Potato marketing channels in mozambique: A survey of tete province potato farmers and traders

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ABSTRACT

This study analyzes the potato marketing channels in Tete Province of Mozambique involving potato farmers and traders, to critically report the actual trend of potato marketing, by assessing mainly potato price spread and marketing channels of potato production and marketing, given that this province concentrates potato production in the country. In the province, the study primarily targeted the districts of Tsangano, Angonia, Moatize, and Tete town, focusing on farmers, who are the main suppliers of potatoes. Primary data were collected in February 2021 through a survey employing structured questionnaires administered to 453 farmers in Tsangano and Angónia, and 152 traders across ten potato markets located in Tsangano, Angónia, Moatize, and Tete town. A multistage sampling method was utilized to select the locations for data collection. Marketing margin equations were applied to identify potato marketing channels and assess the profitability of this activity. Therefore, the study identified five market channels. Hence, farmers received 100% of the consumers' price when they sold directly to consumers, followed by 50.4% to retailers and 42.1% to wholesalers. The smallholder potato farmers attained good market prices since the breakeven price was found to be 7.6 MZM/kg, which was below the prevailing market price of 12.8 MZM/kg. This means potato farmers are not making losses under the prevailing market price; the business is profitable, and they are not exploited by potato traders. Policy recommendations that support channel 1 should be strengthened since it would assist farmers in marketing potatoes through economies of scale in Mozambique.

Keywords: *Potato, Marketing channels, Marketing margins, Breakeven theory, Tete province, Mozambique.*

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Highlights of this paper

- The research outcomes emphasize the importance of potato production and marketing by smallholder farmers and traders in the study area.
- The farmers were receiving a reasonable price since the breakeven price was found above the prevailing market price.
- The potato traders should be supported through the availability of cold storage facilities to stabilize prices and stimulate potato production among potato farmers.

1. INTRODUCTION

The agricultural sector continues to be considered the main driver of economic growth in Mozambique, despite the recent emergence of new high-growth sectors, including the extractive industry and electricity distribution. Based on Ministry of Agriculture and Food Security [1] and Ministry of Agriculture [2], agriculture employs about 72% of the country's workforce, which corresponds to 5.7 million people engaged in food and cash crop production, including agricultural industries, markets of agricultural inputs, and agricultural outputs. It was also reported that agriculture contributes 24% to the country's Gross Domestic Product (GDP). Out of 4,363,294 hectares, almost 4,309,314 hectares, or 98.7%, are planted areas managed by smallholder farmers. Therefore, revitalizing smallholder agriculture through the promotion of production oriented toward markets and improved access to profitable markets would increase the quantities marketed, which is a prerequisite for achieving high and sustainable economic growth.

In Mozambique, the potential of the main food crops production (maize, rice, millet, sorghum, common bean, cowpea, pigeon pea, groundnut, cassava, sweet potato, and potato) has not yet been fully exploited. For example, out of eleven provinces in the country, Tete province ranks first in potato production. According to Ministry of Agriculture and Rural Development [3], 88% of the land allocated to potato production in the country is located in this province, and the crop is essential for the development of farmers and the country. Potato is an important food crop that serves as a source of income for the local population. Tete province contributes around 90% of the national potato production, followed by the provinces of Niassa, Manica, and Maputo, Martinho et al. [4]. As described by Schelling [5], potato productivity is below the realizable potential. In Tete province, an average of 10 tonnes/ha has been registered, compared to a research-level productivity of 20 to 30 tonnes/ha. This low potato productivity contributes to a reduction in the quantity of potatoes marketed, affecting current demand since the country continues to register an increase in human population, estimated by National Institute of Statistics [6] to grow at 3% per year.

The problem of low potato productivities and, consequently, the reduction of marketed potato quantities indicates that the marketing of agricultural crops has not performed well in stimulating production. To address marketing and production failures and increase income from potatoes, knowledge of marketing channels, quantities, and price information is essential. According to Kohls and N. [7], marketing channels are alternative pathways for the flow of products from farmers to consumers. As noted by Adugna [8], this flow involves intermediaries through which a commodity passes from producers to consumers. The assessment of marketing channels aims to investigate the main aspects of production and marketing costs among marketing actors. The motivation for this study, based on the reviewed literature, stems from the identified gaps in existing knowledge.

