



AN ANALYSIS OF THE MACADAMIA NUT VALUE CHAIN IN CHIPINGE DISTRICT, ZIMBABWE

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ABSTRACT: This study analysed the macadamia value chain in Chipinge District, Manicaland, using 2022 cross-sectional survey data from 150 growers, 6 traders, and 2 processors selected through stratified, random, and purposive sampling. Functional analysis identified key actors: input suppliers, estate, medium-scale, and smallholder farmers, merchants, and processors, engaged in input supply, cultivation, local processing, and export of nut-in-shells. Cost–return analysis showed smallholders earned the lowest profit (US\$0.58/kg) compared to merchants (US\$0.68), estate farmers (US\$0.67), and processors (US\$2.20). Value addition was highest among processors (US\$3.80), followed by smallholders (US\$1.25), estates (US\$1.14), and merchants (US\$0.97). Smallholders faced limited skills, weak markets, and low prices, while merchants and processors reported poor quality and high taxes. The study recommends targeted extension support, improved finance, high-yielding varieties, and stronger coordination to enhance smallholder participation and competitiveness through increased exports of processed macadamia products.

KEYWORDS: Macadamia value chain, Smallholder farmers, Value added, Cost and returns analysis, Chipinge District.



INTRODUCTION

Macadamia nuts are among the world's rarest and most valuable nuts, with global demand rising due to their health benefits (Keesecker, 2020; INC, 2023). The global market for macadamia nuts reached US\$1.4 billion in 2022, reflecting a 24 percent growth since 2012 and is projected to grow by 8.2 percent annually through 2030 (INC, 2023). Due to increased demand, most producer countries, such as South Africa, have expanded macadamia production by over 3,000 ha per year, while China is expected to double its macadamia production area from 30,000 hectares between 2023 and 2030 (SAMAC, 2023.; INC, 2023). Native to Australia, macadamias are now grown in several countries, both developed and least developed, including South Africa, Australia, Guatemala, USA, Kenya, Mozambique, Zimbabwe and Malawi with South Africa as the leading global producer (INC, 2023). In developing countries, macadamia production supports millions of smallholder farmers as a critical source of income, and generates immense employment opportunities in rural areas (Bandason et al., 2021a.; Jaskiewic Mac., 2015.; Zuza et al., 2024).

In Zimbabwe, macadamia is a high-value export crop also contributing to economic diversification, and is sold mainly as dried macadamia nut in shell (NIS) (ZimTrade, 2022). Introduced in 1965 in Chipinge district, and covering only 400 hectares (ha), macadamias initially served large-scale commercial farmers before expanding to smallholder farmers after the implementation of the Fast Track Land Reform Program (FTLRP) in 2000. The policy restructured land ownership by integrating new farming groups, including smallholder A1¹ farmers and medium -to large-scale A2² farmers (Zamchiya, 2013). Many farmers inherited farms with established orchards and adopted macadamia as their primary cash crop, shifting away from tea and coffee in response to declining world prices for these commodities. Currently, Zimbabwe has over 10,000 hectares of macadamia, mainly in high rainfall areas of Manicaland province, namely Chipinge, Chimanimani, and Mutasa districts, producing about 40,000 metric tons annually (MLAFWRD, 2023). Zimbabwe ranks sixth globally in macadamia exports, earning US\$15.56 million and accounting for 4 percent of global macadamia trade (Mharidzo et al., 2022). In 2022, macadamias were the top horticultural export crop, contributing 30 percent of horticultural export earnings, which in turn accounts for 4.5 percent of the total agricultural export earnings and 6.5 percent of the agricultural gross domestic product (GDP) (Ministry of Agriculture, 2023). Each year, approximately 10,000 people in Manicaland province are employed in the macadamia nut sector or macadamia-related activities (MLAFWRD, 2023).

Chipinge District is the hub for macadamia production, accounting for over 70 percent of the cultivated macadamia area in Manicaland province and more than 90 percent of Zimbabwe's macadamia area (MLAFWRD, 2023). Although large-scale farmers dominate macadamia output, more than 80 percent of smallholder households in the district depend on macadamia for income (Agricultural Marketing Authority (AMA), 2023). Since 2000, the area and output of macadamia in Chipinge District have constantly increased. For instance, in 2022, the

¹refers to small-scale farmers who were allocated smaller plots of land (10 hectares and below), under the Fast Track Land Reform Program (FTLRP) implemented in Zimbabwe in 2000. The A1 model was designed for intensive farming, promote small-scale cash crop production and increase food production at the household level.

²refers to medium- to large-scale commercial farmers who were allocated larger plots of land, above 10 hectares under the government's Fast Track Land Reform Program (FTLRP) implemented in 2000. The A2 model was designed to promote commercial farming and increase agricultural production and exports.



district's production value rose to US\$10 million, covering 7,000 ha, with a total production quantity of 35 million kilograms, an increase of 117 percent in output since 2016 (MLAFWRD, 2023). Smallholder farmers with an average land area of 5-6 ha cultivate 0.5-1.5 ha of macadamia on average, each hectare holding 300 trees, yet many grow only a few trees, less than twenty, yielding about 150 kg per year, generating around US\$300. Smallholder farmers have grown their hectarage from less than 1000 ha in 2010 to 3,300 ha in 2015 (MLAFWRD, 2015). Macadamia production in Chipinge District creates more than 4,500 jobs on farms and macadamia factories annually, thereby sustaining local people's livelihoods. This support has led to macadamia, commonly referred to as Chipinge's "cash cow" or "green diamond".

Despite its importance, the majority of smallholders have not benefited immensely from the production of macadamia because of low prices, weak bargaining power and limited storage or aggregation capacity. As such, they are compelled to sell fresh nuts directly to merchants at low prices amid rising production costs, poor coordination regarding export standards and limited access to market information. Shrestha et al. (2020) noted that farmers receive lower margins along agricultural export value chains because of monopolized middlemen market systems. In particular, where intermediaries are the main source of price information for farmers, they are disadvantaged in price negotiations, which often limits their ability to access competitive prices (Nguyen et al., 2023). The same is witnessed along the macadamia value chain in Chipinge district, the price valuation of macadamias lacks transparency along the supply chain, with farmers blaming merchants for reaping their profits.

