

**MARKET EFFICIENCY, CHOICE OF MARKETING CHANNEL
AND SUPPLY OF MACADAMIA AMONG SMALL HOLDER
FARMERS IN EMBU WEST SUB-COUNTY**

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DECLARATION

This thesis is my original work and has not been presented elsewhere for a degree or any other award

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DEDICATION

This work is dedicated to the Almighty God for the gift of life and guidance during my studies. I also dedicate this work to my loving family, friends and my supervisors.

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TABLE OF CONTENT

DECLARATION	ii
DEDICATION	iii
ACKNOWLEDGEMENT	iv
TABLE OF CONTENT	v
LIST OF TABLES	viii
LIST OF FIGURES	ix
LIST OF APPENDICES	x
LIST OF ABBREVIATIONS	xi
OPERATIONAL DEFINITION OF TERMS	xii
ABSTRACT	xiii
CHAPTER ONE	1
INTRODUCTION	1
1.1 Background information	1
1.2 Statement of the problem	4
1.3 Objectives	4
1.3.1 General objective	4
1.3.2 Specific Objectives	4
1.4 Research questions.....	5
1.5 Justification	5
1.6 Scope of the study.....	6
1.7 limitation of the study	6
1.8 Assumptions.....	6
CHAPTER TWO	7
LITERATURE REVIEW	7
2.1 Overview of the Macadamia sub-sector in Kenya.....	7
2.2 Factors affecting market efficiency	7
2.3 Factors influencing choice of marketing channels.....	8
2.4 Factors affecting the quantity supplied to markets	10
2.5 Theoretical framework.....	11
2.5.1 Supply theory	11
2.5.2 Random utility theory	12

2.6 Conceptual framework.....	12
.....	13
CHAPTER THREE	14
METHODOLOGY	14
3.1 Study area.....	14
3.2 Research design	14
3.3 Target population and sample size.....	14
3.4 Sampling design and procedure	15
3.5 Data collection instruments.....	16
3.6 Data analysis	17
3.7 Analytical test	17
3.7.1 Heteroscedasticity test	17
3.7.2 Multicollinearity test.....	17
3.8 Model specification.....	18
3.8.1 Effect of selected socio-economic and institutional factors on market efficiency	18
3.8.2 Influence of selected market and socio-economic factors on choice of market channel	19
3.8.3 Assessment of socio-economic factors influencing the quantity supplied	19
CHAPTER FOUR.....	20
RESULTS	20
4.0 Characteristics of the Respondents	20
4.1 Socio-economic Characteristics of the Respondents	20
4.2 Institutional factors	21
4.3 Market factors	22
4.4 Descriptive Analysis on Costs and Marketing Efficiency	22
4.5 Descriptive statistics on choice of marketing channels	25
4.6 Selected Socio- economic Factors that Affected Choice of a Marketing Channel	25
4.7 Market factors that affected choice of marketing channel.....	26
4.8 Reasons for choosing a market channel.....	27
4.9 Quantity of macadamia supplied to the market	28
4.10 Effects of Socio-Economic Factors and Institutional Factors on Marketing Efficiency.....	28

4.11 Influence of Market and Socio-Economic Factors on the Choice of Marketing Channels.....	30
4.12 Effects of Socio-Economic Factors on the Quantity of Macadamia Supplied	34
CHAPTER 5	36
DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS	36
5.1 Discussion of the results	36
5.1.1 Choice of marketing channel in the study area.....	36
5.1.2 Effects of Socio-Economic Factors and Institutional Factors on Marketing Efficiency.....	37
5.1.3 Influence of Market and Socio-Economic Factors on the Choice of Marketing Channels.....	38
5.1.4 Effects of Socio-Economic Factors on the Quantity of Macadamia Supplied ...	41
5.2 Conclusions.....	42
5.3 Recommendations.....	43
5.3.1 Factors influencing market efficiency	43
5.3.2 Factors influencing choice of marketing channels.....	43
5.3.3 Factors affecting quantity supplied to the market.....	43
5.4 Areas for further research	43
REFERENCES.....	45
APPENDICES	54
APPENDIX 1: Variables and their appropriate signs.....	54
APPENDIX 2: Questionnaire	56

LIST OF TABLES

Table 3.1: Summary of household sampled in the study area	16
Table 4.1: Descriptive summary on socio-economic factors.....	21
Table 4.2: Institutional factors in the study area	21
Table 4.3: Mean of costs and market efficiency	22
Table 4.4: Distribution of market efficiency.....	23
Table 4.5: ANOVA of marketing efficiency and prices across marketing channels ..	24
Table 4.6: ANOVA of socio-economic factors across marketing channels	26
Table 4.7: Market factors across marketing channels.....	27
Table 4.8: Quantity of macadamia delivered to the market.....	28
Table 4.9: Factors affecting market efficiency	30
Table 4.10: Factors influencing choice of marketing channel	33
Table 4.11: Factors affecting quantity of Macadamia supplied to the market.....	35

LIST OF FIGURES

Figure 2.1: Conceptual framework	13
Figure 4.1: Sources of market information in the study area	22
Figure 4.2: Marketing channels chosen by farmers	25
Figure 4.3: Reasons for choosing a marketing channel in the study area	28

LIST OF APPENDICES

Appendix 1: Table of variables and their appropriate signs	54
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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
CAGR	Contribution Annual Growth Rate
Ha	Hectares
INC	International Nut and Dried Fruit Council
Kgs	Kilogram
Kms	Kilometers
KES	Kenya shilling
KNBS	Kenya National Bureau of Statistics
LM	lower Midland
NGOs	Non-Governmental Organizations
NIS	Nut-in-shell
Nut PAK	Nut Processors Association of Kenya
OLS	Ordinary Least Square
RU	Random Utility theory
STATA	Statistics and data
UM	Upper Midland
VIF	Variance Inflation Factor

OPERATIONAL DEFINITION OF TERMS

Market efficiency	Market efficiency is the ratio of marketing output to input and measures efficiency of profit earned by marketing channels and producers as a function of operating cost to show market margins and profit earned by producers (Dukpa, 2020; Kyomugisha et al., 2017; Mgale & Yunxian, 2020).
Market	Physical or virtual arrangements where the buyers and sellers meet to exchange goods and services for specified and mutually agreeable benefits including money (Kalita, 2017).
Marketing channels	Alternative routes of product flow from producer to the market (Lee et al., 2020) In this study, marketing channels involved selling to local traders, brokers, marketing organizations and factories.
Supply	willingness and ability to sell a product.
Small holder farmer	A farmer operating in a farm size of less than a hectare (Zaehringer et al., 2018).

ABSTRACT

In Kenya horticulture contributes greatly to the economy and particularly nuts play a crucial role in income generation with macadamia production been ranked among the top enterprises. The crop leads to job creation and acts as an income incentive to smallholder farmers. Despite its potential in the Kenyan economy, macadamia production has not been fully exploited resulting from a weak link between extension and farmers. This has occasionally translated to low market efficiency, farmers participating in low rewarding channels and farmers producing low yield. The study provides insight on market efficiency, choice of marketing channel and quantity of macadamia supplied to the market. The study was guided by three objectives; to assess selected institutional and socio-economic factors that affect market efficiency, to determine selected market and socio-economic factors that influence participation in various marketing channels and to assess socio-economic factors that affect the quantity of macadamia supplied to the market. The study provides information on most profitable marketing channels available to farmers. Data used in the study was collected using a structured questionnaire from 337 smallholder macadamia farmers who were selected randomly in Embu West Sub-County using stratified multistage random sampling technique. The study was guided by the Supply theory and Random Utility theory to explain how farmers made decision to participate in a channel and supply macadamia. A cross sectional survey design was adopted in the study. In assessing the institutional and socio-economic factors that affect market efficiency, the study adopted the stochastic frontier production function analysis. In determining selected market and socio-economic factors that influence choice of a marketing channel the study used the multinomial logit regression model and to assess the socio-economic factors that influence the quantity of macadamia supplied to the market the study adopted the multivariate multiple regression model. The findings revealed that the mean of market efficiency was 8.15 %, broker channel 48.1% was the most preferred channel and farmers supplied an average of 128.37 kilograms. The findings of this study provide information to sectors involved and policy makers and recommends on the need to put feasible strategies such as increasing extension and setting more collection centers for profitable channels to enable farmers fetch higher returns from macadamia farming.

CHAPTER ONE

INTRODUCTION

1.1 Background information

Globally, the top producers of macadamia are South Africa and Australia which produce 29% and 25% respectively of the total world's macadamia (Bouarakia et al., 2023). Kenya is an upcoming competitor accounting for 13% share of total global macadamia nut production (Mbogo et al., 2021; Muchangi et al., 2021). The crop is gaining popularity as it can be consumed raw, salted, roasted, used as additive in cakes, confectionary and ice creams (Kalita, 2017; Zuza et al., 2021). Due to its high economic incentives, countries like South Africa have gone to an extent of growing more than 600,000 trees annually and a country like China looks forward to increase its production thrice (Parshotam, 2018).

The crop is estimated to contribute to less than 2% of the total global nuts produced (Brinkhoff & Robson, 2020) and macadamia nuts showed a Contribution Annual Growth Rate (CAGR) of 8% globally during the 2018/2019 year period (Quiroz et al., 2019). Globally production of macadamia is forecasted to increase due to the change in eating habits where consumers are looking for healthy natural and organic foods (Modem, 2022).

In 1946 a researcher called Bob Harries introduced macadamia in a firm in Thika and his primary intention was to diversify incomes from the deteriorating coffee sector (Canwat et al., 2020; Perdoná & Soratto, 2015), but due to potentials of the crop it was later adopted for various reasons such as beauty, shade and to mark boundaries (Mbogo et al., 2021; Verma et al., 2017). There are two species commercially grown for nut production namely, *Macadamia integrifolia* and *Macadamia tetraphylla* which are also the main varieties grown in Kenya (Brinkhoff & Robson, 2020; Muchangi et al., 2021). Farmers are trying to meet the demand for macadamia which is far below the supply and are slowly transitioning to macadamia farming from coffee farming because the land remains productive for macadamia production despite the changing weather patterns that have been witnessed in the previous years (Annika et al., 2019; Canwat et al., 2020; Perdoná & Soratto, 2015). Macadamia is a major export crop where 99% is exported contributing to 38% of the total nut crops produced in Kenya creating direct or indirect employment in the sector (Mbogo et al., 2021). Growth of the crop helps to

transform Kenya's economy as contained in Kenya Vision 2030 (Murioga et al., 2016; Quiroz et al., 2019). Despite this, farmers in developing countries have been harvesting premature crops and affecting quality of products (Reardon et al., 2019; Tura et al., 2016) where in macadamia sector it has resulted from farmers who are deceived by the high prices in some seasons (Nhantumbo et al., 2017).

