraints, governance capacity, and market integration dynamics (World Bank, 2023; Shilomboleni et al., 2024). This review therefore examines mango value chains, profitability determinants, and rural industrialisation while critically engaging with evidence relevant to Limpopo Province and districts such as Waterberg.

2.1. Mango Value Chains and Profitability

Globally, mango production and trade have expanded steadily, reflecting rising consumer demand for fresh and processed fruit products across developed and emerging markets (FAO, 2023a; OECD & FAO, 2025). Changing dietary patterns, urbanisation, and growing preference for convenience foods have

increased demand for processed fruit products, including dried mango, pulp, juice concentrates, and chutneys (International Trade Centre, 2023). These developments have stimulated renewed academic and policy attention to value chain upgrading strategies in producing countries seeking to capture greater local value (UNCTAD, 2023). Within Africa, South Africa remains one of the continent's most established mango producers, with production concentrated primarily in Limpopo Province (SAMGA, 2024). Industry statistics confirm that Limpopo accounts for majority of national plantings, benefiting from favourable climatic conditions and established irrigation systems (SAMGA, 2024; NAMC, 2024). This concentration positions the province as a strategic site for examining value addition opportunities. While fresh domestic markets remain significant, substantial volumes are channelled into processing industries, particularly for atchaar and juice production (NAMC, 2024). This illustrates the embedded nature of mangoes within both primary and secondary segments of the agri food system. Despite this established production base, price volatility remains a recurring challenge with import tax announcement for American markets. The NAMC (2024) reports that seasonal oversupply during peak harvest depresses farm gate prices, narrowing margins for growers without storage or processing alternatives and this is also prevalent in the Waterberg District as it total does not have any form of agr-processing infrastructure. Regions with high volume of commodity production are constantly vulnerable to such volatilities, as highlighted in broader African commodity analyses (UNCTAD, 2025). When the produces are processed into other forms of products this can buffer producers against seasonal price collapses by converting perishable fruits into products with extended shelf life. The type of innovation and approach is supported this argument, but it is further noted that profitability outcomes depend on operational efficiency and market access rather than processing alone (World Bank, 2023; Hidayati et al., 2023). Provision of infrastructure reliability is central to this discussion. The World Bank (2023) underscores that, value addition enhances margins only when supported by dependable logistics, electricity, and transport systems and can be driven by the market demand of that product. Energy insecurity which is a common challenge in developing countries and rising operational costs pose significant risks to agro-processing enterprises (African Development Bank Group, 2024). The South African national industrial policy recognises these constraints and emphasises the need for coordinated investment in energy and infrastructure to support agro industrial competitiveness across the country (DTIC, 2023). The researcher observes that in rural districts, infrastructural gaps may offset the price premiums associated with processed products, thereby weakening viability. Empirical evidence suggests that cooperative or cluster models can enhance value retention by reducing per unit costs and strengthening bargaining power (Christian et al., 2024; Widadie et al., 2024). Shared processing facilities allow emerging producers to overcome capital barriers and comply with quality standards and product compliance especially when processing perishable products. Agribusiness empowerment interventions have demonstrated positive livelihood impacts when collective action and institutional support are present (Adeyanju et al., 2023). However, the researcher cautions that cooperative success depends on governance capacity and trust, as weak coordination can undermine anticipated efficiency gains (Shilomboleni et al., 2024). Regulatory compliance and food safety standards add another dimension to profitability and viability of the agro-processing industry. International trade and domestic retail markets increasingly demand traceability, certification, and quality assurance for both raw and processed agricultural products (FAO, 2023a; OECD & FAO, 2025). While certification unlocks access to premium markets, it also increases fixed costs. Emerging enterprises must invest in equipment, record keeping systems, and compliance procedures. The researcher argues that cumulative compliance costs,