Although several studies have examined export-oriented agricultural value chains and analyzed the cost and margin distribution among actors (see Nguyen et al., 2023; Patience & Ali, 2017; Owusu-Adjei et al., 2017; Zainol et al., 2023; Aliyu Danmaigoro et al., 2023; Sori & Wana, 2019), very few have focused on macadamia, and no such study has been done in Zimbabwe. Keeseker (2020) found that macadamia growers in Myanmar captured 45 percent of the total value, due to low input requirements for its cultivation. In Zimbabwe, government efforts under the Horticultural Recovery and Growth Plan (HRGP) (2020-2025), aim to enhance aim to enhance smallholder macadamia production through improved varieties, extension services, and market access. However, maximising benefits requires a clear understanding of how value is distributed and how actors are linked. Such insights are crucial for assessing the policy impacts, improving marketing channels, and unlocking the growth potential of smallholder macadamia and the integration of the Zimbabwean macadamia value chain into global markets. This study, therefore, addresses this gap by analysing the macadamia value chain in the Chipinge district of Zimbabwe. The specific objectives are to (i) map key actors and their roles, (ii) determine margins and value added at each stage, and (iii) assess production and marketing constraints to improve performance and competitiveness.

METHODOLOGY

This study was conducted in Chipinge District, Zimbabwe, between January and December 2022, covering one full macadamia cropping season. It adopts a mixed-method approach that employs both qualitative and quantitative research designs. The analysis focused on cross-sectional survey data for the 2022 macadamia cropping season.

Study Area

The study was carried out in Chipinge District, with a humid subtropical dry winter climate. The average annual rainfall is 1,105 mm, and the annual average temperature is 21.03°C (69.85°F), which is -1.7% lower than Zimbabwe's average. The district is agrarian, with more than 90 percent of working adults engaged in farming and farm-related activities for their livelihoods (ZIMVAC, 2022). The major crops grown in the district include tea, coffee, macadamia nuts, avocado, and dairy.

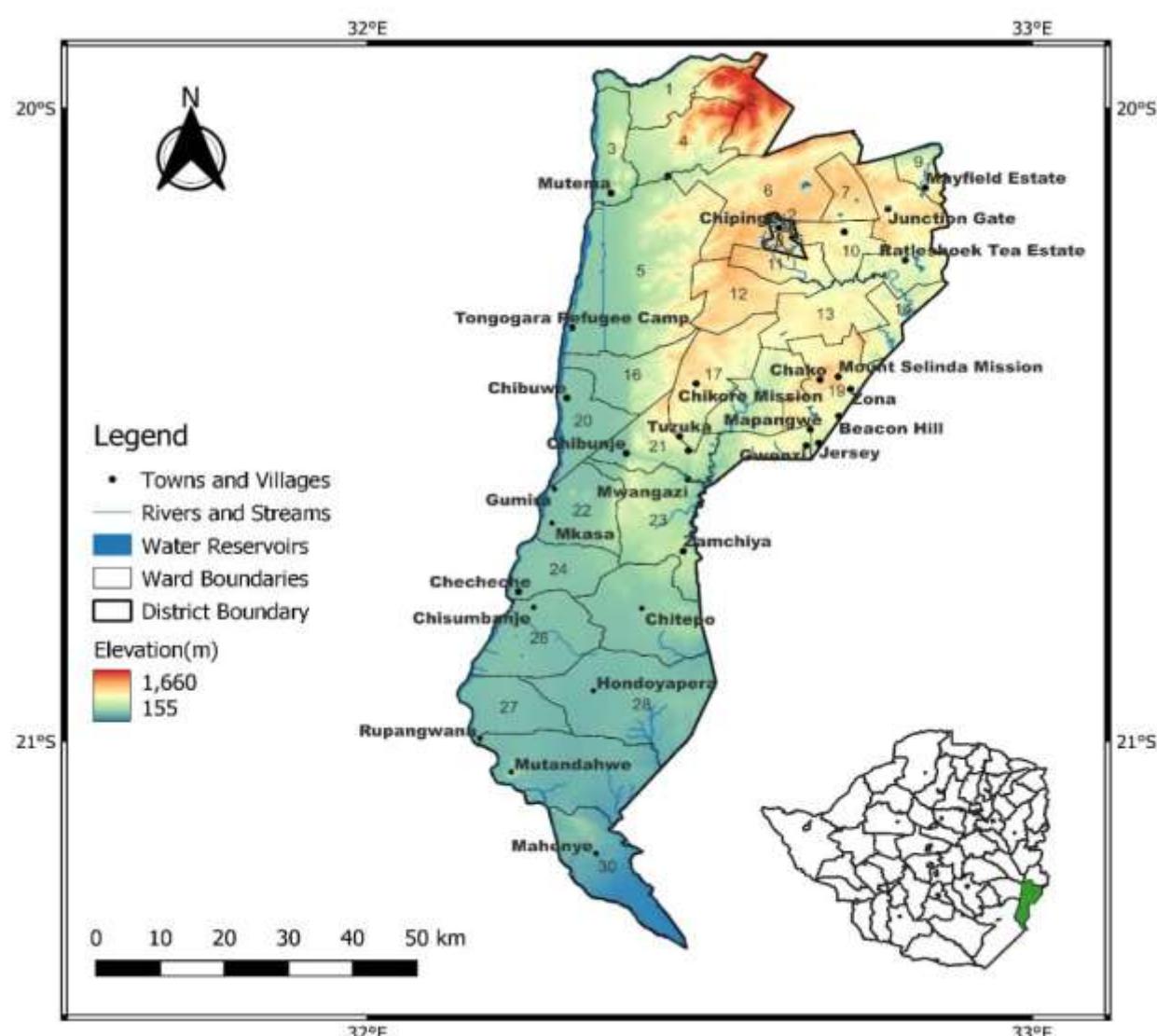


Figure 1: Chipinge District Map

Sampling and Sample Size

The list obtained from the Agricultural Marketing Authority (AMA), an organization mandated to register all macadamia value chain players, formed a sampling frame of 321 farmers, eight traders, and two processors. A combination of stratified, proportionate, and simple random sampling techniques was used to select 131 farmers from three different farming categories (strata): smallholder farmers (A1 and communal farmers), medium-scale farmers (A2 farmers), and large-scale commercial estates (Table 1).