The studies on potato marketing are limited in the country. Few authors have investigated the current level of potato markets, such as Schelling [5], Demo et al. [9], and António et al. [10]. However, these studies had limitations, such as not presenting marketing margins among farmers and traders, nor illustrating the different channels of potato marketing along the marketing chain, which are crucial for stimulating potato production and marketing. This study discusses the main characteristics and marketing margins of the major potato marketing actors across markets, with the overall objective of identifying and assessing the nature and performance of potato marketing

channels in Tete Province, Mozambique, the study area. The specific objectives include describing the major actors involved in potato production and marketing, and assessing the potato price spread across the marketing channels.

2. LITERATURE REVIEW

The theoretical framework used in this paper is the profit maximization theory that focuses on how the level of output is chosen by profit-maximizing firms, producers, or traders. In this case, producers or traders pursue the goal of achieving the possible largest economic profits. According to Nicholson and Snyder [11], a producer or a trader chooses both its inputs and its outputs with the sole goal of achieving maximum economic profits, so that the difference between its total revenues and its total economic costs is as large as possible. However, economic profits (π) are the difference between revenues and costs, and these depend on the quantity produced or ordered. That is,

$$\pi(q) = p(q) * q - C(q) = R(q) - C(q) \qquad (1)$$

The derivative of Equation 1 with respect to q and set equal to zero 0, is the necessary condition for selecting the value of q that maximizes profits.

$$\frac{d\pi}{dq} = \pi'(q) \Longrightarrow \frac{dR}{dq} - \frac{dC}{dq} = 0 \Longrightarrow \frac{dR}{dq} = \frac{dC}{dq} \Longrightarrow MR = MC \qquad (2)$$

Equation 2 is the first-order condition for a maximum, where the economic profits are to be maximized. The firm is supposed to choose the output for which marginal revenue equals marginal cost.

For a profit maximum, the Equation 2 is only a necessary condition. For sufficiency, it is required that Equation 2 be satisfied.

$$\frac{d^2\pi}{dq^2}\Big|_{q=q^*} = \frac{d\pi'(q)}{dq}\Big|_{q=q^*} < 0 \qquad (3)$$

Meaning that marginal profit must be decreasing at the optimal level of output q (q^* is the optimal level of output q). Hence, for $q < q^*$ profit must be increasing $[\pi'(q) > 0]$ and for $q > q^*$ profit must be decreasing $[\pi'(q) < 0]$. The true maximum profit is achieved if this condition holds. Additionally, this condition holds if marginal revenue is constant or decreasing in q and marginal cost is increasing in q.

Assuming that there are markets (k) for a farmer or trader to sell their outputs, they choose to sell q_i at market j such that profit is maximised. For several markets $k = 1,2,..,j$ the profit will be maximised as,

$$Max\ \pi(q) = q * p(q) - TC^V - TC^F \Longrightarrow Max\ \pi(q) = q * (p_o + \phi) - (TC^V + TC^F)$$

Taking the first order condition,

$$\pi(q)' = [q * (p_o + \phi)]' - (TC^V + TC^F)' = MR - MC \qquad (4)$$

A trader maximises profit at a point where $MR = MC$, that is

$$[q * (p_o + \phi)]' = (TC^V + TC^F)'$$

A trader should continue selling when the second order for profit maximisation holds. That is,

$$[q * (p_o + \phi)]'' < (TC^V + TC^F)'' \qquad (5)$$

For any marketing channel chosen by farmers or traders, they should attempt to reduce transaction costs in order to maximize profit after selling their potatoes. However, firms are able to sell their outputs if the revenues are greater than costs based on the existing market ***j*** conditions. Assuming that the price of potatoes in two spatially separated markets is and , the law of one price (LOP) suggests that at all points in time, if a transfer cost ***C*** is allowed to move the commodity from market ***1*** to market ***2***, the relationship between the prices is as follows:

$$p_{1t} + p_{2t} = c \qquad (6)$$

If this relationship is observed between these two prices, the two markets are said to be integrated and the prices are in equilibrium. That is, a commodity can move from market ***1*** to market ***2*** since the price in market ***2*** is higher

than the price in market ***1***. The observed difference is that of transaction cost ***c*** that was already explained. Continuing to increase the supply of the commodity to market ***2*** from market ***1***, the price in market ***2*** will fall back to equilibrium with the price in market ***1***. Hence, the benefits from this business will cease and the flow of commodities will end. In both cases, these actors seek to maximize profits to compensate the costs of producing (farmers) or the costs of supplying potatoes to several markets for final consumers (traders).

3. METHODOLOGY

3.1. Research Design

A descriptive research design was used in this study.