when combined with energy and logistics challenges, may disproportionately affect small scale processors in rural areas (Ruben, 2024). Post-harvest loss further shapes value chain outcomes. FAO (2023a) estimates that significant volumes of perishable horticultural produce are lost due to inadequate storage and processing capacity. Reducing these losses aligns with sustainability and resource efficiency objectives (Hidayati et al., 2023). Agro processing is an ideal solution to create alternative markets for fruit that does not meet fresh export standards, thereby enhancing capturing the secondary value agricultural produces (NAMC, 2024). However, the researcher emphasizes that processing capacity must be aligned with production volumes, as overinvestment without sufficient throughput may undermine financial sustainability and feasibility of the industry. Market access dynamics are equally influential. Export markets offer price premiums but require stringent phytosanitary compliance and reliable logistics (ITC, 2023; World Bank, 2023). This is advocated by the Perishable Products Export Control Board (PPECB) in South Africa. Domestic markets may present fewer regulatory barriers but are highly competitive and price sensitive. The researcher introduces a balanced market portfolio perspective, suggesting that district level processing strategies should integrate domestic retail, regional distribution, and selective export participation to mitigate risk (UNCTAD, 2023; OECD & FAO, 2025).

2.2. Rural Industrialization and Agro processing

Agro processing occupies a central position in contemporary debates and dialogues on structural transformation, particularly in developing economies seeking to move beyond primary commodity dependence. The role of value addition in supporting structural change and reducing commodity dependence is widely emphasised in recent development literature (UNCTAD, 2023; UNCTAD, 2025). By converting raw agricultural outputs into higher value products, agro processing extends economic activity beyond the farm gate and increases the fair share of value retained within producing regions. In this sense, it functions not merely as a technical activity but as a strategic instrument for industrial development and maximize investment returns of the products (World Bank, 2023). The multiplier effects associated with agro processing are especially significant in rural contexts. Agro-industrial development stimulates employment in processing plants, packaging, transport, maintenance, and ancillary services, while strengthening linkages between farm and non-farm activities whilst ensuring consumers receive quality products (FAO, 2023a; African Development Bank Group, 2024). These linkages generate non-farm income opportunities that can stabilise household livelihoods in areas historically dependent on seasonal agriculture. In rural districts such as the Waterberg District, which is characterised by limited formal employment, the potential for labour absorption across multiple nodes of the value chain is particularly relevant and important of the livelihoods of rural communities (Natarajan, Newsham, Rigg, & Suhardiman, 2022). Agro processing of perishable products therefore contributes to both income diversification and sustainable local economic resilience. Within South Africa, agro processing is formally recognised as a priority sector in industrial policy frameworks. The DTIC (2023) identifies food and agro processing as a driver of inclusive industrialisation, export diversification, and regional development. Incentive schemes such as production support programmes and special economic zones aim to attract investment and stimulate enterprise growth in the secondary agricultural sector (DTIC, 2022, 2023). These interventions signal a policy commitment to leveraging agricultural endowments for broader industrial gains. However, the translation and implementation of national policies into localised industrial outcomes remains uneven and a major barrier. While national

industrial policy outlines substantial support mechanisms, provincial and district level realities often reveal implementation bottlenecks that delays potential development opportunities of the rural areas (DTIC, 2023). In rural districts, limited administrative capacity, weak coordination between stakeholders, and infrastructural backlogs constrain the effectiveness of incentive programmes. Similar governance and coordination constraints in commercialisation of agrarian programmes processes have been observed elsewhere in Africa (Hall et al., 2017). The divergence between policy ambition and operational execution raises questions about the institutional conditions necessary for agro processing to fulfil its transformative potential. Infrastructure consistently emerges as a foundational determinant of agro industrial competitiveness especially in rural areas. Reliable electricity, adequate water supply, efficient transport networks, and digital connectivity are essential for processing industries that rely on timely production and distribution (World Bank, 2023; African Development Bank Group, 2024). Processing facilities require consistent power for machinery, refrigeration, and quality control systems. Interruptions increase production costs, reduce output reliability, and undermine competitiveness and compromise the quality of the products. In rural districts such as Waterberg, lack of infrastructure provision increases operational risk and deters private investment especially associated with processing raw of agricultural produces. Transport and logistics also represent another critical infrastructural dimension. Agro processing relies on efficient movement of raw materials from farms to factories and finished goods to markets. High transport costs erode margins, particularly for small and medium enterprises operating far from major urban centres where these processing industries exist (World Bank, 2023). Geographically dispersed and marginalized rural settings, poor road conditions and long distances to ports or wholesale markets can offset gains achieved through value addition. The sustainability of rural agro processing therefore depends not only on production quantities and efficiency but also on integrated logistics planning to research the desired market destinations. Access to finance further shapes the trajectory of rural industrialization. Small and medium agro-processing enterprises often face collateral requirements and credit constraints that limit capital investment which are potential opportunities to create employments in these rural areas (FAO, 2023a; Ruben, 2024). Processing activities typically require upfront quantum investment and expenditure on equipment, storage facilities, and compliance systems. Without affordable financing, entrepreneurs struggle to scale up operations or upgrade to modern technological viable systems. Although development finance institutions and commercial banks provide sector specific products, such provision and uptake in rural areas remains bleak and limited (DTIC, 2023). Blended finance models and public private partnerships are frequently proposed as mechanisms to bridge financing gaps especially for rural setup. Policy frameworks emphasise co-funding arrangements and risk sharing instruments to stimulate investment in priority sectors (DTIC, 2023; OECD, 2024). Yet the effectiveness of such mechanisms depends on complementary support structures, including technical assistance and business development services. Evidence from value chain development initiatives indicates that, finance must be combined with institutional strengthening and capacity building to produce long-term sustainable outcomes (Hidayati et al., 2023; Widadie et al., 2024). Environmental sustainability has become an increasingly prominent dimension of agro-processing discourse. The transition toward climate resilient and resource efficient production systems is central to contemporary agricultural policy debates (African Development Bank Group, 2024; FAO, 2023b). Processing activities are often energy intensive and generate waste streams that require careful management system envisioned to protect and prevent environmental challenges. Integrating renewable energy solutions, improving water efficiency, and valorising by products can