Macadamia production in Kenya by small holder farmers is mainly concentrated in the eastern and central region which lead in production. It is acknowledged that the contribution according to County are Embu County contributing (36.5%), Murang'a (17.2%), Meru (11.8%), Machakos (7.8%), Kiambu (7%), Nyeri (5.8%), Tharaka Nithi (5.5%) and Kirinyaga (4.4%) (Wasilwa et al., 2019). large scale production is done by companies such as Kenya Nut Company, Jungle Nut and Agriculture Development Cooperation. Nationally the area currently covered by the macadamia crop is estimated at 6,173 hectares (Mbogo et al., 2021). The sub-sector revenue generation is approximately four billion Kenyan shilling resulting from export earnings and sale of planting material (Wasilwa et al., 2019). Kenya has about 100,000 smallholder farmers who produce an average of 42,500 tones Nut In Shell (NIS). According to Nut Packaging Association of Kenya (Nut PAK) production in Kenya has increased rapidly during the past ten years, from an average of 11,000 tones Nut In Shell in 2009 to 42,500 in 2020 tons (Njue et al., 2023). This has also led to an increase in the processing capacity in the country to grow from 4 processors in 2009 to at least 26 processors in 2022 (Irugu et al., 2023).

Embu County favors production of various cash crops with macadamia being among the high value leading crops. The sector is dominated by smallholder farmers who in most cases do not produce sufficient volumes making processing and marketing to be taken by a few commercial producers who control the value chain (Parshotam, 2018). Trading of macadamia in Embu County is dominated by monopolistic firms with factories been the primary processors such the Limbua Company limited (Annika et al., 2019). Private marketing organizations also buy macadamia in huge amounts without necessarily processing macadamia and sell to other factories in neighboring Counties. Due to the low volumes harvested intermediaries such as brokers and local traders assemble the nuts at relatively lower prices and gain volumes to trade with the factories and marketing organizations (Murioga, et al., 2016). Brokers are seen to fully sell to factories and market organization while the local traders sell part of their macadamia in

the open market to local consumers and nursery growers. This causes farmers to be involved in channels without prior knowledge making it necessary to provide farmers with information in profitable marketing channels that fetch higher prices so as to increase market efficiency (Reddy et al., 2018; Xaba & Masuku, 2012). Better access to markets increases yield and quantities supplied therefore serving as an effective means of elevating poverty from smallholder farmers (Mango et al., 2018). However, this has not yet been achieved to help smallholder macadamia farmers to fully benefit from the sector.

Macadamia market in Kenya and neighboring African Countries is characterized by: price fluctuation and unstable structure characterized by a weak link between agricultural extension services and farmers, little collective action in marketing thus lowering the efficiency in the market system (Kalita, 2017; Zuza et al., 2021). Smallholder farmers in developing countries are characterized by owning small pieces of land which is the case with macadamia farmers and face challenges in advancing from subsistence farming to commercialization (Adaobi et al., 2020; Ferris et al., 2014; Shamdasani, 2021).

Macadamia farmers face problems such as lack of adequate information on the correct varieties to grow, limited agronomic knowledge and inadequate marketing information that affects their overall yield and marketable output (Adaobi et al., 2020; Mbogo et al., 2021). Factories and marketing organizations in macadamia market tend to lack a regular scheme like that of other crops such as tea and coffee when sourcing thus making farmers in most cases lack consistency on whom they sell resulting to low prices (Annika et al., 2019). Buyers who rely on smallholder producers face supply failures because smallholder farmers have inadequate resources such as poor transportation services and market information which is the case with macadamia farmers who tend to supply less of their macadamia to profitable market available to them (Canwat et al., 2020).

Most studies in macadamia have laid much focus aspects such as improving quality of macadamia, improving productivity through improved cultivars and how to improve genetics on macadamia species (Annika et al., 2019; Muchangi et al., 2021; Murioga, et al., 2016; Verma et al., 2017) however, little has been done on marketing and supply of the crop thus making this study necessary to breach the knowledge gap.

1.2 Statement of the problem

Macadamia is a high value nut since it fetches high returns due to its demand in the international market. Farmers have continued to adopt and grow the crop and participate in marketing of macadamia. However, in Kenya farmers have not reaped much out of the high valued crop as they have not been producing high yields and are still not involved in profitable marketing channels. This has resulted to smallholder farmers opting to use intermediaries in most cases who are brokers who buy macadamia at low prices. Several interventions have been put in place to promote smallholder farmers market participation in the domestic market but with little success. The market is not well structured and documented at the local levels and hence it is unclear how the macadamia trade occurs. As a result regular fluctuations of prices is reported that often denies the farmers much expected benefits from the crop. It is unclear how efficient the market is and in most cases, farmers result to marketing their produce without full information and knowledge because of scarcity of extension services, farmers groups and little collective action. Further, there is paucity of research based information regarding determinants of choice of marketing channel and market efficiency of macadamia markets. It is unclear what the producers of macadamia supply which occasion market price fluctuations. This study comes in hand to bridge these knowledge gaps

1.3 Objectives

1.3.1 General objective

To evaluate factors influencing marketing efficiency, choice of marketing channels and supply of macadamia among smallholder farmers in Embu West Sub-County

1.3.2 Specific Objectives

1. To assess the effect of selected socio-economic and institutional factors on marketing efficiency among smallholder macadamia farmers in Embu West Sub-County
2. To determine the influence of selected market and socio-economic factors on the choice of marketing channels by smallholder macadamia farmers in Embu West Sub-County
3. To assess the effect of socio-economic factors on the quantity of macadamia supplied by smallholder farmers in Embu West Sub-County

1.4 Research questions

1. What are the effects of selected socio-economic and institutional factors on marketing efficiency among smallholder macadamia farmers in Embu West Sub-County?
2. What is the influence of selected market and socio-economic factors on choice of marketing channels among smallholder macadamia farmers in Embu West Sub-County?
3. What is the effect of socio-economic factors on the quantity of macadamia supplied by smallholder farmers in Embu West Sub-County?

1.5 Justification

Macadamia production is among the crops that can be exploited to improve farmers' income in the entire globe and specifically to the Sub-Saharan Africa countries and particularly in Kenya. Production and consumption of macadamia is stipulated to increase due to its high nutritional value that has resulted from a change in dietary requirement. Macadamia production has not been fully invested in due to factors such as choice of low profitable marketing channels and low market efficiency resulting from low extension services and lack of adequate market information. Growth of an efficient macadamia sector through smallholder farmer involvement in profitable marketing channels will largely help in attaining the sustainable development goal one of alleviating poverty through providing farmers with income to sustain their livelihoods. Supporting the macadamia enterprise will contribute to higher supply in the market and help support the horticultural sector in Kenya, which is part of attaining the vision 2030 economic growth pillar.

As climate change is occurring, the land still remains suitable for macadamia production when intercropped with other crops such as coffee because the crop is tolerant to low rainfall received in some seasons. The study provides farmers with information on most profitable marketing channels available to them to help in decision making that would aid in attaining higher marketing efficiency and increase the quantity of macadamia supplied in the market. The study adds to the existing literature on macadamia marketing and provides information for policy making to help farmers leap more by trading in profitable channels.

1.6 Scope of the study

The study covered the geographical area of Embu West Sub-County in Embu County Kenya and the target population was macadamia farmers. Market efficiency was evaluated on the farm level and marketing channels used included local traders, brokers, marketing organizations and factories. Supply of macadamia was on the market where buyers bought macadamia.

1.7 limitation of the study

Lack of accurate records on farmer household such as records on prices of macadamia, records on extension services and lack of records on quantities supplied to market was a great challenge. This was countered through consulting from various extension officers where they sold their macadamia.

1.8 Assumptions

The study assumed that house-holds that were interviewed were adequately representing the macadamia farmers in the area of study. Quantity of macadamia supplied was only considered for the two boom harvesting seasons annually. The first season occurred in the month of February and the second in the month of September. Marketing channel chosen was where farmers sold macadamia during the boom harvest.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of the Macadamia sub-sector in Kenya

Macadamia nut has gained popularity because of its high economic incentive returns and Kenya produces 13% of the world's macadamia nut (Mbogo et al., 2021). Macadamia nuts are produced both in small scale and in large scale where 99% of macadamia is exported and the remaining is used for domestic consumption such as through snack. The United States, Britain and China are the largest buyers (INC - International Nut&DriedFruit, 2023). Macadamia production is practiced in many parts of the country with eastern and central being ranked among the largest producers (Wasilwa et al., 2019). In Kenya the sector produces more than 42,500 tons of nut in shell per annum mainly from small holder farmers (Njue et al., 2023). Area currently covered by the macadamia crop is estimated at 6,173 hectares and the sub-sector revenue generation is approximately four billion Kenyan shilling resulting from export earnings and sale of planting material.

In Embu County the improved varieties of Macadamia *integrifolia* grown are Murang'a 20, Kirinyaga 15, Kiambu 3 and Embu 1 which produce higher yields. The other species grown is Macadamia *tetraphylla* which is the traditional variety that produces relatively lower yield. (Muchangi et al., 2021).

2.2 Factors affecting market efficiency

Market efficiency shows ratio of marketing output compared to input used and measures efficiency of profit as a function of operating cost to show margins of the channels and profit earned by producers (Dukpa, 2020; Kyomugisha et al., 2017; Mgale & Yunxian, 2020).

Ability to have access to more lucrative markets is essential for income generation to help smallholder farmers attain food security. This encourages farmers to diversify their production through adopting improved technologies that would result in yielding quality produce fetching better prices (Bonanno et al., 2018; Mgale & Yunxian, 2020). In a market it is generally assumed that participants are aware of market prices and that there are regulations that control the markets though this is not the case in macadamia markets where prices are fluctuating and not predictable (Annika et al., 2019).

Distance to the market and information flow on prices are major indicators market efficiency and if physical trade flows are the main means of connecting markets distance is very crucial to enhance market integration and long distances are associated with little flow of prices information leading to inefficiencies (Svanidze & Götz, 2019).

A study by Olubukola et al. (2017) revealed that the level of education, experience, age, household size and the method of processing in southwest Nigeria affected efficiency of markets among food vendor where experience showed that market participants knew technicality of the market, education helps in adapting changes in the business. Higher education translated to higher chances of better business operations and that age negatively affected and lowered technical efficiency in food vendor market as the aged were associated with poor resource management. However, the study did not expound fully on institutional factors rather more focus was on socio-economic factors.

A study done by Murioga et al. (2016) assessed marketing efficiency of macadamia food system and revealed that gender and education play an important role in attaining market efficiency. Education was associated with helping farmers in implementing and adopting extension service taught in trainings. Gender affected market efficiency where male farmers dominated the sector because macadamia is a cash crop .Nevertheless, institutional factors were neglected in the study giving socio-economic and market factors lead in the study.