3.2. Study Area

In Mozambique, among eleven provinces, Tete province is located in the Central Region, which lies between latitude 14°00' and 17°42' South and longitude 30°13' and 35°20' East. Tete province covers an estimated land area of 100,742 km² and has a population of approximately 2.2 million. The elevation ranges from 200 to more than 1,000 meters above sea level, placing Tete within the country's tropical dry and humid climate zones. The average annual temperature varies from 22°C to 32°C, with mean yearly rainfall between 180 and 360 millimeters, according to the Government of Tete Province [12]. Tete province comprises 15 districts, and the study focused on four districts: Tsangano, Angonia, Moatize, and Tete town.

3.3. Sampling Methods and Sample Size

The primary data were collected from potato farmers and traders in the study area through the administration of structured questionnaires and interview schedules, carried out by the author and three enumerators.

3.3.1. Potato Farmer Survey

For potato farmers survey, the sampling method used was a multi-stage approach. In the first stage, Tete province was purposively selected. The second stage involved purposively selecting Angónia and Tsangano districts. In the third stage, four localities in Angónia and three localities in Tsangano were selected randomly. The fourth stage included selecting 220 smallholder potato farmers in Angónia and 233 in Tsangano, totaling 453 respondents.

3.3.2. Potato Trader Survey

In relation to potato traders, the sampling method used was a multi-stage approach. In the first stage, Tete province was purposively selected. The second stage involved purposively selecting Angónia, Tsangano, Moatize, and Tete town districts. The third stage included purposively selecting ten markets: Tsangano turn-off and Chiandame (Tsangano), Lizulu and Nguenha (Angonia), Mussacama and Bairro 4 (Moatize), Cambinde, 1° de Maio, Canongola, and Kwachena (Tete town). The fourth stage involved randomly selecting 32 potato traders in Tsangano markets, 33 in Angonia, 26 in Moatize, and 61 in Tete town markets, totaling 152 respondents.

3.4. Methods of Data Analysis

3.4.1. Description of the Major Actors in Potato Production and Marketing

This specific objective was analyzed by using descriptive statistics, namely frequencies, means, and percentages.

3.4.2. Assessment of the Potato Price Spread on the Marketing Channels

This specific objective was analyzed by using the tools of marketing margins.

3.5. Specification of Model

3.5.1. Marketing Margin Analysis

To construct the marketing margins, the information on costs and prices was collected from the survey that was conducted. To compute the total gross marketing margin, TGMM, the price paid by the final consumer and the price paid to the immediate actor along the channel were used, Ghorbani [13] and Bassey et al. [14].

$$\text{TGMM} = \left(\frac{\text{sp}-\text{bp}}{\text{sp}}\right) * 100 \quad (7)$$

Where:

TGMM: Is the total gross marketing margin.

Sp: Is the selling price of potatoes by a trader in MZM/kg.

Bp: Is the buying price of potatoes by traders in MZM/kg.

Once TGMM is generated, it becomes crucial to incorporate the concept of producer participation, which is the percentage of the price paid by the consumer that belongs to the farmer.

$$\text{PP} = 1 - \text{TGMM} \quad (8)$$

Where: PP: Producers' participation.

In addition to this, there is a NMM, which is the percentage of the price paid by the consumer that is earned by the intermediaries as their net income after subtracting marketing costs.

$$\text{NMM} = \left(\frac{\text{GMM}-\text{MC}}{\text{CP}}\right) * 100 \quad (9)$$

Where:

NMM: Net marketing margin.

GMM: Gross marketing margin.

MC: Marketing costs.

CP: Consumer price.

3.5.2. Breakeven Analysis

Breakeven analysis enables farmers to determine the profitability of their farm enterprises. Through breakeven analysis, the farmer identifies the breakeven price (BEP) and the breakeven output or breakeven yield (BEY) levels, Nalivata and Maonga [15].

3.5.2.1. Breakeven Price (BEP)

Breakeven price (BEP) is the price level that would allow the farmer to meet all the variable costs if the produced quantity of the commodity was sold at that price. In a situation where the prevailing market price is exploitative, the breakeven price provides farmers (producers) with a basis to negotiate an upward price adjustment for a profit. It is calculated by dividing total variable costs (TVC) by the quantity of production or yield (Q).

$$\text{BEP} = \frac{\text{TVC}}{\text{Q}} \quad (10)$$

Where:

BEP: Breakeven price.

P: Expected price paid to farmers.

TVC: Total variable cost of production. This is the variable cost at the farmer's level, including expenses such as the cost of seeds, fertilizers, pesticides, and hired labor.