enhance both environmental performance and long-term cost efficiency (OECD & FAO, 2025). In rural South Africa, the integration of renewable energy into agro-processing facilities presents both opportunities and constraints. Renewable systems such as solar installations can reduce dependence on unstable and continuously interrupted grid electricity and lower long term operating costs, yet high initial capital requirements may constrain adoption among small enterprises (African Development Bank Group, 2024). Embedding environmental considerations in feasibility assessments from the outset strengthens the strategic coherence of agro industrial initiatives and supports long term resilience (Shilomboleni et al., 2024). Another dimension of rural industrialisation concerns spatial equity. Industrial development can inadvertently reinforce regional disparities if investment concentrates in already developed nodes resulting in continues migration to already highly populated urban areas (UNCTAD, 2025). Agro-processing strategies that prioritise rural districts must therefore address historical infrastructure deficits and institutional weaknesses. Without targeted interventions, rural areas risk remaining peripheral suppliers of raw commodities rather than becoming centres of value creation (World Bank, 2023). Institutional coordination also plays a decisive role in shaping outcomes. Effective agro-processing ecosystems require collaboration between farmers, processors, financial institutions, regulators, and local government authorities. Fragmented institutional arrangements can delay project implementation and increase transaction costs or totally result in project collapses (DTIC, 2023). Evidence from cooperative and value chain initiatives suggests that coordinated platforms can enhance smallholder participation and improve opportunities and integration in the market fraternities (Christian et al., 2024; Adeyanju et al., 2023). In sum, agro processing represents a promising pathway for rural industrialisation, but its success is contingent on more than policy declarations. The literature demonstrates that infrastructure reliability, financial accessibility, institutional capacity, and environmental sustainability are interdependent factors shaping competitiveness and possible inclusivity of the rural farmers (World Bank, 2023; OECD, 2024). In districts such as Waterberg, leveraging agricultural potential for industrial transformation requires integrated planning that addresses structural constraints while fostering local enterprise development. When these conditions are met, agro processing can extend value chains, generate employment, and contribute meaningfully to inclusive rural development and potential economic growth.

2.3. Literature Gap

While the national and global literature provides substantial evidence on the potential of agro processing to enhance rural development, there is limited district specific analysis of economic feasibility in potential mango producing regions such as Waterberg. Much of the existing work concentrates on national market intelligence, aggregate production trends, or broad value chain performance rather than detailed assessments of micro level cost structures and local institutional dynamics (NAMC, 2024; World Bank, 2023). Similarly, international outlook reports emphasise sectoral growth and trade prospects but do not sufficiently interrogate sub regional viability conditions which where ordinarily mapped for production of these agricultural products (OECD & FAO, 2025; UNCTAD, 2023). A critical gap therefore exists in understanding how localised factors such as infrastructure reliability, cooperative governance, production scale, and access to finance interact to determine profitability at district level. Although studies highlight the importance of smallholder integration, institutional coordination, and inclusive value chain development (Christian et al., 2024; Hidayati et al., 2023), these analyses are rarely grounded in district specific economic modelling. Without such granular