Further a study conducted by Tenaye, (2020) on analyzing efficiency of smallholder agriculture farmers in developing countries in Ethiopia revealed that policy measures affected market efficiency. This included cost of labor, seed quality and fertilizer application. Cost of labor was to be lowered to attain more market efficiency, higher quality seeds were associated with higher yield production and more returns. Fertilizer application was associated with higher yields and suggestions on policy intervention were necessary to aid attain more market efficiency. Nevertheless, the study did not expound on some institutional factors like extension making it necessary for this study to address.

2.3 Factors influencing choice of marketing channels

Choice of marketing channels among smallholder farmers is affected by factors such as socio-economic, institutional, market factors and external factors like natural calamities and political instabilities. The effect can either be disadvantageous or advantageous

(Kiprotich, 2014; Kyaw et al., 2018; Xaba & Masuku, 2012). Smallholder farmers can participate in one or more marketing channel depending on prices offered by the alternative markets (Plakias et al., 2020).

Studies on factors influencing choice of marketing channels have shown that market factors like, transaction costs and prevailing market prices in market associations greatly affect choice of a channel. Farmers dislike channels associated with higher transaction cost as they lower their profit margins. Farmers also are seen to be attracted by better prices and tend to choose channels offering higher prices (Kaygisiz, 2021). A study by Musara et al. (2018) on marketing channel preferences by small scale sorghum farmers in Zimbabwe showed that farmers preferred trading with the local traders. This was because of reduced transaction cost which was associated with covering shorter distances to the market. However, the study did not expound on market factors such as quality of products and socio-economic factors clearly showing a gap in research. Payment period affected choice of marketing channels by smallholder citrus farmers in Pakistan where most farmers preferred instant payment and better prices offered to them according to a study done by Siddique et al. (2018).

A study by Shamdasani, (2021) revealed that participation in a marketing channel between the rural and urban people in India was affected by gender, age and farming experience. Majority of smallholder farmers who were the aged and in most cases women were affected by road network connectivity to the take their produce in the urban areas. This made them incur higher transaction costs while transporting rice to the market thus affecting their decision to participate in profitable markets making them sell to middlemen. However, in this study much was not investigated on market factors.

Further Dessie et al. (2018) conducted a study on choice of market outlet among wheat farmers in Ethiopia and revealed that age, education and credit access affected choice of retailers as a market channel. The aged were attracted by the channel due to their payment flexibility, education made farmers more willing to explore channels without intermediaries and credit accessibility made farmers more willing to trade with channels that gave them financial aid. However, the study neglected some institutional factors such as access to extension. A study conducted by Kumar et al. (2015) on choice of marketing channel among milk farmers in India showed that farmers preferred selling to cooperatives and government agencies because they could access credit unlike

selling to local traders where they could not access credit. However the study did not expound much on social economic factors.

Statistics revealed that transport ownership affected the choice of marketing channel among pineapple farmers in Kenya who choose the factory channel. Transport ownership boosted the willingness of participating in a certain market because of convenience of farmers to reach the places of marketing (Kiprotich, 2014). Nevertheless, this study neglected the effect of market factors on choice of factory channel.

Membership to groups, contract marketing, access to extension services, marketing experience and prices affected participation in milk marketing channels in Rwanda where milk farmers choose participating in formal markets such as cooperatives. This was linked with the channel providing farmer with extension, credit and stable prices unlike other channels. However, more focused was laid on institutional factors and neglected the socio-economic factors (Innocent, 2018). Results using the Tobit regression model showed that farm size, age, education, distance to markets and ownership of transport affected choice of participating in marketing channels (Panda & Sreekumar, 2012; Sahara et al., 2015). Education level influence participation in modern markets as farmers who are more educated tend to adjust to new market in a confident way by meeting their requirements, distance to market was significant in that as the time and costs associated with transport increased farmers opted a traditional channel that did not require additional time and cost.

2.4 Factors affecting the quantity supplied to markets

Agricultural produce supply in most cases is perceived of only by participation of large scale producers and small scale farmers are neglected although they participate in the market either to sell their surplus or to earn income (Musyoka, 2020). Although trends on export have been on an increase majority of these smallholder farmers have not fully benefited out of this because of transaction cost that has consequently affected the quantity supplied in markets.

Higher prices and demand affects quantity of produce delivered in a market at a particular time by making farmers more vibrant to take their produce to the market (Yu et al., 2020). A study by Musyoka et al. (2020) conducted in Kenya showed that age of the smallholder farmer, extension contacts, market access, market prices and amount of

credit accessed greatly affected quantity of mangoes supplied to the market. Extension was associated with improvement in quality and household capability of acquiring new technologies to increase market supply. Market access was explained in the sense that most farmers were involved in the local market through market days and showed that access to market could help farmers produce more.

A study conducted by Tura et al. (2016) on intensity of market surplus among teff farmers in Ethiopia showed that, proximity to the market, transport ownership, household size, farm size and prices of commodities affected supply. Farmers are motivated by higher prices and tend to sell their stored surpluses, ownership of transport facilitated flow produce to markets, larger household size were associated with lower quantity of produce taken in markets as most are used for domestic consumption, farm size affected quantity supplied in the sense that higher farm sizes contribute to higher quantities and lower farm sizes low quantities. Despite this, the study did not expound on socio-economic factors such as experience.

A study by Kognisi et al. (2021) showed that social trends such as marketing of health benefits, technology trends, ecological trends, political trends and European market requirement affect quantity of produce delivered in markets. This is because farmers would shift to production of health beneficial crops and more economic rewarding crops. Farmers would also grow crops that were highly adaptable to ecological conditions in their regions and those that were politically influenced more so to fetch more returns in European market. However, the study ignored factors such as socio-economic factors.

In general it is evident that although farmers participate in marketing of agricultural produce, there is scanty of research based information on how the trade occurs and the factors that determine quantity supplied to the markets. Therefore this study focused on breaching the knowledge gaps.

2.5 Theoretical framework

2.5.1 Supply theory

The supply theory was used to expound on the interaction between the factors that affect quantity of macadamia supplied to the market. In this theory supply is considered as farmer's readiness and the capability to sell a product. The theory postulates that the supply of products is dependent on the prices in the market and cost of producing goods

(Musyoka, 2020). A greater difference between the prices and cost values shows more willingness of the farmers to take the product to the market. The readiness to take the products to the market is dependent on the prices of good and the cost of labor. Small holder macadamia farmers were accessed to determine amount of macadamia supplied in relation to prices. That is, low prices in the market was related to oversupply and higher prices to under supply. This notion was expressed linearly as shown in equation 2.1

$$Qx^2 = f (p_x, w \dots n) \quad (2.1)$$

where Qx^2 the quantity of macadamia supplied, p_x is the price per kilogram of macadamia harvested and, w is labor.

n , are factors like the quantity of macadamia harvested, experience, macadamia land size, and household size which were analyzed to show significance influence on the supply of macadamia.

2.5.2 Random utility theory

The theory was applied to explain how macadamia farmers make choices to participate in various marketing channels among competing alternatives. The theory postulates that individuals make rational choices so as to maximize utility conditioned upon a set of constraints. The theory further assumes that individuals have full information and knowledge on available alternatives and that they will always choose the alternative that provides the highest utility. The theory additionally strive to make sure that, returns of using a channel are more than costs to ensure individuals maximize their utility.

Thereby, founded on the concept of random utility theory and the concept of multinomial logit regression, macadamia farmers were assumed to have full information on available marketing channels to them at the farm level and were expected to choose the most rewarding channel to them (Davis et al., 2017). Therefore, this study was drawn from the RU theory to explain how macadamia farmers maximize utility while choosing a channel to participate.

2.6 Conceptual framework

Conceptual framework shows the link between the dependent and independent variables. Socio-economic, institutional and market factors are the independent variables while marketing efficiency, choice of marketing channel and quantity supplied are the dependent variables. However intervening variables such as government rules were also shown as they were expected to affect the overall outcome.

