

**ANALYSIS OF THE CARROT VALUE CHAIN AND DETERMINANTS OF
OUTLET CHOICES BY SMALLHOLDER FARMERS IN NAKURU COUNTY,
KENYA**

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**A Thesis Submitted to the Graduate School in Partial Fulfilment of the Requirements
for the Master of Science Degree in Agribusiness Management of Egerton University**

EGERTON UNIVERSITY

NOVEMBER, 2024

DECLARATION AND RECOMMENDATION

Declaration

I declare that this is my original work and has not been presented for the award of a degree in any other university.

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Recommendation

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DEDICATION

I dedicate this work to my lovely wife, children, parents and my siblings for their support and prayers.

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Firstly, I express my gratitude to the Almighty God for granting me strength, good health, and courage during the duration of this study. Secondly, I extend my appreciation to Egerton University for the opportunity to pursue my studies. I am also thankful to the Faculty of Agriculture and the Graduate School for their significant contributions to my work. Special acknowledgment goes to the Department of Agricultural Economics and Agribusiness Management (AGEC/AGBM) for providing a supportive learning environment. Additionally, I am deeply grateful to my supervisors, Prof. Hillary K. Bett and Dr. Oscar Ingasia, for their unwavering guidance and support throughout the research process. I also extend my thanks to my colleagues for their valuable insights during my studies. Gratitude is also extended to the enumerators who assisted during the data collection process. Lastly, heartfelt appreciation goes to my wife and children for their love, prayers, and understanding. While I may not be able to mention everyone by name, I am sincerely thankful to all who contributed to the success of my MSc. studies and my entire education journey.

ABSTRACT

Smallholder farmers had limited access to relevant market information for their farm produce, especially those from rural areas who entirely depended on rain-fed agricultural activities for their livelihoods. Specifically, smallholder carrot farmers were faced with numerous decisions in the allocation of available scarce resources, especially when dealing with several market failures and competitiveness bottlenecks that limited their productivity. Additionally, the supply of carrots in various market outlets in Kenya did not match the demand, yet they fetched a higher premium in formal market outlets. Thus, efforts to increase market participation among carrot producers had great potential to lift them to an overall better household income level. This study aimed to analyse the carrot value chain in Nakuru County with the specific objectives of understanding the available carrot market outlets/channels, gross margins along different market outlets/channels, as well as the main conditioning factors towards the development of a vibrant carrot value chain in a holistic manner. A multi-stage sampling method was employed to obtain a representative sample of 195 carrot farmers and 30 traders, and a semi-structured questionnaire was used to collect data through face-to-face interviews. Data collected were analysed using an Excel spreadsheet, SPSS, and STATA software. Accordingly, this study used a gross margin analysis, double hurdle model, and a multinomial logit model, and the results showed that more than two-thirds (81%) of the sampled carrot-producing households in Nakuru County marketed their produce (market participants). They sold their produce at the farm gate (29.94%), cleaning point (25.48%), local market (21.02%), external market (15.92%), and export market (7.64%). The carrots in the study area were mainly purchased by aggregators (33.76%), brokers (27.39%), wholesalers (18.47%), retailers (15.92%), and consumers (4.46%), particularly at the farm level. The gross margin analysis results indicated that carrot producers recorded positive average gross margins ranging from KES 44,800 to KES 113,200 per acre in the five market outlets. The results further suggested that gender, age, market distance, land size, experience, land size under carrots, household size, and distance to the cleaning point were important factors conditioning the household decision to choose a specific carrot market outlet, as well as the level/intensity of market participation. These findings imply that policymakers and other stakeholders should promote the reduction of several carrot market failures as well as competitiveness bottlenecks and support farmers to access credit and appropriate market information regarding demand and prices on various market outlets.