analysis, policy recommendations risk remaining overly generalised and disconnected from operational realities. Contextual livelihood dynamics, resilience and sustainable capacities further complicate and already exist bleak picture, suggesting the need for more place-based inquiry for possible interventions for development (Natarajan et al., 2022; Shilomboleni et al., 2024). Furthermore, much of the literature implicitly assumes a linear progression from primary production to full scale processing as an indicator of upgrading. Commodity diversification debates increasingly caution against this uniform pathway, noting that hybrid and adaptive strategies may better reflect producer capacities and risk management considerations (UNCTAD, 2025; Ruben, 2024). Evidence from business model innovation in high value markets suggests that flexible arrangements, including partial processing and mixed market orientation, can enhance resilience for smallholders (Widadie et al., 2024). There is therefore scope for future scholarship to explore non-linear value chain configurations that integrate fresh market sales with selective processing as part of diversified risk management strategies in rural districts such as Waterberg.

2.4. Conclusion of the Literature Review

The literature affirms the theoretical and empirical potential of agro processing to contribute to rural transformation, income diversification, and structural change. Evidence from global and South African contexts indicates that mango value addition can enhance profitability, reduce post-harvest losses, and stabilize producer incomes under conducive conditions. However, the researcher concludes that profitability is not automatic. Infrastructure reliability, regulatory compliance, market access, financial inclusion, and governance capacity significantly shape outcomes. District specific feasibility assessments remain underdeveloped in the literature, particularly in Limpopo's Waterberg District. There is therefore a clear need for context grounded analysis that integrates value chain theory with financial modelling and institutional evaluation. Such research can provide a more nuanced understanding of how mango processing enterprises can be designed to achieve both economic viability and inclusive rural development.

3. Theoretical Framework and Methodology

3.1. Theoretical Framework

This study is anchored in Value Chain Theory and Sustainable Livelihoods Theory, both of which are widely applied in contemporary agrifood system research. Value Chain Theory emphasises upgrading along production and marketing chains to capture greater value through activities such as processing, packaging, and branding. Recent work on sustainable agrifood value chain transformation highlights that agro-processing facilitates functional upgrading and strengthens linkages between agriculture, processing/manufacturing, and markets (Hidayati et al., 2023). In the context of mango production, processing represents forward integration within the value chain, allowing producers and local enterprises to retain a larger share of final market value while improving competitiveness in domestic and export markets (Widadie et al., 2024). Sustainable Livelihoods Theory complements this perspective by focusing on income diversification, resilience, and reduced vulnerability among rural households. Contemporary adaptations of the livelihood's framework stress the importance of diversified asset portfolios, institutional support, and market integration in strengthening rural resilience (Natarajan et al., 2022). Empirical assessments of agricultural development interventions in Africa further

demonstrate that livelihood outcomes improve when value addition strategies are linked to broader resilience building measures (Shilomboleni et al., 2024). Together, these frameworks provide an analytical lens for examining how value chain upgrading and diversification influence profitability, sustainability, and rural economic outcomes.

3.2. Methodology

A qualitative dominant case study design supported by secondary quantitative data analysis was adopted (Braun & Clarke, 2021; Chand, 2025). The design is appropriate for contextualised economic assessment and aligns with recent analyses of agricultural and food systems transformation in Africa (World Bank, 2023). No human participants were involved, and the study relied exclusively on publicly available secondary data; therefore, ethical clearance was not required. Data were sourced from official production and industry reports, including publications from the DLRRD (2025), Statistics South Africa (2024a, 2024b), and NAMC (2024), as well as peer reviewed journal articles. Additional contextual and policy insights were drawn from international outlook and commodity reports (OECD, 2024; OECD & FAO, 2025; UNCTAD, 2023). Literature searches were conducted using Scopus, Web of Science, and Google Scholar. Search terms included “mango value chain South Africa,” “agro-processing profitability Limpopo,” and “horticulture rural development.” Inclusion criteria required peer reviewed articles or official institutional reports published within the last five years, focusing on agro-processing, value addition, rural industrialisation, or horticulture economics in South Africa or comparable developing contexts (Booth, Sutton, & Papaioannou, 2021). Exclusion criteria eliminated opinion pieces without empirical evidence, studies unrelated to fruit value chains, and publications older than five years unless foundational to theoretical framing (Hall et al., 2017). Literature was evaluated based on methodological rigour, relevance to mango value chains, and transparency of data sources. Quantitative data were subjected to cost benefit estimation using reported production costs and processing margins, while qualitative findings were synthesised thematically to identify recurring economic, institutional, and governance determinants of viability (Braun & Clarke, 2021).