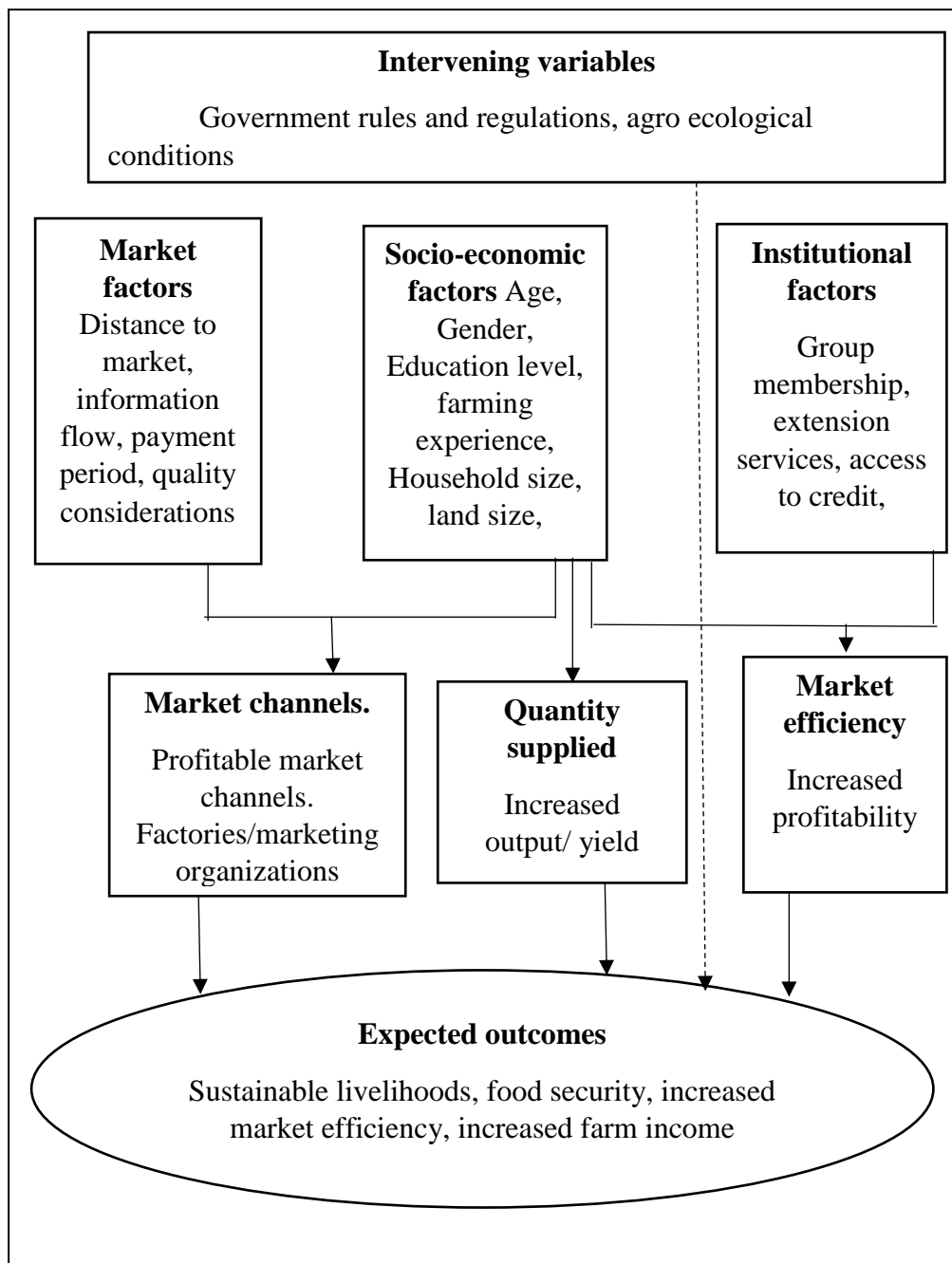


Figure 2.1: Conceptual framework

Source: Own conceptualization

CHAPTER THREE

METHODOLOGY

3.1 Study area

The study was conducted in Embu West Sub-County of Embu County. The geographical area was chosen because it is the leading producer of macadamia in the County. Temperatures in the region vary between 12°C to 27°C and the region is located in latitude 0° 31'58.80"N and longitude 37°27'0 00E. The average annual rainfall ranges from 640 mm to 1495 mm with September experiencing highest temperatures and July witnessed to be the coldest month. There is a bimodal rainfall pattern characterized by two different rainy season. From March to May the long rains are experienced while between October and November the short rains are experienced. The County has a population of 608,599 while Embu West Sub-County has a population of 127,100 (KNBS, 2019). The region has a landscape of highlands and lowlands and rises from about 515m above sea level. The region classification is in the upper midland (UM 2, UM 3) with nitisols soils that are dark brown in color, with acidic humid top soils and of good drainage (Nkirote, 2016).

The main economic activity is agriculture and main cash crops in the county are coffee, khat, tea, bananas, mangoes and macadamia among others while the main food crops grown are maize, beans, cabbages, kales, avocados and cassava among others.

3.2 Research design

A cross sectional survey design was used for its suitability while describing, analyzing and interpreting conditions and variables that existed in the market without manipulating the environment and it was also affordable in data collection using a questionnaire compared to other methods. Respondent information was gathered using a semi-structured questionnaire created using the Kobo Collect tool.

3.3 Target population and sample size

Macadamia farmers in Embu West Sub-County were the target population because it is ranked to be the highest producer of macadamia in the County. There are approximately 2800 macadamia farmers in the region. A formula suggested by Israel (1992) was used to obtain the sample size and is explained as follows;

The sample size can be reduced slightly if it is lower than (10,000). This is because sample size represents relatively adequate data for a small population than for a large

population. Using the Cochran formula (Israel, 1992) the sample size (n_0) can be adjusted

$$n = \frac{n_0}{1 + \frac{(n_0-1)}{N}} \quad (3.1)$$

where n is the sample size and N is the population size.

Because there are 2800 macadamia farmers in Embu West Sub County the sample size was therefore calculated as follows

$$n = \frac{384}{1 + \frac{(384-1)}{2800}} = 337 \text{ macadamia farmers} \quad (3.2)$$

drawing from the formula a total of 337 macadamia farmers was sampled.

3.4 Sampling design and procedure

The unit of research was the farm households while the sampling frame consisted of all farmers practicing macadamia production and who were involved in macadamia marketing. Consequently, a multistage stratified random sampling technique was used in selecting the sample, where in the first stage three out of the five locations were selected in Embu West Sub-County on basis of high macadamia production. On the second stage three sub locations per the three locations were randomly selected totaling to nine. In the third stage two villages per sub location were randomly selected and probability to size was used to randomly select farmers to be interviewed. The method is not only reasonable but also portrays a clear representation of the target population (Masunga, 2014). This is shown in Table 3.1 of this study.

Table 3.1: Summary of households sampled in the study area

Ward	Sub location	Village	Sample size
Gaturi south	Nembure	Nembure	25
		Karurina	30
	Gatunduri	Njakairi	18
		Gatunduri	15
	Ena East	Kivue	19
		Ena	23
Mbeti North	Gatituri	Gatituri	30
		Gakinduriri	17
	Itabua	Itabua	22
		Njumbiri	13
	Kiangima	Kangaru	15
		Kiangima	20
Kithimu	Kithegi	Kiethiga	18
		Kwamethanol	20
	Ena West	Karingari	15
		Muconoke	15
	Kithimu	Kithimu	10
		Kamuthatha	12
Total 3	8	16	337

3.5 Data collection instruments

A structured questionnaire was administered for collecting primary data from the macadamia farmers and was pretested for validation. Secondary data from sources such as existing literature in publications and other internet sources was used in the study for comparison to enrich the findings for the purposes of validating the survey.

Ten questionnaires were administered randomly to the sampled farmers to ascertain if they were dependable. This was done outside the study area and was done in Embu East Sub-County and further the sample was not used in the actual sample size to ensure variability and reliability of the results. A test for the reliability of the instruments was done using the split-halve method. The correlation coefficient (r) between halves of the

instruments was calculated using Pearson Product linear correlation coefficient formula (Heale & Twycross, 2015) as shown below;

$$r = \frac{N \sum XY - [\sum(X) (\sum Y)]}{\sqrt{[N\sum X^2 - (\sum X^2)][N\sum Y^2 - (\sum Y^2)]}} \quad (3.3)$$

where:

r , is the coefficient correlation between halves. Since r represents one-half of the instrument, X , is the odd scores, Y , is the even scores, $\sum(X)$, is the sum of X scores, $\sum Y$, is the sum of Y scores, $\sum X^2$, is the sum of X squared scores $\sum Y^2$, is the sum of Y squared scores, $\sum XY$, is the sum of the product of paired X and Y scores, N , is the number of paired scores. Therefore the reliability was calculated as follows;

$Re = \frac{2r}{1+r} = 2 * \text{reliability for } 1/2 \text{ tests} / 1 + \text{reliability for } 1/2 \text{ tests}$; r should lie between 0 and 1 and a stronger reliability value is near one. Ten questionnaires were used in the pre-test to access the accuracy of the data collection instrument. A correlation coefficient, r of 0.696 was realized showing that the instrument was reliable.

3.6 Data analysis

Descriptive and inferential statistics were used in data analysis. Descriptive statistics included mean, frequencies, percentages and standard deviations. Additionally, inferential statistics used empirical models such as the stochastic frontier, multinomial logit and multivariate regression. Data was analyzed using STATA version 17.

3.7 Analytical test

Heteroscedasticity and multicollinearity test were done to check if correlation problem occurred between the dependent and the independent variables in the regression model.

3.7.1 Heteroscedasticity test

This occurs when the variance of the error term is not constant. This was done to ensure a constant variance among the residuals occurred in the regression model. The chi-square of the Breusch-Pagan test value was (0.000) and the probability of the joint significance of regressors was (0.001) indicating that at least one of the estimated coefficient was a non-zero clearly showing that heteroscedasticity problem did not occur.

3.7.2 Multicollinearity test

This was done to show if a linear relationship between the independent variables occurred in the multivariate regression model. This was explained using the values of

the Variance Inflation Factor (VIF). The values of VIF should lie in between one and ten and the values exceeding ten or below one indicate there is multicollinearity. However results in this study showed that values of the independent variables in chapter four faced no multicollinearity.

3.8 Model specification

3.8.1 Effect of selected socio-economic and institutional factors on market efficiency

Kyomugisha et al. (2017) defines market efficiency as the difference between total output and total input. Market efficiency is evaluated using the following formula (Kyomugisha et al., 2017)

$$ME_{an} = \frac{P_{an}Q_{an} - \sum_{i=1}^n (r_{ai}X_{ai} + MC_{ai})}{\sum_{i=1}^n (r_{ai}X_{ai} + MC_{ai})} * 100 \quad (3.4)$$

where ME_{an} is the market efficiency of the macadamia market at the farm level, P_{an} is the price of macadamia sold by the farmer, Q_{an} is the quantity of macadamia sold by the farmer, r_{ai} is the unit cost of the inputs used by a farmers, X_{ai} is the quantity of input used by a farmer, $r_{ai}X_{ai}$ is the input costs incurred in macadamia production. In this study costs included that of fertilizer, manure and labor which most farmers were found to use. MC_{ai} , is the marketing costs incurred in marketing of macadamia. In this study marketing cost included cost of buying sacks for storage, cost of communication with buyers and cost of transportation to the market.

The study adopted the stochastic frontier production function analysis to show the relationship between multiple predictor variables and the predicted variable. It is regarded as one of the most powerful statistical models in statistical analysis to measure efficiency. The model was expressed linearly as follows:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \dots + \beta_nX_n + \epsilon \quad (3.5)$$

where Y is the market efficiency of macadamia market, β_0 is the constant, β_1 to β_n are the coefficient of the independent variables, X_1 to X_n are the independent variables, ϵ is the error term

3.8.2 Influence of selected market and socio-economic factors on choice of market channel

The study considered the multinomial logit regression model as it has advantages of evaluating alternative individual choices where in our study local traders, brokers, marketing organizations and factories channels were considered.

Model adopted for the study was expressed as shown below,

$$Y_{ij} = \beta_0 + \beta_1 X_1 + \dots + \beta_K X_K + \varepsilon \quad (3.6)$$

where

y_{ij} is the probability of choosing a certain marketing channel and i was represented in form of (local traders=1, brokers=2, marketing organizations=3 and factories=4) chosen by the n th farmer; β is a vector of the covariates, β_0 is the constant and X are the parameter estimates and ε is the disturbance term.

3.8.3 Assessment of socio-economic factors influencing the quantity supplied

Multivariate multiple regression model was used and represented in form of

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_n X_n + \varepsilon \quad (3.7)$$

where Y is the quantity supplied to the market, β_0 is the constant, β_1 to β_n are the coefficient of the independent variables, X_1 to X_n are the independent variables, ε is the error term.

CHAPTER FOUR

RESULTS

4.0 Characteristics of the Respondents

The study used socio-economic, institutional and market factors. Socio-economic factors in the study were those that related to farmer's resources and characteristic of the household like age, gender, land size, education level, household size, farming experience and transport ownership. Institutional factors consisted characteristics related to services that are provided by both public and private institutions that promote agricultural productivity like credit accessibility, access to extension and group membership among farmers. Market factors included characteristics related to the market like distance to market, information flow, payment period and output quality considerations.

4.1 Socio-economic Characteristics of the Respondents

Descriptive statistics in Table 4.1 revealed that most of the respondents are aged over 50 years probably because older people owned land compared to younger age groups. Considering education level of the respondents, most farmers spent an average of 6.18 years in school. Being keen on how farmers were experienced in macadamia farming majority of the farmers had over 27 years' experience because macadamia trees took a relatively longer period to mature. Farmers were found to have an average of 0.12 hectares of land allocated to macadamia production although they owned an average 0.84 hectares of land and owned an average of 5 macadamia trees. Household size in the area consisted an average of 5 individuals. It was also revealed that most farmers covered about 3 Km to their nearest market. Summary of the descriptive analysis of socio-economic factors is presented in Table 4.1 of this study.