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LIST OF ABBREVIATIONS AND ACRONYMS

AFFA	Agriculture, Fisheries and Food Authority
COVID-19	Corona Virus Disease
DH	Double Hurdle
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GMM	Gross Marketing Margin
GoK	Government of Kenya
Ha	Hectares
ICT	Information and Communication Technology
Kgs	Kilograms
KNBS	Kenya National Bureau of Statistics
KES.	Kenya Shillings
MAPS	Medicine and Aromatic Plants
MDGs	Millennium Development Goals
MNL	Multinomial Logit
MOALF	Ministry of Agriculture, Livestock and Fisheries
NMM	Net marketing Margin
RUM	Random Utility Model
SAP	Structural Adjustment Programs
SDGs	Sustainable Development Goals
SSA	Sub-Saharan Africa
TGMM	Total Gross Marketing Margins
TGPM	Total Gross Profit Margin
TOE	Total Operating Expenses
UAE	United Arab Emirates
USA	United States of America
USDA	United State Department of Agriculture

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Globally, agricultural production in developing countries has been declining by 0.7% (FAO, 2021), and in Sub-Saharan Africa (SSA), the adverse weather conditions and conflicts in East, and West African countries have resulted in widespread crop damage, and consequently, production downturns (Lokuruka, 2020). In Kenya, about 2.4 million people are estimated to be severely food insecure due to the prevailing dry weather conditions, which have had a negative impact on crop and livestock production, constraining food availability and access across the country (FAO, 2021; Keya *et al.*, 2019). Accordingly, the higher prices of agricultural produce in Kenya are mainly due to reduced domestic supplies following the below-average first-season harvest caused by the predominant erratic rainfall, which has resulted in a reduced output in Kenya (FAO, 2021). Despite this challenge, the Kenyan economy is heavily dependent on agriculture, which is the biggest foreign exchange earner and it plays a great role in the achievement of the country's blueprint, vision 2030. The sector contributes to over 30 percent of the Gross Domestic Product of Kenya and employs over 60 percent of Kenyans (KNBS, 2019).

Horticulture is one of the leading sub-sectors of agriculture, contributing 36% of agricultural GDP, and has been ranked the third largest foreign exchange earner after tea and coffee. Additionally, the sector contributes significantly to the Kenyan economy by providing employment opportunities to about 350,000 individuals directly and supports over six million livelihoods (GoK, 2021; Onyango, 2016; Otieno *et al.*, 2015). Accordingly, only 4% of all the horticultural produce (Fruits and Vegetables) is being exported while 96% is being consumed locally, thus contributing significantly to household food and nutrition security for many smallholder farmers who produce over 90% (Wesonga & Opile, 2017). The key to the sector's success can be attributed to the use of the latest technology, availability of technical training, and easier access to international markets like the United Arab Emirates (UAE), United States of America (USA), and more, which have recently been created for our farmers (GoK, 2021). Furthermore, the producers and exporters among other value chain actors have been trained and supported on requirements for international accreditations on food safety and traceability by industry associations and other players to enhance the quality of the country's horticultural produce.

Despite the COVID-19 pandemic challenges, the horticulture sector performance in Kenya has shown tremendous growth both in value and volume of production over the years. In terms of the export earnings for the year 2020 stood at Ksh.151 billion, where the flowers earned the country Ksh 108 billion, fruits Ksh 18 billion while vegetables earned Ksh 24 billion (Average exchange rate in 2020: 0.0094 USD). However, a huge proportion of these earnings went to the payment of air freights and thus, making the producers, and exporters to miss the kind of profits they expected (Dijkstra, 2018; GoK, 2021). Moreover, there was a 5% improvement in earnings as compared to 2019, which stands at about 145 billion. In addition, the country's annual crop production stands at 6 million tons of food crops, 4.2 million tons of horticultural crops, and 500,000 tons of industrial crops, all supporting 10 million households.

Market participation by smallholder farmers in developing countries is constrained due to factors that are internal to the farmer or household, and external, from the surrounding environment (Poole, 2017). Moreover, the intensity of market participation is influenced by the ability of farmers to produce products, which meet market expectations in terms of quality, standards, supply consistency, and ability to deliver products on time for sale at a viable price (Khoza *et al.*, 2019; Maestre *et al.*, 2017). The horticultural export market is governed by very strict rules and standards, which farmers must adhere to access these markets (Otieno *et al.*, 2015). The presence of these standards has increased the need for value addition because most of the horticultural products are very perishable and thus, loss in quality could result in huge losses to the farmers. This, therefore, calls for the need to have faster and easy access to markets since storage systems might prove to be unaffordable to most smallholder farmers (Kasso & Bekele, 2018). Furthermore, Kyaw *et al.* (2018) opined that poor farmers are unable to participate in the markets due to internal factors such as low literacy levels, small land sizes, low asset values, low access to credit, and limited ability to produce surpluses for the market. The dominance of subsistence agriculture, as well as higher transaction costs, also limits smallholder participation in agricultural markets (Mmbando *et al.*, 2017; Okoye *et al.*, 2016).