4. Results

The results are presented under three interrelated themes that directly address the research questions: first, whether mango processing in Waterberg District is economically viable compared to selling fresh fruit; second, which value chain factors influence profitability; and third, which structural conditions enable or constrain sustainable mango-based enterprises. The findings are grounded in recent production statistics, industry market intelligence, and agro-processing literature published within the last five years.

4.1. Comparative Profitability of Fresh Versus Processed Mango Products

Recent industry data confirm that mango production in South Africa remains concentrated in Limpopo Province, with seasonal output peaks contributing to price volatility in domestic markets (NAMC, 2024). Farm gate prices for fresh mangoes fluctuate significantly during peak harvest months due to oversupply and limited storage capacity (Stats SA, 2024a). This pattern is consistent with broader global evidence that perishable horticultural commodities are highly sensitive to supply shocks when value addition capacity is limited (FAO, 2023a; UNCTAD, 2023). The researcher’s analysis of indicative cost and price structures suggests that value addition through drying or juice processing generates higher gross

margins than fresh fruit sales, if processing operates at sufficient scale and efficiency. Table 1 and Figure 1 present a comparative margin structure compiled from recent South African industry and market intelligence reports.

Table 19. Indicative Margin Comparison for Fresh and Processed Mango Products in South Africa

Product Type	Average Farm Gate Price (R/kg)	Estimated Processing Cost (R/kg)	Estimated Selling Price (R/kg)	Estimated Gross Margin (%)
Fresh Mango	6.80	5.00	6.80	26
Unripe Mango (for atchaar/processing)	4.00	6.50	18.00	50
Dried Mango	6.80 input	16.00	30.00	42
Mango Juice	6.80 input	11.50	22.00	36

Source: NAMC (2024); Stats SA (2024a); FAO (2023a).

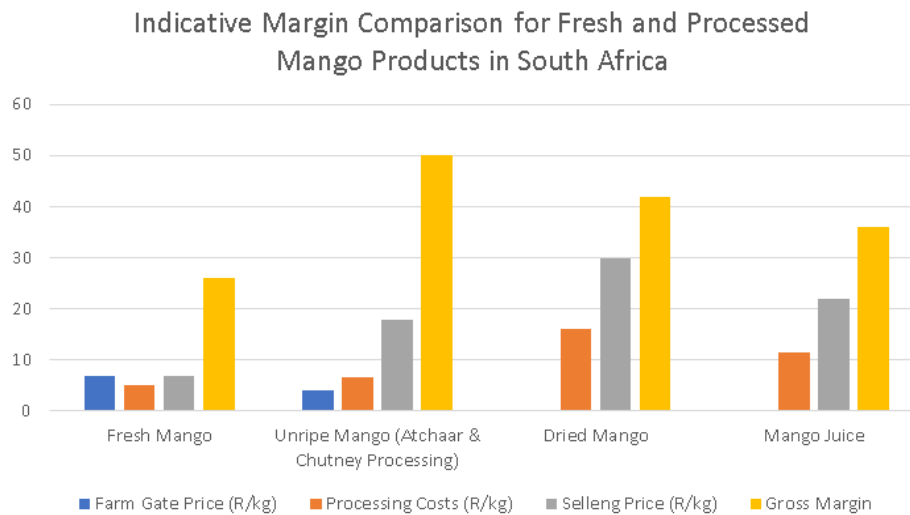


Figure 10. Indicative Margin Comparison for Fresh and Processed Mango Products in South Africa

Sources: NAMC (2024); Stats SA (2024a); FAO (2023a).