Q: Quantity of potato produced.

3.5.2.2. Breakeven Yield (BEY)

Breakeven yield is the total output that the business needs to sell in order to cover its total costs. Breakeven output or yield (BEY) is determined by dividing total variable costs (TVC) by the prevailing market price (P).

$$BEY = \frac{TVC}{P} \quad (11)$$

4. RESULTS AND DISCUSSIONS

4.1. Socio-Economic Characteristics of the Sampled Potato Farmers

4.1.1. Age

The results in Table 1 showed that the age of the sampled household heads in the districts of Angonia and Tsangano had a mean of 40.7 years. The t-test indicated similarity between these two districts, and the mean suggests that all participants were within the economically productive age. The findings are consistent with Ansah et al. [16] and Tolno et al. [17], who reported that the sampled smallholder farmers in their study areas were within the economically active age group.

4.1.2. Level of Education

The result showed that the number of years spent in school by the household heads has a mean of 5.1 years in the two districts. The t-test indicates that the education level attended by producers was similar in both districts of Angonia and Tsangano. This result slightly differs from Tolno et al. [17], who found 2.8 years as the average number of years spent in school by potato producers in Guinea.

4.1.3. Sex

The study demonstrated that at least 70.4% of household heads indicated that their households were male-headed. The district of Tsangano had higher proportions of male-headed households than the district of Angonia. The composition of households by gender was not far from the national average. According to National Institute of Statistics [6], 66.2% of the households covered by the Housing and Population Census conducted in Mozambique in 2017 were male-headed. Thus, in Mozambique, most household heads were male. Additionally, this survey showed that 29.6% of the households were female-headed. The researcher's observations and producer's responses both demonstrated that males played an important role in decision-making for the production and marketing of potatoes.

4.1.4. Household Size

The result in Table 1 shows that the composition of the sampled households had a mean of 5.5 persons per family, which implies a better participation of the family in potato production. The availability of labor for work per family was proportional to the family size. The t-test shows that the family sizes of the sampled farmers in these two districts were significantly different at the 1% level of probability.

4.1.5. Distance to the Nearest Market

The study reveals that the mean distance to the main market is 10 km in Angónia and 16 km in Tsangano, meaning that on a market day farmers are required to cover this distance, which has implications on the price

negotiated with traders to cover transportation costs. This is somewhat different from the findings of Tolno et al. [17], who found 4.4 km as the distance to the nearest market.

4.1.6. Area Allocated to Potato Production

From the results, it was found that land resource endowment is one of the most valuable factors that determine the quantity of potatoes produced and is a basic asset for producers. In this context, the mean area allocated to potato production was found to be 1.1 hectares, with a mean deviation of 0.98 hectare, and this land area allocated to potato farming differs between these two districts. Hailu [18] showed that in Ejere district, Ethiopia, the mean land size allocated to potatoes was 0.3 hectares, and Tolno et al. [17] found 0.89 hectares in Guinea for potato production. This indicates that Angonia and Tsangano districts are strong producers of potatoes in Mozambique.

4.1.7. Experience on Potato Production

The results indicate that surveyed farmers had an average of 10.5 years of farming experience, with a standard deviation of 9.4 years. Farmers with more experience were located in Tsangano district, with a mean of 14 years, whereas Angonia reported a mean of 7 years. The t-test shows a significant difference in farming experience between these two districts.

Table 1. Characteristics of potato farmers by sampled districts.

Characteristics	**Districts**		**Total**
	Angónia(n=220)	**Tsangano (n=233)**	**(n=453)**
1. Age (Years)			
Mean	40.6	40.8	40.7
Standard deviation	13.1	12.2	12.6
Pr (|T| > |t|) = 0.8324>0.05			
2. Education (Years)			
Mean	4.9	5.3	5.1
Standard deviation	2.8	3.1	3
Pr (|T| > |t|) = 0.1284>0.05			
3. Sex			
Female	45.5	14.6	29.6
Male	54.5	85.4	70.4
4. Household Size (Number)			
Mean	5.3	5.7	5.5
Standard deviation	1.9	1.8	1.9
Pr (|T| > |t|) = 0.0142<0.05			
5. Distance to the nearest market (km)			
Mean	10.4	16.4	13.4
Standard deviation	7.8	30.6	22.8
Pr (|T| > |t|) = 0.0000<0.05			
6. Potato Area (ha)			
Mean	0.8	1.3	1.1
Standard deviation	0.8	1.1	0.98
Pr (|T| > |t|) = 0.0000<0.05			
7. Experience on potato farming (Years)			
Mean	7.2	13.7	10.5
Standard deviation	6.9	10.3	9.4
Pr (|T| > |t|) = 0.0000<0.05			

4.2. Socio- Economic Characteristics of the Sampled Potato Traders

4.2.1. Age

The mean age of the sampled traders was 33.9 years, and a t-test showed significant differences in age composition between wholesalers and retailers, with retailers being younger compared to wholesalers. This suggests that all of them are within the economically productive age.