Table 1: Proportionate Sampling of Macadamia Farmers

Farming type	Number of registered macadamia growers	Proportionate sampling	Sample size
Smallholder	262	$(262/320) \times 131$	107
Medium Scale	49	$(49/320) \times 131$	20
Commercial Estates	9	$(9/320) \times 131$	4
Total	320		131

In proportionate sampling, the sample size of each stratum is proportional to the population size of the stratum (ILU, 2015). The sample size, n of each stratum is given as (equation 1);

Where,

n = the sample size

K = population size of stratum

N = entire population

Based on availability and willingness to be interviewed, six (6) traders and two (2) processors were purposively selected from the Chipinge district market.

Data and Data Collection

Primary and secondary data were collected. Primary data were collected using questionnaires and interview guides, including household demographic and socioeconomic characteristics, level of technology employed, enterprises, and operational budgets for macadamia nut cropping, processing, and trading. Secondary data were collected by reviewing literal documentation and government reports. Written informed consent was obtained from all participants after they received a detailed information sheet outlining the purpose of the study, potential risks and benefits, and data confidentiality measures.



Data Analysis

Functional Analysis

According to the FAO (2005) functional analysis provides an overall description of the value chain system. This analysis divides the chain into its primary functions, identifies the specific agents responsible for each function, and tracks the transformation of the main product throughout the chain, highlighting its various forms and stages of development. In this study, functional analysis was used to identify macadamia value chain actors, their activities, and the interactions between them, as well as products in various forms that emerged from the chain. The information is then summarized in the form of a commodity value chain map. Value chain agencies' characteristics were also presented using descriptive statistics, including averages, frequency, standard deviations, and pie charts.

Cost and Returns Analysis

The Cost and Returns analysis estimated costs, returns, and value-added at the different stages along the macadamia value chain in the study area. The budgeting technique used to determine costs and returns was adopted from *ILU, 2015*, where net income (NI) is expressed as follows:

$$NI = GI - (TVC + TFC) \dots (2)$$

$$TC = TVC = TFC \dots \dots (3)$$

$$ROI = \frac{NI}{TC} \dots \dots \dots (4)$$

Where;

NI= Net Income.

GI= Gross Income.

TC=Total Costs.

TVC=Total Variable Cost.

TFC=Total Fixed Costs.

ROI=Return on Investment.

The value added by an agent is the gross income (GI) minus the intermediate inputs (II), which refers to inputs that are totally transformed or consumed during the accounting period, usually one production year. According to (FAO, 2005), the value-added (VA) is computed as;

$$VA = GI - II \dots \dots (5)$$

Where;

VA=Value Added

II=Intermediate Costs

RESULTS AND DISCUSSION

Socio-economic Characteristics of Respondents

Socio-economic characteristics of macadamia farmers

As shown in Table 2, the mean ages of smallholder farmers, medium-scale farmers, and commercial estate managers are 55, 57, and 51, respectively. This means that most farmers were still within their productive age and old enough to have adequate skills and experience in macadamia production.

Table 2: Age, household size and experience of macadamia growers

	Smallholder (n=107)		Medium scale (n=20)		Commercial estates (n=4)	
	Mean	SD	Mean	SD	Mean	SD
Farmers' Age	55	11.4	57	11.9	51	3.6
Farm size (ha)	4.9	1.1	55	63.07	1100	16.2
Area under macadamia cultivation (ha)	1.1	6.3	40	44.9	7801	19
Number of years in macadamia cultivation	14	3.7	17	2.8	19	1.8
Household size (unpaid family labor (18-65)	3	2.1	4	3.1		
Number of permanent employees	1	2.6	7	2.9	21	11.5

Source: Authors' survey results: 2022

The average farm holdings were 4.9, 56, and 1100 ha for smallholders, medium-scale farms, and commercial estates, respectively. At all three farming scales, more than a third of the land was devoted to macadamia farming, which implies that macadamia farming was a major undertaking among farmers in the study area. The distribution of growers according to the number of years of macadamia farming showed that commercial estates, medium-scale farmers, and smallholder farmers had a mean experience of 19, 17, and 14 years in macadamia farming, respectively. The family size for the active labor force between the ages of 18 and 65 averaged three in smallholder farming households and four adults in medium-scale households. A higher number of smallholder household members contributes to family labor. An average of seven permanent employees was recorded in medium-scale farming and 38 employees in commercial estates, indicating the importance of additional paid labor to complement family labor with an increase in landholding.

Of the total household heads interviewed, the results showed that more than 70 percent were males across all farming categories (Table 3). The dominance of men in macadamia farming is understandable, considering the high labor requirements in macadamia farming, as indicated by (Rickle et al., 2019), and the low level of mechanisation in Zimbabwe farming generally prompts the use of manual labor (Mafirakurewa et al., 2023). Furthermore, all estate heads, 70 percent of the medium-scale farmers, and 84 percent of the subsistence farmers in the sample



were married. Findings on the sources of income showed that farming was the main source of income for 94.4% of the interviewed smallholder-farming households. Education level was categorized into three groups: primary education (1-9 years), secondary education (10-15 years), post-secondary education (above 15 years), and none (0 years).