The table and figure 1 demonstrate that although processing costs are significantly higher than fresh marketing costs, the final selling price of processed products compensates for these additional expenditures. Dried mango products, in particular, command price premiums in differentiated retail and niche markets (NAMC, 2024). This finding aligns with broader assessments of agrifood value chain upgrading, which indicate that processed products enhance value capture by extending shelf life and reaching higher value market segments (Hidayati et al., 2023; OECD & FAO, 2025). The results therefore support the first research question: mango processing in Waterberg District can be economically viable relative to fresh sales, particularly when price volatility in fresh markets is high. However, profitability remains conditional. Achieving high margins in agro processing depends on sufficient processing volumes that allow fixed costs such as energy, packaging equipment, and regulatory compliance certification to be distributed across larger production outputs. Evidence on smallholder integration into high value markets underscores that scale and business model efficiency are decisive determinants of

competitiveness (Widadie et al., 2024; Ruben, 2024). Furthermore, price stability is improved through processing. Fresh mangoes are subject to rapid deterioration and forced sales during peak harvest periods, while dried or bottled products allow delayed marketing and storage (FAO, 2023a). This temporal flexibility reduces exposure to short term price collapses and supports more predictable revenue streams.

4.2. Value Chain Determinants of Profitability

The second research question concerns which value chain factors influence profitability in mango-based enterprises. The literature emphasises infrastructure reliability, logistics efficiency, certification compliance, and market access as decisive variables (World Bank, 2023; Hidayati et al., 2023). The results confirm that these factors significantly shape the economic feasibility of mango processing in Waterberg. Electricity reliability is a critical determinant. Agro processing is energy intensive, particularly for drying and pulp extraction. Broader continental analyses indicate that energy insecurity constrains agro-industrial expansion and increases operating costs (African Development Bank Group, 2024). Small and medium enterprises often incur additional expenses for backup systems, which reduces net margins. Transport and logistics also influence cost structures. According to NAMC (2024), transport costs and infrastructure constraints affect distribution efficiency. Evidence from African agricultural transformation studies highlight that weak logistics systems erode value addition gains, particularly in remote districts (World Bank, 2023). For Waterberg producers located far from major urban markets, logistics expenses can offset competitive advantages unless collective transport arrangements are established. Cooperative models have demonstrated potential to improve smallholder participation and reduce transaction costs (Christian et al., 2024).

Table 20. Key Value Chain Factors Affecting Mango Processing Profitability

Factor	Influence on Profitability
Electricity reliability	Increased operating costs and downtime
Transport logistics	Higher distribution expenses
Food safety compliance	Capital and certification costs
Market diversification	Improved price stability
Economies of scale	Reduced average processing cost

Sources: African Development Bank Group (2024); FAO (2023a); NAMC (2024), OECD & FAO (2025); World Bank (2023); Widadie et al. (2024)

Compliance with food safety standards represents both a challenge and an opportunity. FAO (2023a) indicates that certification enhances market access and consumer trust but requires upfront investment in quality control systems. The findings suggest that while compliance increases initial costs, it enables entry into higher value retail channels, thereby improving long term profitability. Market diversification emerges as a significant risk management strategy. Enterprises that combine fresh fruit sales, local retail distribution of processed products, and selective export participation are better insulated against market shocks (OECD & FAO, 2025; UNCTAD, 2025). Profitability is therefore strengthened not only by processing itself but by diversified market integration.

4.3. Structural and Institutional Conditions in Waterberg

The third research question examines structural conditions enabling or constraining sustainable mango-based enterprises in Waterberg. Rural infrastructure quality, access to finance, and institutional coordination are central themes in recent agrifood transformation literature (World Bank, 2023; African Development Bank Group, 2024). Access to finance remains uneven for small scale agro processors. Capital requirements for processing equipment and certification systems are substantial (FAO, 2023a). Studies on agribusiness empowerment in Africa indicate that financial inclusion and targeted support significantly influence enterprise sustainability (Adeyanju et al., 2023). However, collateral requirements and limited rural uptake of blended finance mechanisms continue to constrain expansion. Institutional coordination also influences sustainability. Cooperative and cluster approaches can reduce input costs and share risk among producers (Christian et al., 2024). Where governance is effective, collective processing facilities enhance bargaining power and scale efficiency. Conversely, weak governance undermines sustainability.