4.2.2. Level of Education

The result in Table 2 reveals that the mean number of years that traders spent in school is 7.5 years, and the t-test shows a significant difference, given that retailers are more educated than wholesalers. However, as described by Kadigi [19], attending school is an important factor that ensures a trader has access to market information, availability of potato supply, and critical decision-making during business arrangements. Attending school helps improve working efficiency, which probably guarantees more income.

4.2.3. Household Size

The result in Table 2 shows that the composition of the sampled traders had a mean of 5.4 persons per family, which ranged from 1 to 12, implying better participation of the family in potato trading. The t-test indicates that the family sizes of the sampled traders in these two categories were significantly different at the 1% level of probability.

4.2.4. Sex

In terms of the sex distribution by scale of business, 53.3% are female and 46.7% are male. Its disaggregation indicates that 83.3% of males participate in this activity as wholesalers, while 62.3% participate as retailers.

4.2.5. Distance to the Source of Potato

In terms of the distance to the sources of potato, the results reveal that wholesalers covered more distance to reach the farmers, with a mean of 168 kilometers, than retailers, who took an average of 30 kilometers to reach the wholesalers. This makes sense since all wholesalers bought potatoes directly from farmers in the productive areas, while 48.4% of the retailers bought potatoes from wholesalers, and they also covered a mean of 30 km to reach the wholesalers. From the total amount marketed by farmers, 41% was bought directly by wholesalers.

4.2.6. Trading Experience

With respect to a trading experience factor, the survey reported a mean of 9.3 years, with wholesalers showing more years of experience (13.7 years) than retailers (8.2 years) in potato marketing. Between wholesalers and retailers, the t-test showed a significant difference in trading experience. Experience is an indicator of market performance, where more experienced actors are expected to be more efficient and able to face risks. This makes sense since all wholesalers bought potatoes directly from farmers, and this increased risks such as high transport costs to the localities in order to contact farmers and bring potatoes to supply rural and urban markets.

4.2.7. Sources of Potato

From Table 2 it has been shown that 100% of wholesalers buy potatoes from farmers who distribute and sell to the retailers who resell to the consumers. However, 51.6% of the retailers buy potatoes from wholesalers, and the remaining percentage buy directly from farmers.

Table 2. Potato traders' characteristics by scale of business on the sampled markets.

Characteristics	Scale of business		Total
	Wholesalers (n=30)	Retailers (n=122)	(n=152)
1. Age (Years)			
Mean	36.7	33.2	33.9
Standard deviation	6.3	7.8	7.7
Pr(|T| > |t|) = 0.0242<0.05			
2. Education (Years)			
Mean	6.4	7.8	7.5
Standard deviation	3.8	3	3.2
Pr(|T| > |t|) = 0.0353<0.05			
3. Household Size (Number)			
Mean	6.1	5.2	5.4
Standard deviation	2.2	1.8	1.9
Pr(|T| > |t|) = 0.0204<0.05			
4. Sex (%)			
Female	16.7	62.3	53.3
Male	83.3	37.7	46.7
5. Distance to the Sources of Potato (km)			
Mean	168	30.2	57.4
Standard Deviation	99.1	51.9	84.1
Pr(|T| > |t|) = 0.0000<0.05			
6. Experience (Years)			
Mean	13.7	8.2	9.3
Standard deviation	6.2	5.4	6
Pr(|T| > |t|) = 0.0000<0.05			
7. Source of potato			
Farmers	100	51.6	61.2
Wholesalers	0	48.4	38.8

4.3. Potato Marketing Channels

Table 3 presents the results of productivity and produced quantity for a rain-fed period of the 2019/2020 season, as well as the marketed quantity after harvest. Angónia and Tsangano, jointly, sold 84.4% of the produced quantity of potatoes to various markets through different market channels according to demand. Additionally, the mean productivity obtained from farmers in both districts was 4,362 kg/ha, which is below the research level estimated by Schelling [5] to be between 20 and 30 tonnes per hectare in Mozambique. This low productivity affects, in the short term, the availability of significant quantities for the market. Therefore, supportive efforts to potato farmers are necessary to increase productivity and, consequently, quantities for the market.