In Kenya, the liberalization of the agricultural sector early in the '90s resulted in a free-market policy and increased private sector participation in the markets (Kipkorir, 2020). This led to an increase in the number of buyers and marketers of agricultural produce and the overall implication was that marketing channel alternatives for producers were widened unlike before (Baumüller, 2016). In addition, the increase in informal marketing channels,

because of the liberalization of the markets, affect marketing decisions by farmers due to the arbitrary price setting to their detriment and disadvantage. This is because the decision on which market outlet to choose has a direct impact on household income due to their differences in terms of resource endowments, and access to the market outlets, prices, and transactional costs involved (Abate *et al.*, 2019; Koech, 2015).

Vegetable production, particularly carrots (*daucus carota*), are essential root vegetable crops commonly grown/produced in cool areas and are used in most diets worldwide (Mwangi *et al.*, 2020; Que *et al.*, 2019). Carrots are a great source of carotene, vitamin A, vitamin B, and vitamin C, and have traditionally been believed to be a cure for eyesight problems, lowering cholesterol and improving digestion (Singh *et al.*, 2021; Varshney & Mishra, 2022). Carrot roots can be consumed raw or cooked, alone or in combination with other vegetables as an ingredient in soups, sauces, and dietary compositions (Raees-ul & Prasad, 2015). There has been a rapid rise in the consumption of carrots in today's human diets owing to their antioxidant, anti-carcinogenic, anti-diabetic, and anti-inflammatory properties; it is also an important source of dietary fibre (Kwiatkowski *et al.*, 2015; Mozaffarian *et al.*, 2018). Carrots can remain in good condition, especially, when they are mature and harvested under moist conditions, and undamaged and free of diseases and pests, for 100-150 days when the foliage is removed and they are stored at 1-4° C with 95 to 100% relative humidity (Ilic *et al.*, 2017).

In Kenya, the major counties producing carrots include Kiambu, Migori, Meru, Nyandarua, Siaya, Kisii, Nyeri, Nakuru, and Bungoma. Carrots are majorly produced for domestic market while a small percentage of baby carrots are exported (Mwangi, 2021; Match-Marker, 2017; Ronald *et al.*, 2015). Common varieties in Kenya include but not limited to Chantney, Nantes, and Oxheart. Nantes variety is the most preferred by farmers due to its colour and sweet taste. Furthermore, carrots contribute approximately Ksh 1.9 billion, amounting to 2.8% of the total domestic value of exotic vegetables (Stöber *et al.*, 2018). Besides, carrots have the potential to contribute to poverty reduction, food security, income generation, and even achievement of Sustainable Development Goals (SDGs). In Nakuru County, carrot is one of the high-value horticultural crops produced by smallholder farmers with landholdings of 2-5 Ha (GoK, 2021). Additionally, it is among the short-season crops of 2-3 months with a high potential for good yields for family food security and fresh market sales. It does well in the cooler areas of Nakuru County under both irrigated and rain-fed conditions. Therefore, to realize the full potential of the carrot industry, the markets must

be set right while enhancing smallholder market participation, because it plays a very important role in the development of a successful agribusiness (Carrot) value chain. Furthermore, the promotion of market participation of smallholder carrot farmers, and their sustainable access to various market channels, will facilitate their adoption of such channels, and enhance their graduation to market-oriented production, hence, improving their productivity, post-production management practices, as well as the establishment of direct and strong market linkages in a sustainable manner.

1.2 Statement of the Problem

Smallholder carrot farmers face a myriad of challenges when it comes to efficiently utilizing their limited resources due to market failures and competitiveness bottlenecks, ultimately hampering their productivity. Moreover, the current supply of carrots in various market outlets across Kenya falls short of meeting the demand, even though carrots command a premium price. The surge in demand for carrots in recent years can be attributed to factors such as market liberalization, rapid urbanization, improving living standards, and the preferences of the urban middle class for high-quality, safe, diverse, and convenient food options. Additionally, heightened consumer awareness regarding the nutritional and medicinal benefits of carrots has contributed to this increased demand. However, the inability of smallholder carrot farmers to meet this demand results in missed market opportunities, negatively impacting their household welfare indicators.