Table 4.1: Descriptive summary on socio-economic factors

Mean estimation	Sample size (n= 337)	
	Mean	Std.Dev.
Household size (No.)	4.57	.13
Age (yrs.)	50.50	.73
Education (yrs.)	6.18	.29
Farm size (Ha)	.84	.04
Macadamia land Size (Ha)	.12	.01
Number of trees	5.45	.27
Farming experience (yrs.)	27.88	.75
Distance to market (Kms)	3.35	.08

4.2 Institutional factors

Results further showed that 29.67% of the sampled farmers had access to extension services. This was from a mix of bodies offering extension which included; None Governmental Organizations (NGOs), farmer’s organizations, media, County extension officers and research institutions. Statistics also showed that 14.4% of the farmers were able to access credit. This was through bodies such as cooperatives and farmers groups. When group membership was evaluated it was revealed that 26.81% of the total respondents were affiliated to groups such as farmers’ self-help groups and cooperatives where they could acquire information about macadamia marketing.

Table 4.2: Institutional factors in the study area

	Sample size (n=337)	Percentage (%)
Access to Extension		
Yes	100	29.67
No	237	70.33
Access to credit		
Yes	49	14.40
No	288	85.60
Group membership		
Yes	90	26.81
No	247	73.19

4.3 Market factors

It was revealed that 51.1% of the respondents accessed market information. This was mainly on factors such as, information on new markets where farmers could sell their macadamia, prices of macadamia and information concerning quality of macadamia. This was mainly through other farmers at 37.09% where farmers receiving market information could communicate to others.

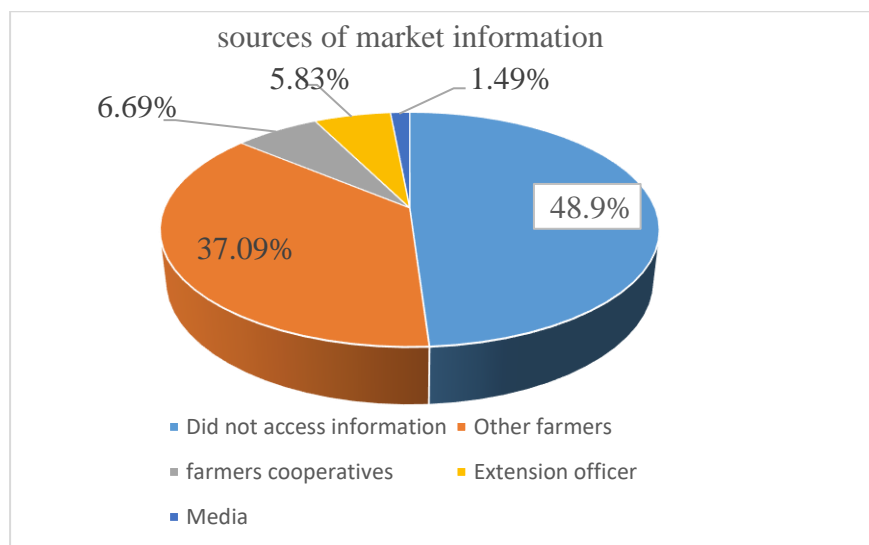


Figure 4.1: Sources of market information in the study area

4.4 Descriptive Analysis on Costs and Marketing Efficiency

Market efficiency for each farm was computed using equation 3.4 in chapter 3. The results are as shown in the in Table 4.3 of this study.

On average farmers spent KES 2748.07 on labor. Labor was measured in terms of the number of persons that regularly work during harvesting, staking and pruning of macadamia and are paid. Therefore, unpaid labor force such a family labor and help from friends, for which we could not estimate the cost was excluded. Farmers spent an average of KES 751.19 in inputs. This included cost of manure application, pest control and cost of fertilizer. Additionally, farmers harvested an average of 128.37 kgs of macadamia which they sold at an average price of KES 87.45 generating an average of KES 11,225.53 annually. Farmers generally incurred a marketing cost of KES 417.21 which consisted of communication cost, storage cost and transportation cost.

Table 4.3: Mean of cost and market efficiency

Mean estimation	Sample size (n = 337)	
	Mean	Std.Dev.
Cost of labor (KES)	2748.07	127.13
Cost of inputs (KES)	751.19	25.19
Quantity sold (Kgs)	128.37	12.20
Price per Kg (KES)	87.45	.65
Marketing cost (KES)	417.21	5.75
Income from macadamia (KES)	11225.53	817.98
Market efficiency (%)	8.15	.30

Further farmers were categorized to show market efficiency distribution and the highest efficiency was 15% while the least was 3%. Distribution of the market efficiency is as shown in Table 4.5 of this study. The majority (35.9%) of the farms had a market efficiency ranging between 6% and 9%. Higher market efficiency was associated with higher profit margins.

Table 4.4: Distribution of Market efficiency

Market efficiency (%)	No. (n=337)	Frequency (%)
0-3.0	24	7.10
3.1-6.0	101	30.00
6.1-9.0	121	35.90
9.1-12.0	69	20.50
12.1-15.0	22	6.50

The mean of marketing efficiency and prices for each marketing channel was computed. Further ANOVA was done to test if there was a significance difference in the mean of the market efficiency and prices among different marketing channel. Trading in factory channel had the highest market efficiency compared to the other market channels

mainly because factories bought macadamia at relatively higher prices. This is as shown in Table 4.5 of this study.

Table 4.5: ANOVA of marketing efficiency and price across marketing channels

	Mean				sig
	Brokers (48.1%)	Local traders (23.4%)	Factories (15.1%)	Marketing organizations (13.4%)	
Market efficiency (%)	6.07	5.21	11.53	9.97	.04*
Price (KES)	82.01	77.22	109.90	100.32	.01*

**Significance at 5%*

4.5 Descriptive statistics on choice of marketing channels

It was found that most of the farmers preferred selling their macadamia to brokers 48.1% and the least 13.40% choose marketing organizations.

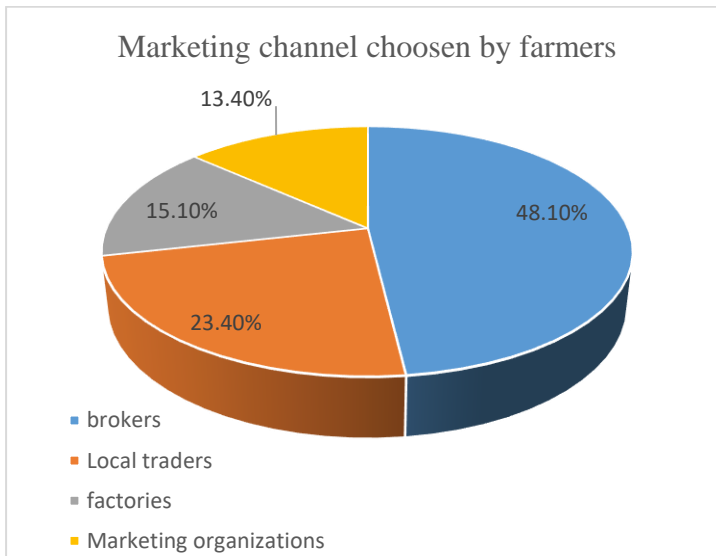


Figure 4.2: Marketing channels chosen by farmers

4.6 Selected Socio- economic Factors that Affected Choice of a Marketing Channel

Statistics in Table 4.6 indicate that the mean of age was highest 65.39 years in marketing through factories and this implied that the elderly preferred selling through factories. Farm size was largest 1.56 hectares for those marketing through factories and farm size under macadamia was also largest among those who marketed through factories 1.17 hectares indicating that there is close association between farm size and choice of marketing channel. Farming experience was highest 42.55 years in marketing through factories indicating that as the years in macadamia farming increased farmers were more willing to involve in more lucrative markets. Quantity supplied to market was highest in factories 878.43 Kgs because factories were characterized by buying bulk products. However, distance to the market was highest in marketing through factories 5.95 Kms as the factories were mostly near the urban centers that are far from most farmers.

Table 4.6: ANOVA of socio-economic factors across marketing channel

	Mean				sig
	Local traders (23.4%)	Brokers (48.1%)	Marketing organizations (13.4%)	Factories (15.1%)	
Household size (No.)	4.08	4.85	4.22	4.75	.43
Age (yrs.)	39.97	47.95	61.25	65.39	.01*
Education (yrs.)	7.05	5.63	6.96	5.92	.43
Farm size (Ha)	.81	.92	1.13	1.56	.08**
Macadamia farm size (Ha)	.05	.06	.12	.17	.06**
Farming Experience (yrs.)	18.89	24.78	38.22	42.55	.01*
Quantity sold (Kgs.)	119.43	176.42	522.44	878.43	.03*
Distance to market (Kms)	2.11	3.31	4.82	5.95	.07**

* indicates 5% significance while, ** indicates 10% significance

4.7 Market factors that affected choice of marketing channel

Statistics given in Table 4.7 revealed that access to market information in the area was highest 23.13% among those who marketed through factories. A majority of farmers 73.19% were not affiliated to any farmer group and those associated with group membership majorly used factories as their marketing channel. Group membership was mainly in cooperatives and farmers' group.

Table 4.7: Market factors across marketing channels

Market factors	Local traders (23.4%)	Brokers (48.1%)	Marketing organizations (13.4%)	Factories (15.1%)
Access to Market information				
Yes (%)	6.61	5.63	15.73	23.13
No (%)	93.39	94.37	84.27	76.87
Group membership				
Yes (%)	0.77	0.49	12.23	13.32
No (%)	99.23	99.51	87.77	86.68

4.8 Reasons for choosing a market channel

As shown in figure 4.3 farmers are attracted to a marketing channel by payment on spot at 36.80% as they did not like delayed payment. A channel was chosen at 28.19% because through it farmers would sell bulk products at higher prices. Farmers at 26.71% claimed to participate in a channels because it was the only channel which could buy their low volumes. Collection centers along the road side were easily accessible at 5.04% to farmers. A few farmers faced theft 3.26% that led to harvesting and selling their macadamia nuts to avoid further losses.