Table 3. Productivity, production, and marketed quantities by farmers.

Districts	Productivity (kg/ha)	Production (kg)	Marketed Quantity (kg)
Angónia	3,578.6	675,261.0	518,188.6
Tsangano	5,101.8	1,632,535.0	1,429,420.0
Pooled	4,362.0	2,307,796.0	1,947,609.0

Moreover, farmers were found selling potatoes through five different channels as shown in Figure 1. From both districts, wholesalers and retailers were the main buyers of potatoes, with percentage shares of 51.2% and 9.7%, respectively. The potatoes sold directly to consumers by farmers accounted for 0.7%. It is important to note that 38.4% of the potatoes from farmers were purchased by mixed customers, such as wholesalers, retailers, and consumers. Some wholesalers were represented by local collectors and employees of these wholesalers, who were involved in the chain, implying that the quantities of potatoes handled by local collectors were included in wholesaler figures. The

description of the channels identified during data collection is explained as follows. Similarly, Mbise [20] found that farmers and traders were the main actors in maize production and potato marketing in Tanzania. Furthermore, 72.2% of interviewed farmers sold their maize at the farm gate, 4.9% sold at the local market, and 22.9% sold their maize to the government. Four channels were identified.

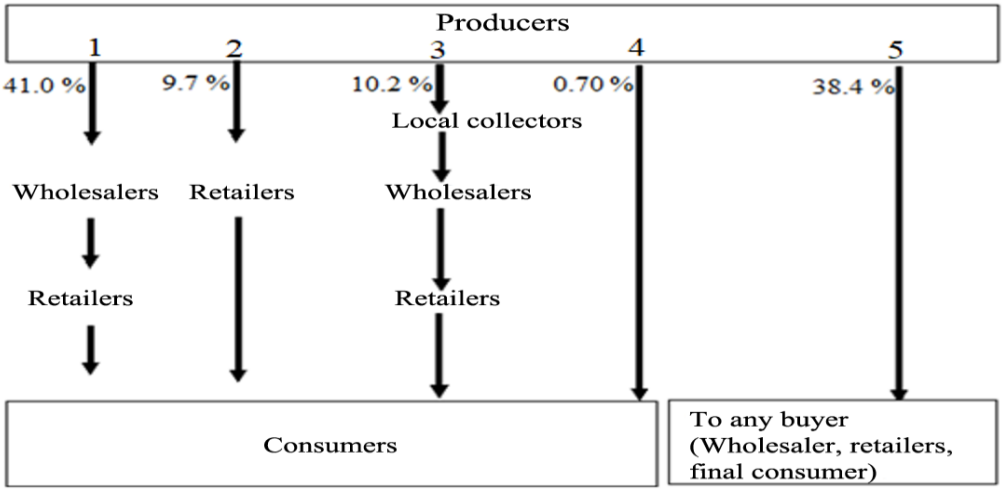

Figure 1. Potato marketing channels from productive localities to the final markets in Tete province.

4.4. Performance of Potato Markets

4.4.1. Marketing Margins

From the information obtained from the survey, the prevailing average selling price per kilogram for potatoes at each level is presented in Table 4.

Table 4. Average selling price per one kilogram of potatoes.

Selling level	Selling price (MZM/kg)
Farmers	12.8
Wholesalers	18
Retailers	25.4

Note: 1 USD = 75,0 MZM (March 2021)

The marketing margins for the different marketing channels of potatoes were then calculated using the equations presented in the methodology. The producer participation was also calculated to determine the portion of the final price paid by the consumer that belonged to the farmer, as presented in Table 5.

Table 5. Gross marketing margins per one kilogram of potatoes, by channel.

Gross marketing margin	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5
Total gross marketing margin	57.9	49.6	-----	0	-----
GMM- wholesaler	28.8	-----	-----	-----	-----
GMM- retailer	29.1	49.6	-----	-----	-----
Producer participation	42.1	50.4	-----	100	-----

Based on the results in Table 5, the farmers' participation in the consumer price was lowest in channel 1 (42.1%), where farmers sell their potatoes to the retailers who, in turn, sell directly to the consumers. Hence, it was highest in channel 4 (100%), where farmers sell their potatoes directly to consumers in rural or urban markets. The producer participation increased to 100% because producers played the roles typically performed by wholesalers and retailers.