Table 3: Socioeconomic characteristics of sampled macadamia growers

Variable		Smallholder n=107		Medium scale n=20		Commercial estates n=4	
		Frequency	%	Frequency	%	Frequency	%
Gender	Male	89	83	14	70	4	100
	Female	18	17	6	30		
Marital status	Married	90	84	14	70	4	100
	Single	3	3	2	10		
	Widowed	14	13	4	20		
Major occupation	Full time farmer	97	91	16	80	4	100
	Part time	10	9	4	20		
Education level	Primary	31	30	2	10		
	Secondary	62	58	11	55	1	25
	Post-Secondary	14	12	7	35	3	75
Membership to association	Yes	78	73	14	70	1	25
	No	29	27	6	30	3	75
Benefits derived from the association	None	81	76	4	20	1	100
	Agricultural advisory	26	24	13	65		
	Securing contracts	6	6	12	60		
Source of finance	Self	95	93	8	40	1	25
	Banks			4	20	3	75
	Contract	17	7	8	40	0	



Main off-taker for fresh nut in shells	Merchants	107	100	20	100	1	25
	Export markets					3	75

Source: *Authors' survey results, 2022*

The majority (62%) of the smallholder farmers had secondary-level education, while 14 percent and 31 percent had passed through post-secondary and primary education, respectively (Table 3). Only 10 percent of the medium-scale farmers attained primary education, and all estate managers attained tertiary education. In total, more than 95 percent of the macadamia producers were literate. This is a sign that macadamia farmers believe that education is a channel to break the vicious cycles of poverty and promote sustainable agricultural production. Among the households in the study area, over 70 percent of smallholder and medium-scale farmers were members of the Macadamia Association of Zimbabwe, but 76 percent of smallholder farmers indicated that they did not receive any form of benefit from the association, compared to 20 percent of the reports from medium-scale farmers. Only one commercial estate was a member of this association, indicating that no benefits were derived from the association. About 65 percent of the interviewed medium-scale farmers reported that they received agricultural advisory support compared to 26 percent of smallholder farmers. Again, 60 percent of medium-scale farmers reported accessing loans through contracts with the help of the association compared to 6 percent among smallholder farmers, an indication that the benefits of membership to the association were not equally accessed by all farm types, with a greater bias towards medium-scale farmers. Banks were the main source of finance for large-scale farmers (75%), whereas smallholder and medium-scale farmers were mainly self-financed. Smallholder and medium-scale farmers sold their macadamia exclusively to merchants compared to commercial estates, who sold 75% of their macadamia produce directly to export markets, and the remainder was sold to merchants.

Socio-economic characteristics of merchants and processors

The majority of the interviewed merchants (90%) had a post-secondary education, indicating a highly educated group (Figure 2). According to the (AMA, 2023) a number of merchants had been in and out of macadamia trade; hence, the number of years in macadamia trade was low (three years), even though it was reported to be a major activity among merchants with a share of 60 percent compared to timber processing and trade (40%). Forty percent of the (40%) merchants also reported limited access to credit, which limits access to potential business expansion and support investment. The majority of merchants (90%) reported that they had access to market and price information, from which 60 percent of the information was from the Internet. Seventy-five percent reported having bargaining power, meaning that most can influence prices or terms. On average, macadamia nut processors had 28 years of experience. Despite processors having many years in macadamia processing, their capacity is still not yet developed, and as such, not a significant undertaking in processing activities (only 3%), with processors engaged in coffee, tea, timber, and tea processing as their major activities.

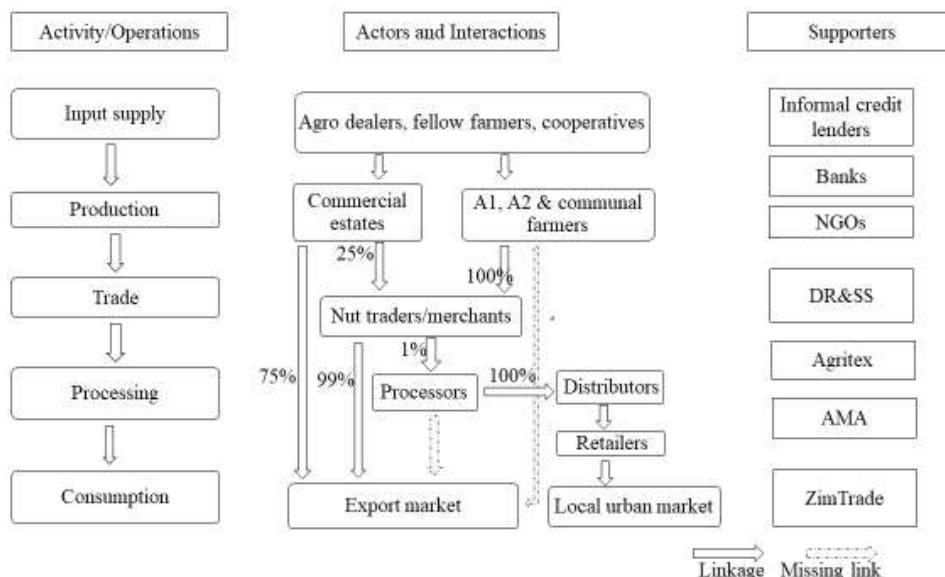
Figure 2: Demographic characteristics of macadamia merchants in Chipinge district

Source: Author's survey results, 2022

Functional Analysis of the Macadamia Value Chain

Analysis of actors, functions and existing linkages in the macadamia value chain in Chipinge District

An overview of the macadamia value chain map for Chipinge District is shown in Figure 3. The primary and supporting actors involved in the macadamia value chain, their functions, and the relationships and linkages between the processes and activities are discussed.

Figure 3: Macadamia value chain Map in Chipinge District

Source: Authors' construct



Primary Actors in Macadamia Value Chain

The main actors in Chipinge's macadamia value chain are input suppliers, producers, merchants, processors, distributors, retailers, and consumers.

Input suppliers: These include agro-dealers and importers, mainly from South Africa, who supply fertilizers, chemicals, and equipment. Commercial estates such as Ariston Holdings, Makandi, and Tanganda, together with smallholder nurseries, provide seedlings. Cooperatives, seed banks, and research institutions like the Coffee Research Institute and Manicaland State University contribute less than 10% of the seed supply. Some merchants offer farmers input loans (fertilizers and chemicals) recovered after harvest.