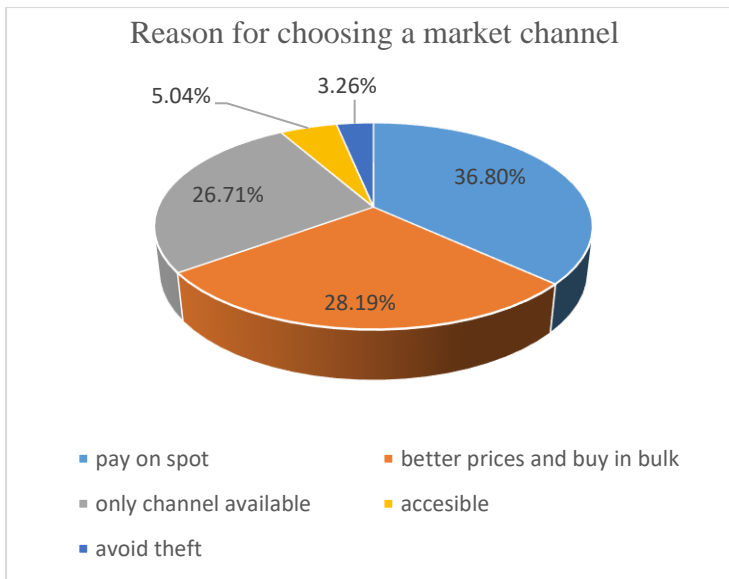


Figure 4.3 Reasons for choosing a marketing channel

4.9 Quantity of macadamia supplied to the market

Farmers harvested and sold an average of 128.37 kgs. However, after buyers sorted macadamia according to size, variety and on quality such as removal of small sized nuts, immature nuts, poor quality nuts characterized by white or black colour, cracks, dirt and infestation by pests, an average of 10.61 kgs of macadamia lacked market. The results are as presented in Table 4.8 of this study.

Table 4.8: Quantity of macadamia delivered to the market

Mean estimation	Sample size (n= 337)	
	Mean	Std.Dev.
Quantity sold (Kgs)	128.37	12.20
Quantity not sold (Kgs)	10.61	.65

4.10 Effects of Socio-Economic Factors and Institutional Factors on Marketing Efficiency

Stochastic frontier production function analysis was used to access socio-economic and institutional factors that affect macadamia marketing efficiency. The model was used because it is widely used and suitable in analysis of efficiency as it allows accounting of selection biasness in the error term (Abdul-Rahaman & Abdulai, 2018). The result of the model are as shown in Table 4.9 of this study. The resultant goodness of fit (R^2) was 0.64 implying the model was well fitted since more than (50%) of the variations in the dependent variable was explained by the specified regressors. Positive results

showed that there was an increase in market efficiency while negative results showed contrast with market efficiency and tend to have negative impact by lowering the percentage of market efficiency. The significant constant in the model result showed that the variability of the independent variables had an effect to the dependent variable while the insignificant constant showed that there are likely other variables not included in the model that had an effect to the dependent variable.

Results revealed that household size (1% significant level) negatively affected market efficiency and increasing household size by a single unit led to a decrease in market efficiency by 0.401 units. Years spent in education (5% significant level) translated to a positive effect with market efficiency and a unit increase in education increased market efficiency by 0.13 units. Macadamia land size (1% significance level) had a positive association with market efficiency whereby increasing macadamia land size by a single unit led to an increase in market efficiency by 0.939 units. A positive relationship was also realized between experience in macadamia farming and market efficiency (1% significance level) and that a unit increase in experience led to an increase in market efficiency by 0.107 units. Lastly the association between access to extension and market efficiency was positive (10% significance level) and a unit increase in access to extension led to an increase in 0.894 units of market efficiency. The results of the model are as shown in table 4.9 of this study

Table 4.9: Factors affecting Marketing Efficiency

Market efficiency	Coef.	St.Err.	p-value	Sig
House hold size (No.)	-.401	.118	.001	***
Age (yrs.)	-.016	.036	.649	
Education (yrs.)	.130	.055	.019	**
Macadamia land size (Ha)	.939	.462	.001	***
Experience (yrs.)	.107	.034	.002	***
Extension access	.894	.54	.098	*
Group membership	.323	.348	.354	
Credit access	-.407	.719	.571	
Constant	6.034	2.517	.016	**
Constant	3.124	.077	.001	***
Constant	6.678	143.948	.963	

*** $p < .01$, ** $p < .05$, * $p < .1$

4.11 Influence of Market and Socio-Economic Factors on the Choice of Marketing Channels

Multinomial Logit regression model was used to determine the factors influencing the choice of macadamia marketing channels. This model was used for its suitability to isolate the marketing channel alternatives to show specific effect of each alternative on choice of marketing channel (Musara et al., 2018). Further the model is suitable to measure the marginal effect and show the expected change in the probability of a particular choice being made with respect to a unit change in an independent variable. Marketing through brokers attracted most farmers and additionally it was among the channels that offered lower prices according to descriptive analysis and was therefore used as a benchmark category. The results are given in Table 4.10 of this study. The likelihood ratio (χ^2) value was 48.827 and significant at 1% level. Variable coefficients are significantly attested to be different from zero using the likelihood ratio. The pseudo R^2 was 0.51 indicating that the selected factors mutually and significantly explain 51%

of the practical discrepancies in the choice of macadamia marketing channels.

The study findings revealed that distance to market (1% significance level) had a negative effect on the choice of local traders compared to brokers whereby increasing distance by a unit led to a decrease in choosing local traders by 0.052 units. Results further showed that information flow associated with the choice of marketing through local traders positively (10% significance level) and this implied that increasing information flow by one unit increases the probability of choosing local traders over brokers by 0.125 units. Age was associated with the choice of local traders positively (1% significance level) which was translated by a unit increase in age led to an increase in choice of local traders by 0.588 units. Experience was another factor that affected the choice of local traders positively (5% significance level). Statistics revealed that increasing experience by one unit resulted to increasing the probability of choosing local traders over brokers by 0.839 units.

Considering the factors influencing the choice of marketing organizations, it was noted that a negative association existed between qualities of macadamia considered for purchase (5% significance level) and choice of marketing organizations. This meant that an increase qualities of Macadamia considered for sale by one unit led to a decrease in choosing marketing organizations by 0.036 units. When payment period was considered a negative relationship was realized (10% level of significance) with choice of marketing organizations over the broker. An additional unit in payment period reduced choice of marketing organizations by 0.235 units. Further it was also showed that age positively affected (1% significance level) the choice of marketing organizations. Specifically, it was realized that increasing age by a single unit leads to the chances of choosing brokers over marketing organizations to decrease by 0.111 units. Years spent in education had a positive relationship with the choice of marketing organizations (1% level of significance) and that increasing the respondent's years spent in education by a unit would result in increasing the probability of choosing marketing organizations over brokers by 0.133 units. Experience was observed to have a positive effect (5% level of experience) on the choice of marketing organizations and that increasing experience by one unit reduces the chances preferring marketing organizations by 0.312 units.

When choice of factories as a marketing channel was considered a negative association

between distance and choice of factories was realized (10% level of significance) and a unit increase in distance to market led a decrease in the choice of factories by 0.063 units. Qualities of Macadamia considered for purchase (5% significance level) positively affected the choice of factories whereby an increase in qualities of Macadamia considered for sale increase choice of factories by 0.097 units. Payment period negatively affected choice of factory (5% significance level) whereby a unit increased in payment period decreased the probability of choosing factories by 0.569 units over brokers. Experience showed a positive association with the choice of factories (5% significance level) and increasing experience by a unit led to an increase in the probability of choosing factories by 0.088 units over brokers. Table 4.10 of this study presents the results of multinomial logistic regression.

Table 4.10: Factors Influencing Choice of Marketing Channel

Market Preference	Channel	Marginal Effects	t-value	p-value	Sig
Base Outcome (Brokers)					
Local Traders					
Distance to market (Kms)		-.0520	2.86	.004	***
Market information		.1250	1.650	.067	*
Payment period		-.0450	-0.230	.780	
Age (yrs.)		.588	-1.820	.069	*
Gender(0=male,1=fe male)		.916	-0.220	.827	
Education (yrs.)		.811	-0.890	.375	
Experience (yrs.)		.839	2.080	.038	**
Constant		.001	-3.120	.002	***
Marketing Organizations					
Distance to Market (Kms)		-.012	-0.000	.996	
Market information		.891	-0.170	.868	
Quality consideration		-.036	2.010	.044	**
Payment period		-.235	4.160	.056	*
Age (yrs.)		.111	-3.690	.001	***
Gender(0=male1=fe male)		.872	1.450	.148	
Education (yrs.)		.133	-2.890	.004	***
Experience (yrs.)		.312	2.020	.044	**
Constant		.596	0.000	.998	

Factories				
Distance to market (Kms)	-.063	-0.000	.096	*
Market information	.696	1.480	.138	
Quality consideration	.097	-0.160	.037	**
Payment period	-.569	3.170	.043	**
Age (yrs.)	.944	-0.150	.882	
Gender(0=male,1=fe male)	.581	-0.940	.345	
Education (yrs.)	.059	0.170	.864	
Experience (yrs.)	.088	-0.470	.048	**
Constant	.053	0.000	.997	

Mean dependent var 1.285, SD dependent var 0.712, pseudo r-squared 0.51,
 No. of observations 337, chi-square 48.827, Prob >chi2 0.001, Akaike crit.(AIC),
 Bayesian crit. (BIC) 509.654, *** shows significance at 1%, ** shows significance
 at 5% while, * shows significance at 10%

4.12 Effects of Socio-Economic Factors on the Quantity of Macadamia Supplied

The effect of social economic factors on the quantity of macadamia supplied was evaluated by the use of multivariate linear regression model. This model was used because of the nature of the dependent variable which was to determine the factors affecting supply of macadamia to the market which is a continuous variable and all macadamia farmers' participated in the market thus the model was termed applicable (Ayalew et al., 2021). With an R- squared of 0.641, the fitted model was considered good since more than 50% of the dependent variable was predicted by the chosen explanatory variables. The P-value of joint significance of the coefficients of the regressors was 0.000 implying the existence of none zero coefficient in the model. The model was therefore considered fit for making inferences.

The model findings in Table 4.11 showed that; age, education, farming experience and macadamia land size owned by farmers were the only significant socio-economic factors that influenced the quantity of macadamia supplied. All the other socio-economic factors used in the model, were found to be insignificant at all significance

levels. Results showed a positive relationship between age, education, experience and macadamia land size to the quantity of macadamia supplied. Specifically, it was found that when age, education, macadamia land size and experience were individually increased by a single unit at ceteris paribus, quantity supplied increased by 5.164, 4.179, 16.401, and 3.027 units respectively. Table 4.11 presents the effects of socio-economic factors on the quantity of macadamia supplied.