Due to this, farmers retained the profits that could have otherwise gone to intermediaries. The availability of consumers in the producer's area also justified the direct sale to them.

The producer participation for channel 5 was not presented because, in this channel, farmers sold their produce to all types of traders in their localities. This means that 38.4% of farmers took the produce from their homes to the local market in their areas during market days, where they sold to wholesalers, retailers, or consumers. Channel 5 is represented by channels 1, 2, and 4. For channel 3, the producer participation was also not calculated since the study did not interview local collectors. However, 0.70% of farmers sold their produce to local collectors who were mandated by wholesalers. Therefore, the information attributed to local collectors was included among wholesalers. This means that channel 3 can be represented by the same marketing margins as channel 1.

Table 6 presents the potato price spread and traders' surplus values across all channels.

Table 6. Potatoes price spread and traders surplus per one kilogram, by channel.

Actors	Variables	Marketing channels				
		1	**2**	**3**	**4**	**5**
Producer	Selling price (MZM/kg)	12.8	12.8	12.8	12.8	12.8
	Production cost (MZM/kg)	8.4	10.5	-	3.1	-
	Net MM (MZM/kg)	4.2	2.1	-	9.7	-
	Gross MM (MZM/kg)	12.6	12.6	-	0.0	-
	PP (%/kg)	42.1	50.4	-	100.0	-
Wholesaler	Buying price (MZM/kg)	12.8	-	-	-	-
	Selling price (MZM/kg)	18.0	-	-	-	-
	Marketing cost (MZM/kg)	2.8	-	-	-	-
	Total marketing costs (MZM/kg)	15.6	-	-	-	-
	Traders surplus (MZM/kg)	2.4	-	-	-	-
Retailer	Buying price (MZM/kg)	18.0	12.8	-	-	-
	Selling price (MZM/kg)	25.4	25.4	-	-	-
	Marketing cost (MZM/kg)	1.5	2.1	-	-	-
	Total marketing costs (MZM/kg)	19.5	14.9	-	-	-
	Traders surplus (MZM/kg)	5.9	10.5	-	-	-

Note: 1=Wholesaler; 2=Retailer; 3=Local Collectors; 4=Consumer; 5=Mixed.

The mean selling price of the farmer was used for all the channels. The consumer price is the one that differed between channels, leading to different total gross marketing margins (TGMM). The gross marketing margins (GMM) for channels 1, 2, and 4 were 12.6 MZM/kg, 12.6 MZM/kg, and 0.0 MZM/kg, respectively. Marketing costs were generated from survey data. The information on the farm gate price, marketing costs, and end price was used to calculate net marketing margins (NMM). The NMM was retained by the various intermediaries within the marketing channels. They were found to be 4.2 MZM/kg (16.5%), 2.1 MZM/kg (8.3%), and 9.7 MZM/kg (75.8%) of the consumer's price for channels 1, 2, and 4, respectively. For channel 3, the NMM went to the wholesalers (in channel 1) since local collectors were in the name of wholesale traders. For channel 5, all the information was not presented, as farmers in this channel reported selling their potatoes to everyone among wholesalers, retailers, and consumers, where the details are already in channels 1, 2, and 4. The results also show that out of the price paid by the consumer, 42.1%, 50.4%, and 100% had gone to the farmer for channels 1, 2, and 4, respectively.

According to Nzima et al. [21], if the traders' share exceeds 30% of the total cost without any improvements in the services provided, the trader is earning supernormal profits. This situation is evident among retail traders in the study area, where they retain more than 30% of the traders' surplus. Retailers in channel 1 receive a share of 30.3%, while those in channel 2 receive 70.5%. This indicates that all retail traders are earning supernormal profits, as their shares are significantly above the acceptable range of 20% to 30%. In contrast, wholesalers are earning normal profits, with their shares around 15.4%, despite incurring substantial costs to transport potatoes to various markets from productive localities. Wegi et al. [22] observed a slightly different outcome, where wholesalers earned higher profits (195.65) compared to retailers (74.0), which was attributed to the business environment. They identified channel 2 as the most profitable, with 77.8% of the consumer's price being a producer's share. These authors recommended strengthening a channel controlled by retailers to improve overall market efficiency.