Producers: Macadamia in Chipinge District is grown by three different types of farmers: smallholder farmers who comprise communal and resettled A1 farming households with land holdings of 3-10 hectares, medium-to large-scale A2 farmers with landholdings of between 11-300 hectares and commercial estates with land area above 300 ha. Producers perform all crop management activities, from land preparation to marketing. Harvesting typically occurs between May and August. Smallholders' hand-pick fallen nuts using family labor, while larger farmers employ hired labor and limited mechanization. Due to inadequate storage and drying facilities, smallholders sell freshly harvested nuts within 24 hours, limiting bargaining power. In contrast, estates dry and store nuts, enabling delayed sales and better prices through direct export.

Merchants/Traders/Buyers: Merchants or middlemen, as they are referred to by farmers, are few, foreign-owned firms licensed to buy nuts by the Agricultural Marketing Authority. Their central roles include buying fresh nuts from farmers, drying, grading, and exporting them mainly to China and South Africa. They also handle aggregation, storage, transport, and export logistics. Their limited number reduces competition, giving them price-setting power. Pricing is based on kernel quality, soundness, and moisture content.

- i. **Moisture content:** Merchants purchase nuts with a moisture content of 20-25 percent and dry the nuts to a moisture content of less than 2 percent when selling to China and around 8 percent when selling to South Africa.
- ii. **Kernel soundness:** A soundness level of 30 percent is required and an unsoundness of 3 percent for macadamias sold to China, whereas a soundness of between 26 -27 percent, with an unsoundness of 6 percent, is required for the South African market.
- iii. **Kernel quality:** The overall quality of macadamia nuts is assessed based on their size, absence of pest damage such as nut borers and sting bites, and overall appearance. Nuts are also classified by cultivar, such as Beaumont, Hybrid, Integifolia, or Tetrofilia. Macadamias are categorized into three grades: grade A, with a diameter greater than 22 mm, costs between US\$2-US\$3.00, grade B, with a diameter of 20-22 mm costs US\$1.50-2.00, grade C, 18-20mm, costs US\$1-1.5, and anything less than a dollar.

Processors: Only two processors, Cropate Investments and Ariston Holdings' Clear Water Estate, operate locally. They add value to dried NIS by dehusking, curing, cracking, roasting, oil pressing, and packaging. Processed products: roasted kernels, macadamia peanut butter, and macadamia oils are sold to distributors or wholesaled to retailers in the local markets. The



machinery used for macadamia processing is obsolete, substandard, and more similar to manual operations.

Distributors and Retailers: Even though they are not licensed and their function is not well structured, distributors such as Gold Fresh and Gytime Foods purchase processed products, repackage, and supply them to supermarkets (TM Pick n Pay, OK, Spar, Bon Marche) and informal traders who are scattered in Chipinge town. Retailers and vendors sell roasted kernels, oil, and nut butter mainly in urban centres like Harare, Mutare, and Bulawayo.

Consumers: Local consumers prefer roasted or salted kernels for household use, while hotels and restaurants use them in confectionery and desserts. About 98% of macadamias are exported, mostly to China, where high-income households sustain strong demand, and to South Africa, which re-exports to Europe and Asia.

Supporting Actors

Support services, such as access to information or knowledge, technology, and finance, are critical to the performance of value chain actors (Khan, 2012). In Chipinge district, several institutions provide such support to macadamia value chain actors. The Agricultural and Rural Development Advisory Services (ARDAS) deliver extension training on pest-resistant varieties, fertiliser use and propagation, typically visiting farmers twice during the summer season. Members of the Macadamia Association of Zimbabwe benefit from training, credit access and market information. ZimTrade, foreign buyers and online platforms are major sources of market intelligence for merchants. Commercial banks, micro-financial institutions, and NGOs offer limited financial services to merchants. AMA oversees production and marketing regulations, licensing and information management within the macadamia sector.

Knowledge and information flow among stakeholders along the Macadamia Value Chain in Chipinge District

The AMA and ARDAS play leading roles in information and knowledge dissemination, though their extension services are often insufficient, given that macadamia is an emerging crop and poorly timed. Many smallholder farmers rely on informal sources, that is, buyers and fellow farmers for production and price information. Information asymmetry persists because merchants control pricing and quality standards at the point of purchase and rarely engage in production management. Farmers depend on merchants for the sale of produce, which makes the value chain in the district trader-driven, and prices are determined by market actors. Despite the conflictive nature of their operations, merchants remain a necessary linkage for farmers to export markets because they have invested in storage and drying facilities which are in proximity to farmers and export linkages. The missing link is a strengthened and organised value chain with set rules and regulations that ensure access to market information, quality assurance and transparency. Strengthened coordination through contract farming would improve trust, product quality and farmer motivation to adopt good agricultural practices (GAPs) or join partnerships that enable them to access credit and loans for inputs if prices and buyers are secured.



Cost and Returns Analysis of Macadamia Value Chain Actors

Cost and returns analysis of farmers

Cost analysis forms the basis for estimating returns and value addition in macadamia production. Average production costs were US\$4,571/ha for irrigated crop and US\$1,695/ha for dryland crop (Table 4). This was equivalent to approximately US\$1.13/kg and US\$1.16/kg under irrigation farming and dryland farming, respectively. More than 50 percent of the total costs in both cropping systems were for inputs (mainly fertilisers 23-25%), pesticides and chemicals, highlighting their importance in macadamia cultivation in Chipinge District.

Labor charges for maintaining crops up to harvesting constituted 35% of the total costs under irrigation and 49% for dryland farming reflecting heavy reliance on manual labour among smallholder farmers, whereas larger farms benefit from mechanization and automation but also incur high depreciation costs, which constitute 10% of the total cost. less than half of the total production cost in both cropping systems. Limited financial resources and small and fragmented plots, characterized by Chipinge District's mountainous terrain, limit smallholder farmers' capacity to mechanize macadamia farming. Manual farming has led to low productivity and low-quality macadamia. As a result, smallholder farmers realized an average yield of 1,460 kg/ha of dried nutshells per hectare compared with 4,045 kg/ha among large-scale commercial producers.