Table 21. Structural Enablers and Constraints for Mango Processing in Waterberg

Structural Factor	Enabling Potential	Constraining Effect
Cooperative processing models	Shared costs and scale efficiency	Governance challenges
Infrastructure investment	Reduced logistics and energy costs	High public expenditure needs
Access to blended finance	Capital mobilisation for SMEs	Limited rural uptake
Post harvest loss reduction	Increased value retention	Requires cold chain systems

Sources: Adeyanju et al. (2023); Christian et al. (2024); FAO (2023a); World Bank (2023)

The results indicate that structural improvements in infrastructure and finance would significantly enhance profitability prospects. Without these enablers, processing enterprises face high transaction costs that may offset revenue gains.

4.3.1 Synthesis of Findings

The findings collectively answer the research questions posed in the introduction. Mango processing in Waterberg District can be economically viable when cost structures are managed effectively, and processing volumes reach sufficient scale. Value chain factors such as electricity reliability, logistics efficiency, certification compliance, and market diversification significantly influence profitability. Structural conditions, particularly infrastructure quality and access to finance, determine long term sustainability. The results align with contemporary value chain transformation scholarship, which demonstrates that forward integration into processing increases value capture when supported by enabling institutional and infrastructural conditions (Hidayati et al., 2023). They also resonate with Sustainable Livelihoods perspectives that emphasise diversification and resilience in rural economies (Natarajan et al., 2022). However, a cautionary conclusion emerges. Processing alone does not guarantee rural transformation. Economic viability depends on coordinated infrastructure investment, financial inclusion, and institutional governance. Without these supports, value addition may remain concentrated among larger enterprises, limiting inclusive rural development in districts such as Waterberg.

5. Discussion

The results demonstrate that mango value addition in Waterberg District can enhance gross margins relative to fresh fruit sales, particularly when processing reaches adequate scale and is integrated into stable markets. This finding aligns with contemporary value chain transformation scholarship in agri food systems. Recent analyses of agrifood value chain upgrading indicate that moving from primary production into processing and manufacturing increases local value retention and strengthens rural industrial linkages (Hidayati et al., 2023; UNCTAD, 2023). The comparative profitability tables presented in the results section confirm that processed mango products such as dried fruit and juice command higher selling prices, thereby expanding the share of final value captured within the production region. The evidence also reinforces the argument that agro processing strengthens economic resilience by reducing exposure to price volatility in fresh produce markets. FAO (2023a) notes that value addition extends shelf life and stabilises revenues in horticultural value chains, particularly in contexts where seasonal gluts depress farm gate prices. In Waterberg, the results show that processing mitigates forced sales during peak harvest periods and creates temporal flexibility in marketing strategies. This supports Sustainable Livelihoods Theory, which emphasises diversification as a mechanism for reducing vulnerability among rural producers (Natarajan et al., 2022; Shilomboleni et al., 2024). However, the results equally demonstrate that profitability is conditional rather than automatic. Infrastructure reliability, especially electricity supply, emerged as a critical determinant of cost efficiency. Continental development assessments highlight that agro industrial competitiveness is closely tied to reliable energy and transport systems (African Development Bank Group, 2024; World Bank, 2023). In the Waterberg context, energy instability increases operating costs through downtime and reliance on alternative power sources. These constraints reduce net margins and create entry barriers for small and medium enterprises. Compliance costs also influence enterprise viability. As shown in the results, food safety standards and certification requirements increase initial capital expenditure. While compliance enables access to higher value retail and export markets, it may deter emerging producers without sufficient financial capacity. FAO (2023a) and OECD (2024) observe that regulatory compliance can enhance long term competitiveness, yet upfront costs disproportionately affect smaller enterprises. Regulatory frameworks therefore require complementary technical and financial support mechanisms to ensure inclusivity. Transport and logistics were identified as additional cost drivers. NAMC (2024) reports that rising transport costs and logistical inefficiencies reduce competitiveness in fruit value chains. Broader agricultural transformation analyses confirm that weak logistics systems undermine value addition gains in rural districts (World Bank, 2023). For Waterberg producers, distance from major urban consumption centres increases distribution expenses, particularly for processed goods requiring secure packaging and storage conditions. The findings reinforce the literature on the importance of coordinated value chain systems (Hidayati et al., 2023). The results further suggest that cooperative processing models could address some of these structural barriers. Evidence from South African case studies demonstrates that cooperatives enhance smallholder participation in agri food value chains by reducing transaction costs and improving collective bargaining power (Christian et al., 2024). Where governance structures are effective, shared infrastructure reduces per unit costs and strengthens economies of scale. In Waterberg, fragmented production could be consolidated through collective processing facilities, thereby improving cost efficiency and market leverage. Public policy support emerges as another decisive factor. Industrial policy frameworks position agro processing as a strategic driver of inclusive