4.4.2. Breakeven Analysis

Table 7 presents the means of the total output, the market prevailing selling price, the total variable cost, the breakeven price, and yield. The means of the total output, the market prevailing selling price, and the total variable costs were obtained directly from Stata, based on the equations presented in the methodology. However, the market price for potatoes (12.8 MZM/kg) was higher than the calculated breakeven price (7.6 MZM/kg), which helps to understand that farmers are not incurring losses and are able to cover all variable costs. This breakeven price information is particularly important, as it provides farmers with a basis for negotiating better market selling prices for potatoes. Additionally, the breakeven price plus 40% is the expected price that should be paid to farmers. If traders pay less than this amount, farmers are exploited and cannot cover production costs, which could lead to a decline in market participation due to losses. Assessing the five marketing channels in Table 6, wholesalers, retailers, local collectors, and even final consumers are paying a fair share to farmers, since the price paid (12.8 MZM/kg) exceeds the breakeven price plus 40% (10.7 MZM/kg). However, it can be concluded that producers are not exploited, and with well-organized production processes, they have been able to increase their marketed quantities and improve their well-being. Mbise [20], studying maize marketing margins and using different approaches in Tanzania, concluded that maize farmers were exploited, as they received a low percentage of the final consumer price. Nalivata and Maonga [15] also found that maize farmers in Malawi were exploited by traders, as they were paid below the breakeven price.

Looking into the breakeven yield, the results in Table 7 show that potato yield levels of 1,487.3 kg/ha would enable the farmer to avoid making a loss under the prevailing market price of 12.8 MZM/ha, meaning that potato production in the study area is profitable. Nalivata and Maonga [15] found that CG7 and Mawanga groundnuts were also profitable since the breakeven yield was below the obtained productivity for groundnut farmers in Malawi. However, the analyses on the gross marketing margin and on the breakeven are important tools that can guide farmers to make decisions prudently with respect to farm management and price setting for profitable farm business. To realize this benefit from farm enterprises, farmers are carefully called to keep farm records of every activity, costs associated, and quantities produced for each piece of land.

Table 7. Breakeven price per kilogram and breakeven output per hectare for farmers.

Parameter	Observations
Yields or Output (kg/ha)	4,362.10
Market price (MZM/kg)	12.8
Total variable costs (MZM/ha)	19,037.10
Breakeven price (MZM/kg)	7.6
Breakeven yield (kg/ha)	1,487.30

4.5. Constraints Faced by Smallholder Potato Farmers and Potato Traders

The study identified three (3) constraints associated with potato farmers and traders, Table 8. These include storage facilities (100%), price information (17.9%), and road quality (79%) for farmers. At the traders' level, the same number of constraints was identified, which included storage facilities (100%), price information (5.9%), and road quality (38%). The results reveal that the availability of cold storage facilities (100%) is the major constraint faced by smallholder farmers and potato traders in the study area, given that it ranks first. In the study area, this can be attributed to the fact that all smallholder farmers and traders depend mainly on storage facilities to stabilize selling prices from farmers to traders as well as from traders to the final consumers. The results agree with Nzima et al. [21] findings that poor road infrastructure, lack of markets, and storage facilities are among constraints to groundnut production and marketing in Malawi.

Table 8. Constraints faced by smallholder potato farmers and potato traders.

Constraints	Frequency	Percentage
Smallholder Farmers	-	-
Storage facility	453	100
Price information	81	17.9
Road quality	358	79
Traders	-	-
Storage facility	152	100
Price information	9	5.9
Road quality	38	25

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

This study assessed the marketing channels of potatoes in Tete province of Mozambique using primary data obtained through structured questionnaires and checklists applied to 453 farmers and 152 traders, respectively, in 2021. The overall potato market was found to have five marketing channels. Smallholder farmers obtained 100% of the consumer price when they sold directly to consumers, and this channel was found to be the most profitable. Moreover, the breakeven analysis showed that smallholder potato farmers were receiving reasonable market prices since the breakeven price was below the prevailing market price, and the breakeven yield was less than what was produced per hectare, implying that smallholder potato farmers do not incur losses under the prevailing market price. Variables such as cold storage facilities, price information, and road quality were identified as constraints to farmers and traders.

5.2. Recommendations

This study supports potato production and marketing in the study area. Based on the results and discussions, the following recommendations are addressed:

- Channel one (1) should be strengthened since it would assist farmers in marketing potatoes through economies of scale.
- Government and other organizations should implement effective agricultural policies that support the potato market chain in this region.
- Government and other organizations should improve road networks to production areas to facilitate potato trading and the availability of farm inputs used for potato production.
- Storage facilities and market infrastructures should be constructed to ensure the availability of high-quality products on the market.

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