Table 4: Cost and returns for macadamia growers

	Large-Scale Irrigated Crop			Smallholder dryland crop		
	US\$/ha	US\$/kg	Percentage ³	US\$/ha	US\$/kg	Percentage
Costs						
Material						
a) Herbicides	269	0.07	5.88	60	0.04	3.54
b) Pesticides(litres)	269	0.07	5.88	140	0.1	8.26
c) Manure	1	0	0	60	0.06	0
d) Fertilizer	1046	0.26	22.88	430	0.29	25.37
e) Electricity	286	0.11	6.26	35	0.02	2.06
f) Irrigation water	172	0.04	3.76	7	0	0.41
g) Fuel	401	0.04	8.77	80	0.05	4.72
h) Consumables	123	0.02	2.69	30	0.02	1.77
Sub-total	2567	0.63	56.16	848	0.50	50.02
Labour Input Costs	1594	0.39	34.87	830	0.49	49.32
Total Variable Costs	4161	1.03	91.03	1678	1.15	99
Gross Margin	3120	0.77	68.26	950	0.65	56.05
Fixed Costs	0	0		0	0	0
Rent and tax	190	0.05	4.16	10	0.01	0.59
Depreciation on Equipment	220	0.05	4.81	7	0	0.41
Total Fixed Costs	410	0.1	8.97	17	0.01	1.00

³ Refers to the proportion of the material item relative to the total cost of production per hectare.



Total Costs	4571	1.13		1695	1.16	
Returns						
Average Output	4045	1		1460	1	
Price (US\$/kg)	1.8			1.8		
Gross Revenue	7281	1.8		2628	1.8	
Net Return	2710	0.67		933	0.64	
Value Added						
Intermediate Costs	2567	0.63		842	0.58	
Total Value Added	4714	1.17		1786	1.22	
Return on Investment	0.59			0.55		

Source: Authors' survey results, 2022

Despite the low productivity of smallholder farmers, macadamia farming in both cropping systems is profitable. At an average market price of US\$1.80, the gross revenue per ha per year was US\$7,281 for estates yielding a net return of US\$2,710 and gross revenue of US\$2,628 for smallholder farmers yielding a net return of US\$933. Large-scale farmers earned a higher net return due to experience, better inputs and economies of scale. These results differ from Schaffnit-Chatterjee (2014), who found lower margins for large irrigated business farmers, attributed to higher rations and utilisation of input costs, rental costs, and taxes, compared to small dryland farmers, where land is freehold and family labor is used.

Cost and returns of macadamia merchants

Table 5: Cost and Returns of Merchants per 1000kilograms of macadamia

Cost Item	Amount (US\$/1000kg)	Unit price/kg (US\$)	Percentage
A. Variable costs			
Intermediate Costs			
a. Utilities (water, electricity, etc.)	56	0.056	0.02
b. Purchase of Fresh Macadamia nut in shell	810	1.81	0.27
c. Transportation	120	0.01	0.04
d. Drying	500	0.5	0.17
e. Packaging	40	0.04	0
f. Shipping and container vessel	330	0.33	0.11
g. Marketing	130	0.13	0.04
h. X-ray	200	0.2	0.07
Sub-total	2186	2.19	0.74
Labour charges	530		0.18
Total Variable Costs	2716	2.72	0.92
B. Fixed Costs			
a. Rent and taxes	100	0.1	0.03
b. Depreciation on equipment	150	0.15	7.89
Total Fixed Costs	250	0.25	0.08



Total Costs	2966	2.97	
C. Returns			
Gross Revenue@780kg	3744	4.8	
Gross Return	1028	1.03	
Net Return	778	0.78	
D. Value Added	1558	1.56	
Return on Investment	0.26		

Source: Authors' survey results, 2022

Merchants purchase fresh nuts-in-shell from farmers, dry, dry grade and export. Table 5 shows that the total cost for 1000kg dried NIS traded was US\$2,966, dominated by the purchase of raw nuts (27%), drying costs (17%), and shipping and container vessel costs for exportation (11%). Labour costs constituted 10 percent of the total cost. Other costs include utilities (water, electricity, etc), purchase of packaging material, X-rays, and payment for government taxes and permits, which constitute the remaining 34 percent. Depreciation of drying and processing equipment and tools, which include scales, driers, and grading machines, was not major constituent of the major cost. With an export price of US\$4.80/kg, gross revenue per 1000kg dried and trade macadamia NIS averaged US\$3,042, yielding a net return of US\$677 and a rate of return of 29 percent (US\$0.29 profit per dollar spent). Thus, the macadamia trade is profitable though capital-intensive.

Cost and returns of macadamia processors

Macadamia processing forms an insignificant part of the macadamia value chain; however, the study analyzed the cost and returns of processors to advise value chain players on the possible expansion path within the value chain. Total processing costs were US\$4,302/1000kgs (Table 6).

Table 6: Cost and returns of processors per 1000kilograms of macadamia nuts

Cost Item	Amount US\$/1000kg	Unit price/kg (US\$)	Percentage
A. Variable costs			
Material input			
a. Utilities (water, electricity, etc)	61	0.061	0.01
b. Purchase of Fresh Macadamia	1810	1.81	0.40
c. Transportation	140	0.14	0.03
d. Drying	500	0.5	0.11
e. Shelling	350	0.35	0.08
f. Roasting and salting	210	0.21	0.05
g. Packaging	40	0.04	0
Sub-total	3111	3.07	0.68
Labour Input Costs	891	1.2	0.19
Total Variable Costs	4002		0.88
B. Fixed Costs			
a. Rent and taxes	100		
b. Depreciation on equipment	200		



Total Fixed Costs	300		0.07
Total Costs	4302		
C. Returns			
Shells (375)	112.5	0.3	
Kennels (504.7kg)	5551.7	11	
Gross Output	5664.2		
Gross Return	1662.2	1.67	
Net Return	1362.2	1.37	
Intermediate Costs	3111		
D. Value Added	2553.2	2.56	
Return on investment	0.32		

Source: Authors survey results, 2022

Just like merchants, the purchase of macadamia nuts in shells as material for processing had the highest cost component, constituting 40 percent to total costs, followed by labor costs (19%). Manual processing operations dominated due to outdated machinery. Other variable input costs included water and electricity bills. Fixed costs (7%) include depreciation charges of drying rentals and taxes. At a price of US\$16/kg for roasted kernels, (US\$/100) processors earned US\$5,664.2 as gross revenue and a net return of US\$1,362 per 1000 kilograms of dried macadamia nuts in shells, representing a 32 percent rate of return. Processing of macadamia is, therefore, profitable but underutilised.