industrialisation and regional development (DTIC, 2023; UNCTAD, 2025). The findings indicate that without institutional backing, including infrastructure investment and blended finance mechanisms, capital intensive processing operations may struggle to achieve financial sustainability. Access to affordable finance and targeted agribusiness empowerment initiatives significantly influence enterprise resilience and growth (Adeyanju et al., 2023; Ruben, 2024). The discussion of market integration further strengthens the argument that diversified market portfolios enhance stability. OECD and FAO (2025) emphasise that enterprises embedded in multiple market channels are less vulnerable to demand fluctuations and external shocks. The results from Waterberg indicate that combining fresh sales with processed product distribution across local retail and selective export markets improves revenue predictability. Processing should therefore complement, rather than replace, fresh marketing within a diversified value chain strategy. Overall, the discussion confirms that mango value addition in Waterberg is economically feasible when embedded within reliable infrastructure systems, supported by institutional coordination, and integrated into diversified markets. The evidence reinforces the theoretical propositions of Value Chain and Sustainable Livelihoods perspectives while highlighting contextual constraints that shape outcomes. Processing enhances value capture and income stability, but structural conditions ultimately determine whether these gains are inclusive and sustainable.

6. Conclusion

Mango value addition in the Waterberg District represents more than a technical adjustment to existing farming practices. It offers a realistic opportunity to deepen rural economic participation and strengthen the productive base of the district. The findings of this study demonstrate that processing mangoes into products such as dried fruit, juice, pulp, atchara and related goods can generate higher gross margins than the sale of fresh fruit alone. By extending shelf life and allowing producers to stagger market entry, processing reduces exposure to seasonal price collapses that often occur during peak harvest periods. In this sense, value addition provides not only financial gains but also greater income stability. At the same time, the study makes clear that viability is conditional. Profitability depends on reliable infrastructure, efficient logistics, and access to consistent markets. Energy disruptions, high transport costs, and compliance requirements increase operational expenses and can erode expected returns if not carefully managed. Processing is therefore not a guaranteed solution to rural development challenges. It is a strategic opportunity that must be supported by coordinated institutional and financial frameworks. When these enabling conditions are present, mango value addition can contribute meaningfully to local industrial development, employment creation, and value retention within the district.

Practical Implications

For local producers, collaboration appears essential. Cooperative or cluster-based processing facilities can distribute capital costs across multiple growers, making equipment acquisition and certification more affordable. Shared infrastructure also improves scale efficiency, which is critical for sustaining competitive margins. Producers should also consider diversified marketing strategies that combine fresh sales with processed product distribution in local and regional markets to balance risk and reward. Policymakers have a central role in strengthening the enabling environment. Investment in rural infrastructure, particularly reliable electricity and transport networks, will directly influence processing viability. Technical assistance programmes that guide small scale processors through food safety and

quality compliance requirements can lower entry barriers and improve competitiveness. Clear and consistent regulatory frameworks further enhance investor confidence and reduce uncertainty. Financial institutions can support this transition by developing tailored funding instruments suited to agro-processing enterprises. Flexible repayment terms aligned with seasonal production cycles, blended finance options, and risk sharing mechanisms would improve access to capital for emerging entrepreneurs.

Theoretical Implications and Further Research

The study affirms the relevance of Value Chain and Sustainable Livelihoods frameworks in understanding rural agro-processing dynamics. It demonstrates that upgrading within the value chain and diversifying income streams are closely linked to enhanced economic resilience. However, the findings also highlight the importance of contextual factors such as infrastructure and governance, suggesting that theoretical models must be applied with sensitivity to local realities. Future research should move beyond secondary data analysis and undertake primary feasibility studies within the Waterberg District. Detailed financial modelling, including sensitivity analysis on input costs, energy prices, and market demand fluctuations, would provide more precise investment projections. Comparative studies across districts could also illuminate how varying institutional and infrastructural conditions influence agro-processing outcomes.

Acknowledgements

We wish to extend our sincere appreciation to the Limpopo Department of Agriculture and Rural Development, and the University of Venda for providing an enabling platform for us to undertake this work.

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