Table 4.11: Factors affecting quantity of Macadamia supplied to the market

Quantity supplied	Coef.	St.Err.	p-value	Sig	VIF
Gender(0=male,1=female)	37.151	23.216	.111		4.03
Household size (No.)	-8.201	5.151	.112		3.64
Age (yrs.)	5.164	1.870	.006	***	1.45
Education (yrs.)	4.179	2.281	.068	*	1.36
Farm size (Ha)	29.770	17.767	.195		1.21
Macadamia land size (Ha)	16.401	11.276	.002	***	1.07
Experience (yrs.)	3.027	1.813	.096	*	1.02
Constant	287.134	70.921	0	***	

Mean dependent var 315.504, SD dependent variable 346.065, R-squared 0.641, Number of obs 337, F-test 64.842, Prob > F 0.000, Akaike crit. (AIC) 4570.860, Bayesian crit. 4609.061, Mean of VIF 1.76, *** shows significance at 1%, ** shows significance at 5%, * shows significance at 10%

CHAPTER 5

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

This chapter provides discussion of the results, conclusions based on the findings, and recommendations to the stakeholders.

5.1 Discussion of the results

5.1.1 Choice of marketing channel in the study area

A plausible explanation on the choice of brokers was due to the fact that it was among the channel that bought macadamia in low volumes, made its payment on spot and was not much quality sensitive as they were only interested with large sized nuts. Farmers relied on money from macadamia to meet their daily needs and were attracted by the instant payment which is in line with the findings of Yadav et al. (2020) that farmers are attracted by channels that pay them instantly. Brokers sold to marketing organizations and factories.

Local traders were intermediaries who bought macadamia along the road side and sold to direct consumers in the market, some bought a certain variety such as macadamia tetraphylla at lower prices and sold to seedling growers while some bought macadamia on basis of size and sold to brokers. The reason for choosing local traders was that they were accessible, made payment on spot and to avoid theft as they would purchase the product throughout the year.

Marketing organizations channel involved private organizations that bought macadamia and would sell the macadamia to other markets outside the County. The channel was quality sensitive, bought higher volumes and offered higher prices which is consistent with a study done by Alian and Sadoulet, (2020) that higher prices were accompanied by higher quality goods. The channel made payment within a period of one week.

Factories were a channel that bought macadamia both in the region and in other neighboring counties on basis of quality aspects exceeding size to check colour, fully matured nuts and nuts free from residues and bought large quantities to process and sell in both local and international market. The channel was preferred by farmers with large volumes and made its payment within a period of one week.

5.1.2 Effects of Socio-Economic Factors and Institutional Factors on Marketing Efficiency

Results revealed that household size had a negative effect indicating that larger household size translated to less market efficiency. This contradicts the findings of Degefu, (2020) that household size increases the farmer ration on labor improving efficiency. Household size increases the dependency ratio (Tenaye, 2020) that makes farmers allocate more land to other subsistence crops for feeding the household and construction of houses for human habituation reducing land for agricultural production. This was caused by low and fluctuating prices in some seasons that made farmers not willing to allocate more of their land to macadamia production. The reduced land that would be planted Macadamia made farmers to produce low yield lowering market efficiency.

A positive association between education and market efficiency was observed. This may be because education associates farmers with better farming techniques and knowledge (Kehinde et al. 2021). As more years are spent in education farmers were seen have the ability to read and write that was highly needed in input application and payment in factories and marketing organizations. Further, educated farmers were willing to involve in more rewarding markets that bought macadamia at higher prices. Therefore, education led to an increase in market efficiency which corresponds with the findings of Gavrel et al. (2016) and Muradi and Rahmani, (2020) that education affects decision making among farmers in the enterprises that they have in the farm, the markets they involve and eventually the overall performance.

Results further showed that farm size under macadamia affected market efficiency positively mainly because as farmers allocated more land to macadamia farming they owned more macadamia trees that translated to more yield. Farmers would then yield more volumes which is consistent with the findings of Aragón et al. (2022) and Helfand and Taylor, (2021) that allocating more land to agricultural crops accompanied by proper management increases technical efficiency. Increased production would attract farmers to participate in more rewarding markets associated with higher prices thus increasing market efficiency.

The findings additionally, indicate a positive relationship between experience and market efficiency. This was noted because an increase in farming experience level is

expected to portray more farming techniques and knowledge which agree with the finding of Kalita, (2017), Saiyut et al. (2019) and Kennedy et al. (2020) that increased experience translates to proper decision making thus increasing marketing efficiency in horticulture crops production. Mgale and Yunxian, (2020) further argue that increased experience leads to choose more rewarding channels that generate higher profit margins leading to increased market efficiency.

Access to extension positively affected market efficiency and this was mainly because trainings are associated with good farming practices and new techniques are taught to increase production (Abdul-Rahaman and Abdulai, 2018; Yitayew et al. 2021). Through trainings farmers are linked to learning better farming techniques such as grafting, cultural methods of pest control and better harvesting techniques that help in producing more yield. This aligns with the findings of Obhodaš and Jaganjac, (2019) who noted that trainings were associated with better farming techniques that increased technical efficiency.

5.1.3 Influence of Market and Socio-Economic Factors on the Choice of Marketing Channels

As shown in table 4.10 the study findings showed that distance to the market had a negative association with the choice of local traders. Increasing distance to the market increases the chances of choosing brokers against that of local traders as many farmers prefer covering shorter distances to markets. Brokers would travel the longer distances to meet farmers at their farm gate and would cater their costs thus farmers would not incur transaction costs which made them choose brokers over the local traders which is consistent with the findings of Sahara et al. (2015), Bouarakia et al. (2023) Kumar et al. (2015) who found out that farmers preferred markets nearer to them to avoid incurring costs.

A positive relationship between information flow and choice of marketing through local traders was realized. This meant that increased information flow increases the chances of choosing local traders over brokers due to brokers' mobility and inconsistency where in every season new brokers were seen and could not release market information easily especially on prices compared to local traders who were always accessible to farmers throughout the year. This is in line with the finding of Innocent, (2018) and Nugroho, (2021) that brokers were exploitive and could not release information easily especially

on prices so that they would benefit more while exploiting those who lacked information thus farmers preferred choice of local traders.

When age was considered a positive relationship was realized with the choice of local traders. This may be associated with the aged disliking the brokers due to their opportunistic behavior that led to them offering low prices and inaccessibility especially when macadamia from the aged were stolen in their farms that made the aged to prefer the local trader.

Experience was another factor that was found to affect local traders positively. Increase in experience resulted to increased probability of choosing local traders over brokers as brokers were found to have an exploitative behavior as they were not consistent where in every season new brokers were witnessed and some farmers lacked trust with them and which corroborates with the findings of Dessie et al. (2018) that wheat farmers disliked broker channel as they were not consistent thus building trust was difficult. A study by Anthony et al. (2021) also noted that experience gives farmers the confidence to trade with more reliable channels that do not exploit them.

Considering choice of marketing organizations, it was noted that qualities of macadamia considered for purchase had a negative effect on the choice of marketing organizations. The study revealed that increasing quality considerations, increases the probability of choosing brokers over marketing organizations because brokers were not considered with quality and could buy the kernels even of poor quality but at relatively lower prices which corroborates with the finding of Lee et al. (2020) that lucrative markets were more concerned with good quality nuts. Farmers were not willing to adhere to quality aspects as they did not want to lower the total macadamia harvested due to rejection in the market.

A negative association between payment period and choice of market organization was realized mainly because brokers made payment on spot unlike market organization who could delay for even a week. This made farmers more reluctant to choose the marketing organizations channel as farmers were in need of money to meet their daily needs. This was consistent with the finding of Kaygisiz, (2021) and Bannor et al. (2023) that delayed payments discouraged farmers from participating in a certain marketing channel.

Further the study showed that age had a positive influence on the choice of market

organization to that of brokers. Specifically, it was realized that when age is increased the probability of choosing brokers over market organization decreases because the aged engaged in more off farm income and relied on other enterprises compared to other age sets and thus were more tolerant to delayed better prices compared to instant low prices. The aged also were characterized by large ownership of land and had allocated more land for macadamia farming thus had large volumes that could be sold on bulk using channels such as marketing organizations. A study by Jitmun and Kuwornu, (2019) collaborates with the findings of this study and found out that the aged were associated with large pieces of land that they mainly used for agricultural purposes thus producing volumes that were sold to profitable channels.

The relationship between years spent in education among the respondents and choice of market organization was positive. This resulted mainly because increase in years spent in education was associated with the desire to explore new markets which shows consistency with the findings of Mango et al. (2018) and Siddique et al. (2018) that education level influenced farmers participation in more lucrative markets. Education level influences farmers in decision making because it increases the chances of making better and more calculative decision to increase profits (Muriithi et al. 2021; Zakaria et al. 2020).

A positive effect between experience and the choice of market organization was also noted in the study. Multinomial logit regression model revealed that an increase in experience lowers the likelihood of choosing brokers to choose marketing organizations as those who had traded for many years disliked brokers due to their opportunistic behavior. Farmers' increase in experience led to more willingness to venture in more lucrative channels making it consistent with a study by Chiv et al. (2020) that as farmers gain more experience farmers tend to be ready to venture in profitable markets open to them.

When choice of factories as a marketing channel was considered, the findings realized that, increased distance to market negatively affected the choice of factories. Farmers are reluctant to cover longer distances and prefer participating in channels nearer them (Kiprop et al. 2020). Farmers disliked transaction costs such as transportation costs that would affect their total earnings which corroborates with a study done by Mossie et al.

(2020) and that of Hung and Khai, (2020) that farmers opted to sell to channels that were nearest to them to avoid incurring transactional costs.

Qualities of macadamia considered for purchase had a positive association with the choice of factories mainly because farmers who were more quality sensitive disliked brokers as they would buy at lower prices. This was because quality products attracted better prices to factories unlike brokers who generalized the prices regardless of quality.

The study further noted that payment period negatively affected choice of factory as many farmers preferred instant payment which is in line with the study of Siddique et al. (2018) that shorter payment periods attracted more farmers in a certain market. Finally, it was reported that experience had a positive effect on the choice of factories as the more the years farmers practiced in macadamia farming the more willing they were to participate in factories as farmer considered their money safe through them and factories could offer financial security through aspects such as acquiring loans and saving through the cooperatives that were available in the factories

5.1.4 Effects of Socio-Economic Factors on the Quantity of Macadamia Supplied

The study findings showed a positive association between age and quantity supplied. This may be attributed by associating age with increased experience in macadamia farming that also had a positive effect on quantity supplied mainly because increased experience in macadamia farming is accompanied with knowledge of better farming methods which result to increased output and supply of macadamia which agrees with the findings of Jaji et al. (2018) who realized that more experience affected supply of pineapple to the market where experienced farmers supplied more.

When education and quantity of macadamia supplied to the market was evaluated a positive relationship was realized. Mainly this was because farmers who spent more years in education were associated with planting the new varieties that yielded more which corroborates with the findings of Eric et al. (2014) that education leads to better farming practices such as technologies on grafting and use of improved varieties that results to increased yield in the farm.