Comparing costs, net return and value added of macadamia value chain actors in Chipinge district.

To examine the competitiveness of the value chain actors, the value-added shares of the chain participants were calculated and compared to the costs incurred by each participant. Processors generated the highest value addition (US\$2,553/1,000 kg), followed by traders (US\$1,558), smallholders (US\$1,220), and large estates (US\$1,170). In terms of profits, all the actors were profitable, with net profits of US\$1362.2, US\$778, US\$ 670 and US\$640 per 1000 kg of nut for processors, traders, estate irrigation growers, and smallholder dryland farmers, respectively. But returns per dollar spent were highest among farmers: US\$0.49 (estates) and US\$0.47 (smallholders), due to lower investment costs. Merchants and processors achieved US\$0.29 and US\$0.32, respectively.

Table 7: Comparison of costs, returns, and value added per 1000 kilograms of macadamia for actors in the macadamia value chain

Indicators	Dryland macadamia farming	Irrigated crop	Average for farmers	Traders and Exporting enterprises	Processors
Total Revenue	1800	1800	1800	3744	5664.2
Intermediate Costs	580	630	605	2186	3111
Value Added	1220	1170	1195	1558	2553.2
Gross Profit	650	670	660	1028	1662.2
Net Profit	640	670	650	778	1362.2
Return on Investment	55	59		29	32

Source: Authors' survey results, 2022

The results align with findings by Keesecker (2020) showing higher returns at the production stage of macadamia, where costs are relatively lower than revenue. Processors' potential is constrained by underutilization of processing capacity, low domestic demand and failure to meet export standards, particularly in the EU market. Expanding processing capacity and improving quality compliance could enhance overall value chain competitiveness.

Challenges Faced by Actors in the Macadamia Value Chain

Factors constraining smallholder macadamia farmers

Smallholder macadamia production in Chipinge district is largely traditional, where small-scale farmers use low-quantity and high-quality modern inputs in combination with mixed varieties of home-grown seedlings. As a result, it was not surprising for farmers to complain of low prices from buyers compared with input prices, mainly fertilizers and chemicals, which have been constantly increasing (Figure 4). Smallholder farmers also reported inadequate equipment to care for the crops, particularly spraying and pruning equipment (leading to serious flower and fruit drop on top of trees), and lack of postharvest storage facilities, which further constrain productivity. Previous research by (Mharidzo et al., 2022) and (Bandason et al., 2021) also acknowledged the high cost of inputs, their late acquisition and poor mechanisation, limiting smallholder farmers' efforts to commercialise.

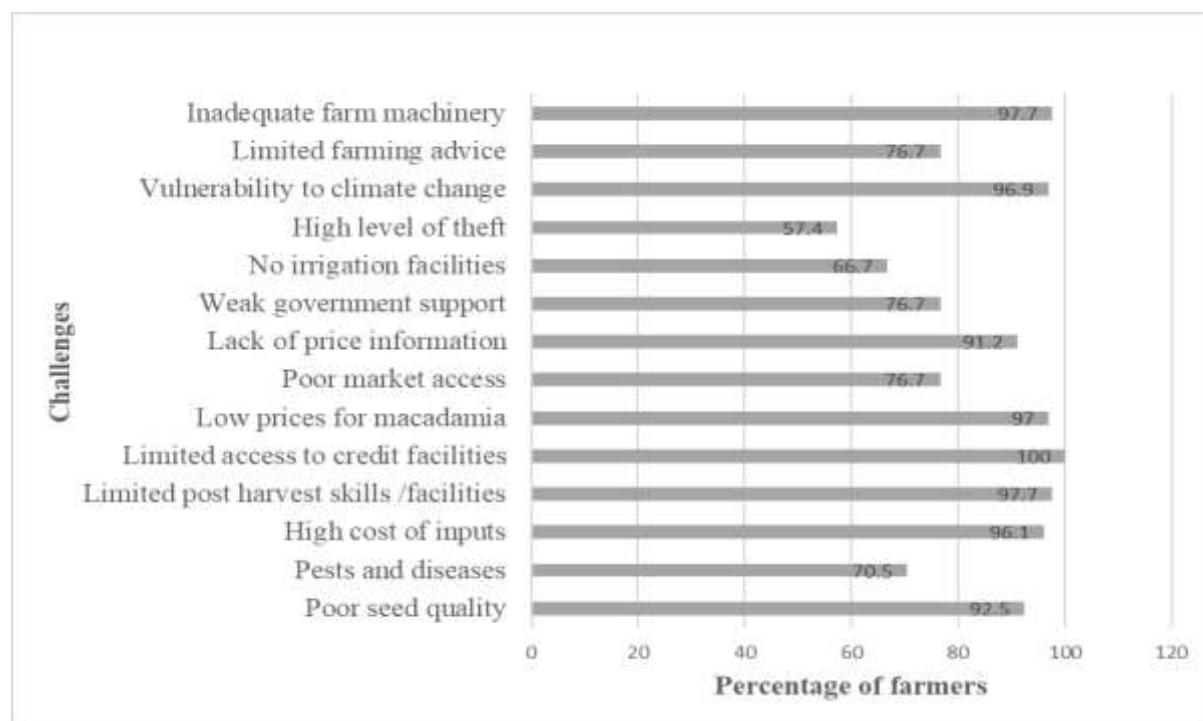


Figure 4: Factors constraining smallholder macadamia farmers in Chipinge District

Source: Authors' survey results, 2022

Access to finance to purchase the required machinery remains poor due to a lack of collateral security, with banks preferring large-scale enterprises. Although smallholder farmers confirmed their access to extension services, they reported that the information relayed to them is inadequate due to the limited expertise of extension staff on macadamia management.