The study further noted a positive association between increased land size for growing macadamia and quantity of macadamia supplied to the market. This is because more land allocated to macadamia was accompanied by increased number of macadamia trees and the resultant effect is increased production of macadamia and hence increased

quantity supply of macadamia. This aligns with the finding of Ermias, (2021) and Ayalew et al. (2021) that an increased allocation of land size to specific crops accompanied by good agricultural practices resulted to more production and supply to the market.

5.2 Conclusions

The study purposed to evaluate factors influencing marketing efficiency by evaluating the costs associated with production and marketing of macadamia against the returns generated after sale of macadamia. Specifically, household size, years spent in education, land allocated to macadamia farming, farming experience and access to extension significantly affected market efficiency. Further, the results revealed that market efficiency of farmers who participated in lucrative marketing channels such as factories was highest because of higher prices offered by the channels.

The second objective was to evaluate market and socio-economic factors that affect choice of marketing channel. Farmers in the area were noted to choose a channel available to them mainly by been attracted by better prices, instant payment, quality considerations and channels that were nearer them to avoid transaction costs. Most of the farmers choose the broker channel although it was among the channel that offered lower prices. Factories were found to be the channel that paid farmers the highest prices while the local traders paid the least. It was further revealed that distance to market, access to information and experience affected the choice of local traders against that of choosing brokers. Quality of macadamia considered for sale, payment period, age of the farmer and education level affected choice of market organization over the broker. Further it was found that distance to market, quality of macadamia considered for sale, payment period and experience had an effect on the choice of factories as a marketing channel over broker.

The third objective was to access socio-economic factors that affect quantity of macadamia delivered to the market. Farmers in the area were noted to have adopted the new varieties mainly to increase production. Most of the macadamia after harvest was delivered to the market because nuts were not perishable compared to other agricultural crops. Additionally, quality considerations such as on size, colour and variety of nuts were considered and affected amount delivered to the market. The study further realized that education, land allocated to macadamia farming, age and farming experience by

farmers had an effect on quantity of macadamia delivered in the market. The aged owned large pieces of land and had more experience in Macadamia farming thus they allocated more of their land to Macadamia farming thus having a positive effect on the quantity of Macadamia supplied to the market.

5.3 Recommendations

Based on the results found in this study the following recommendations are made.

5.3.1 Factors influencing market efficiency

The study recommends to the Ministry of Agriculture in collaboration with the County Government and all value chain actors in Macadamia sector to embrace on provision of more extension services. Extension will act as a source of education to farmers through training them on better farming techniques and through this farmers will deliver quality produce fetching higher prices. Market efficiency was found to be high in marketing channels such as the factories thus provision of extension will enlighten farmers on decision making and requirement needed to trade with more profitable channels.

5.3.2 Factors influencing choice of marketing channels

Distance to the nearest market was found to significantly affect choice of marketing channel thus to help more farmers trade with profitable channels it is recommended that policy makers and sectors involved should put in place feasible strategies to aid in setting up more collection centers for lucrative channels such as that of the factory and marketing organizations to help more farmers reach them.

5.3.3 Factors affecting quantity supplied to the market

Increased education resulted to increased quantity of macadamia delivered to the market thus the National Government in collaboration with the County Government and sectors involved should put in place feasible strategies to encourage more education reaches farmers. This can be done through trainings and encouraging farmer-to-farmer mentorship programs with more experienced farmers so as to help yield more macadamia.

5.4 Areas for further research

The study evaluated factors influencing marketing efficiency, choice of marketing channels and supply of macadamia among smallholder farmers in Embu West Sub-County. Nevertheless, there is still need to evaluate on the market inefficiencies in the

marketing channels so as evaluate the costs incurred by the marketing channels and how they impact farmers' participation.

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APPENDICES

APPENDIX 1: Variables and their appropriate signs

Variable	Description	Measurement	Expected sign
Marketing experience	years participating in a marketing channel	Age in years	+/-
Gender	Gender of respondent	1) Male 2) female	+/-
Family size	People in a household	Number of people	+
Macadamia Land size	Respondent acreage	Number of hectares	+
Quantity sold	Amount of macadamia sold in the market	kilograms	+
Quantity not sold	Amount of macadamia that lacked market	kilograms	
Trainings of farmers	Access to training on macadamia farming	1) Yes 2) No	+
Distance to market	Nearness to macadamia market	kilometers	+
Access to information	Access to t macadamia information	1) Yes 2) No	+
Membership to groups	Member of farmers' group in macadamia marketing	1) Yes 2) No	+
Access to credit	Access to credit	1) Yes 2) No	+
Extension services	Access to extension	1) Yes 2) No	+

Quality control	Standardization macadamia	of	1) Size 2) Color 3) Variety	+
Preferred marketing channel	marketing channel		1) Local traders 2) Brokers 3) Marketing organizations 4) factories	+

APPENDIX 2: Questionnaire

Market efficiency, choice of marketing channel and supply of macadamia among smallholder farmers in Embu West Sub County

Introduction

This questionnaire aims to collect data on market efficiency, choice of marketing channels and supply of macadamia among smallholder farmers in Embu West Sub-County, Kenya. This questionnaire is only for academic purposes and therefore information here will be treated with utmost confidentiality.

IDENTIFICATION DETAILS

Questionnaire NO ()

GENERAL INFORMATION

Enumerator	
Ward	
Sub location	
Village	
GPS	

SECTION A

A) Household socioeconomic characteristics

1. Gender of smallholder respondent. 1= Male () 2=Female ()
2. What is the size of your household?
3. Number of years in education of the respondent?
4. Age of the smallholder respondent in years?
5. Which of the following activities do you participate in apart from macadamia farming? Tick appropriately

Activity	Farming	Trading	Formal employment
Years in the activity			

6. Farm size owned in hectares?
7. Farm size under macadamia production hectares
8. Number of macadamia trees?
9. Which variety of macadamia do you grow? 1= *Macadamia tetraphylla* () 2= *Macadamia integrifolia* () 3= both ()
10. What other agricultural activities do you engage in? 1= Cash crop () 2= Dairy farming () 3= Other horticultural farming ()
11. What is the type of the main road connecting you to the nearest market? 1=Tarmac () 2= Marram () 3= All weather road ()
12. What was its condition in the previous seasons? 1= Good () 2= Poor ()
13. What is your estimated annual farm income from macadamia in Ksh. per year?

B) Information on institutional factors that influence marketing efficiency among marketing

Extension contact

1. Do you receive extension services and training on macadamia marketing? 1= yes () 2= No ()
2. If yes, from which body? 1= County extension officers& research institute () 2= NGOs () 3= Farmer organization () (4) 5= Media ()
3. What type of services do you receive from the extension services? 1= market information () 2= pricing strategies () 3= quality and maintenance programs ()
4. How many trainings did you attended on macadamia farming and marketing in the last two seasons?
5. In the last two seasons how often did you receive the extension services?

6. What was the level of satisfaction on the extension services given? 1= very satisfied () 2= satisfied () 3= average () 4= dissatisfied ()
7. What was the level of satisfaction on the trainings given? 1= very satisfied () 2= satisfied () 3= average () 4= dissatisfied ()

Farmer experience

1. For how long have you grown macadamia in years?
2. How do you compare your production now and when you started? 1= Increased () 2= Decreased () 3= Constant ()
3. How do you rate the performance of your macadamia enterprise? 1= Good profit () 2=Satisfactory profit () 3= Inadequate profit () 4= No profit () 5= Negative profit () 6= Not sure ()

Farmer Organization Membership

1. Do you belong to any farmer group? 1=Yes () 2= No ()
2. If yes, which type of organization. 1= Self Help group () 2= Cooperative Society () 3=Farmers' group ()
3. How many organizations are you a member of?
4. How do you benefit from these organizations? 1= Market information () 2= Credit () 3= Seeking market and linking you to buyers () 4= Input provision () 5= Farmer training ()
5. What is your level of satisfaction in the organization? 1= very satisfied () 2= satisfied () 3= average () 4= dissatisfied ()

Credit access

1. Do you have access to any form of credit? 1= Yes () 2= No ()
2. If yes above, did you receive the credit? 1= Yes () 2= No ()
3. If yes in above, from which body? Fill table below.

Source of credit	Type of credit 1. Cash 2. Input	Value of the credit Ksh.
Farmer groups		
cooperatives		
Sacco		
Others		

4. Did you use all the credit in macadamia production? 1= Yes () 2= No ()
5. If No on above how did you use the credit? 1= other agricultural purpose () 2= Nonagricultural purposes () 3= Household consumption ()
6. What proportion of the credit was used for macadamia production in Ksh?
.....
7. Did you experience difficulties getting the credit? 1= Yes () 2= No ()
8. If you didn't receive the credit, what could be the reason why you did not get credit?
1= Lack of collateral () 2= High interest rates () 3= don't know () 4= Outstanding loan () 5= Do not trust the lenders ()

Land utilization

1. How did you acquire the land? 1= Inherited () 2= Purchased () 3= Rented ()
2. Specify the type of land tenure. 1= land owned with title () 2= land owned without title ()

Labor input in macadamia production

1. What is the main source of labor in macadamia production in your farm? 1= Family labor () 2= Hired labor () 3= Both family and hired labor ()
2. How many units of labor worked in the macadamia field in the last season?
.....
3. How many were member of your household?
4. How many were hired?
5. What is the cost of labor per man day in Ksh?
6. Are there times you experience labor shortages in the farm? 1= Yes () 2= No ()

7. If yes, how do you overcome these challenge? 1= Hiring () 2= Relatives () 3= was not able to overcome the challenge ()

8. What inputs and cost do you use and incur in macadamia farming?

Input	Cost per kg/ litre
Fertilizer	
Manure	
Pesticides	
Others	

Quantity of macadamia sold/ marketing channels.

1. What quantities of macadamia do you harvest from your farm in Kgs?
2. Quantity not able to sell in Kgs?
3. Which market outlets do you sell your macadamia? 1= local traders () 2= brokers () 3= marketing organizations () 4= factories ()
4. What prices per quantity unit for your macadamia during the previous season?
5. Payment period?
6. Reason for choosing the market channel? 1= Better prices& buy bulk products () 2= accessible () 3= pay on spot () 4= only channel available () 5= avoid theft ()
7. Requirement of buyers to the channel you participate in? 1= size () 2= quality () 4= variety ()

Access to market information

1. Have you been receiving information concerning macadamia markets? 1= Yes () 2= No ()
2. If yes, what is the source of the information? 1= Extension officers () 2= Farmers' cooperatives () 3= other farmers () 4= Media ()
3. How often do you get the market information? 1= Daily () 2= Weekly () 4= Monthly () 5= never ()

4. What cost do you incur while marketing your macadamia?

Distance to market

1. What is the approximate distance to your nearest market in Km?

2. Do you own any means of transport? 1= yes () 2= No ()

3. What means of transport do you use to transport your macadamia to the market.
1=Bicycle () 2= motorbike () 3= pick up () 4= animals () 5= picked at my farm
gate ()