Farmers are also vulnerable to climate vulnerability, with inconsistent rainfall, strong winds, and severe temperature changes affecting flowering and yields. This challenge is compounded by the overreliance on natural rainfall for poor small-scale farmers, who also lack the financial means for drilling boreholes. Other challenges include vandalism of orchards by livestock and poor pest and disease control.

Factors constraining macadamia merchants, processors and exporters

The constraints faced by merchants in macadamia's trading, processing, and export activities are described in Figure 5. Merchants reported poor nut quality from farmers, leading to high rejection rates and reduced competitiveness compared with other macadamia-exporters in the region, e.g South Africa and Malawi. As cited by Quiroz et al. (2019), a sizable portion of Zimbabwean macadamia NIS exported to Asian markets still do not meet the standards preferred in the US and EU markets. Macadamia exporters also complained about the volatility of macadamia NIS prices in the international market, exacerbated by the COVID-19 pandemic, the war in Ukraine, and the energy crisis. The merchants were also constrained by poor and inadequate storage facilities to store large amounts of macadamia for trade in export markets. Merchants also complained about the lack of price information, although the problem was more devastating to farmers, as it created an unequal playing field between marketers and farmers. Frequent power (electricity) cuts during drying, leading to unexpected spoilage and additional costs due to the use of generators, is also a major challenge affecting processing.

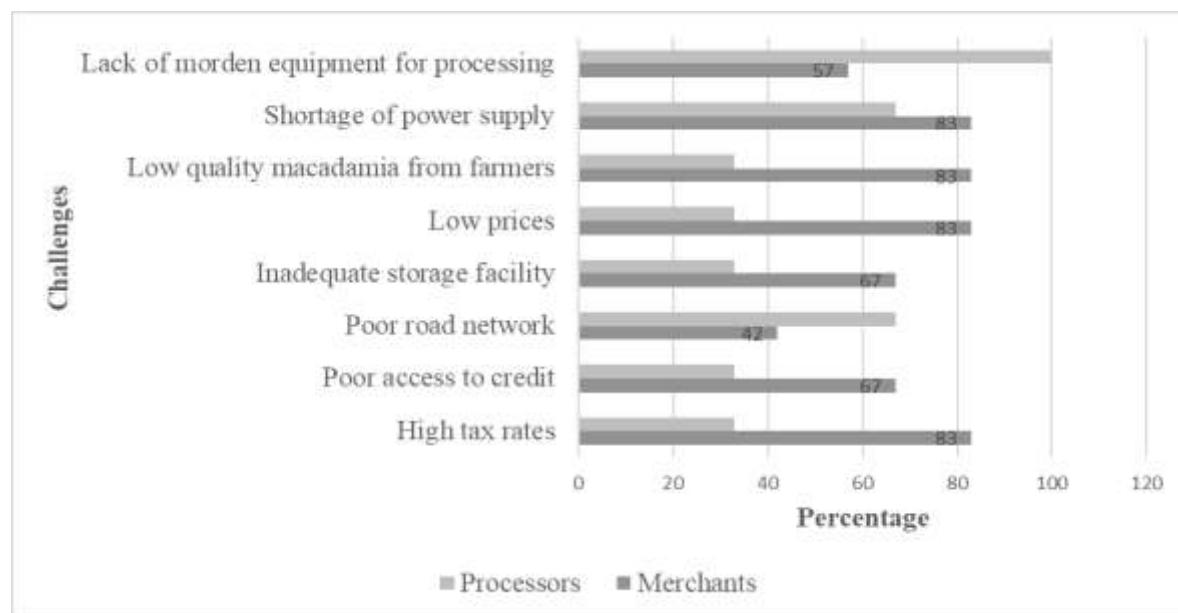


Figure 5: Factors constraining macadamia merchants in Chipinge District

Source: Authors' survey results, 2022

Both processors and merchants complained about high government taxes, licenses and registration fees. Among exporters, the requirement by the government for all exporters to retain 30 percent of their export proceeds in local currency at official rates, in a system favouring foreign currency, was highlighted as another form of tax. Further, delayed payments from importers (60-90 days) constrain liquidity, as farmers demand instant cash in foreign



currency. Processors also face low domestic demand and obsolete processing equipment, resulting in finished products that fail to meet international quality standards.

CONCLUSIONS

This study analysed the macadamia value chain and found that all actors are profitable, with processors earning the highest net profit (US\$1,362.20/1,000 kg), followed by traders/exporters (US\$778) and estate growers (US\$670). Smallholder rainfed farmers earned the least (US\$640/1,000 kg). In terms of added value, macadamia processors led with US\$3.80/kg, followed by rainfed farmers (US\$1.25), irrigated farmers (US\$1.14), and exporters (US\$0.97). Smallholder farmers' low margins stem from limited input use, low yields, and poor access to machinery, finance, and quality planting materials. By contrast, farmers had a much higher rate of return than processors and exporters due to underutilized processing capacity; full capacity use is vital to maximize returns. Achieving this requires meeting export market quantity and quality standards through targeted market research and strategic partnerships.

RECOMMENDATIONS

Based on these findings, we recommend strengthening public–private investment along the value chain to ensure quality inputs, standards, and food safety. Public institutions should enhance smallholder productivity through stronger extension support, farmer training on quality standards and GAPs, improved access to finance and irrigation, and research on high-yield, pest-tolerant varieties. Promote contract farming to improve quality assurance, transparency, and market access. Private sector investment in modern, internationally certified processing and packaging facilities should be prioritized to boost value-added exports. Government support—particularly credit and policy incentives—is essential to stimulate processing and export of value-added macadamia products. In the long term, organising smallholders for on-farm drying before sales could increase their profitability.

FURTHER RESEARCH

While offering useful insights into Chipinge's macadamia value chain, this study faces several limitations. Reliance on cross-sectional, self-reported 2022 data may introduce recall bias, especially among smallholders without formal records. The single-season scope limits assessment of year-to-year variations in climate, prices, and exports, while focusing only on Chipinge, which restricts generalisation to other regions like Mutasa or Chimanimani. Future studies should adopt longitudinal, multi-district designs to capture temporal and spatial dynamics of the macadamia industry.



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DECLARATION OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could influence the work reported in this study.

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