Furthermore, limited market participation among smallholder farmers, who represent many carrot producers, remains a significant obstacle to consistent carrot supply to markets. This challenge affects households differently based on their unique characteristics, asset portfolios, production scales, and labour allocation decisions. Moreover, the capacity of smallholder carrot farmers to access various marketing channels is constrained and subject to dynamic changes. Additionally, inadequate information about available market opportunities and associated prices often hinders smallholder carrot farmers from scaling up their production to meet the rising market demand. Against this backdrop, this study aims to identify effective strategies to enable vulnerable smallholder carrot farmers to participate efficiently and effectively in markets, thereby maximizing their potential contributions to household food security and poverty reduction. Additionally, it seeks to establish optimal avenues for establishing robust linkages between smallholder carrot farmers and markets, while estimating the conditioning factors influencing farmers' market participation levels. These insights are crucial for devising improved strategies that enhance smallholder carrot

farmers' market participation and ensure the sustainability of their livelihoods. Therefore, this study endeavours to bridge these knowledge gaps through an in-depth analysis of the carrot value chain and the determinants of outlet choices among smallholder farmers in Nakuru County, Kenya.

1.3 Objectives

1.3.1 General Objective

The primary aim of this study was to enhance the marketing practices of smallholder carrot farmers, with the overarching goal of alleviating poverty, ensuring food security, and boosting income generation.

1.3.2 Specific Objectives

- i. To delineate the characteristics of smallholder carrot farmers in Nakuru County.
- ii. To evaluate and contrast the profit margins of different participants within the carrot value chain in Nakuru County.
- iii. To assess the factors affecting market participation and the extent of involvement in the market among carrot farmers in Nakuru County.
- iv. To identify the factors that influence the selection of marketing outlets among carrot farmers in Nakuru County.

1.4 Research Questions

- i. What are the distinguishing characteristics of smallholder carrot farmers in Nakuru County?
- ii. How do the profit margins of various actors in the carrot market compare with each other in Nakuru County?
- iii. What factors influence the engagement of carrot farmers in Nakuru County in market activities, and to what extent do they participate in these markets?
- iv. What are the determinants that influence carrot farmers in Nakuru County when choosing their marketing outlets?

1.5 Justification of the Study

The engagement of smallholder farmers in markets plays a crucial role in fostering agricultural growth and sustainable development. Market-oriented production is particularly essential for the advancement of the agricultural sector, upon which many rural households rely for their livelihoods (Smita *et al.*, 2021; Tonui, 2017). To effectively alleviate poverty

and address food insecurity among the rural poor, it is imperative to not only ensure their access to competitive markets for agricultural produce but also to facilitate their active participation in these markets (Botreau & Cohen, 2020). This study focuses on understanding the dynamics of carrot marketing, a significant vegetable with global importance. By examining the existing marketing channels, analysing market margins of key actors, and investigating market participation decisions, valuable insights will be gained for governmental and policymaking entities. These insights can inform the formulation of supportive measures aimed at encouraging market participation among smallholder farmers, thereby facilitating the transition from subsistence to commercial agricultural practices.

Addressing the constraints faced by smallholder farmers and establishing linkages to output markets will serve as a catalyst for carrot producers to enhance their productivity. This, in turn, will contribute to improved food and nutrition security, as well as increased household incomes. The resulting boost in farm output and economic activities will align with the County Integrated Development Plan (CIDP) of Nakuru County, and Kenya's long-term development objectives outlined in Vision 2030. Moreover, aligning with global development agendas such as Sustainable Development Goals (SDGs) number one (eradicating poverty) and two (eliminating hunger), this endeavour will further advance progress towards sustainable development goals both nationally and internationally.

1.6 Scope and Limitation of the Study

The study was limited to the smallholder farmers and market intermediaries within Nakuru County and any generalizations of the results should be confined to the county. The study focused on the analysis of factors affecting market participation and market outlet choice decisions for smallholder carrot farmers in Nakuru County. Some of the information collected relied on recall where record-keeping is not practiced and could have compromised the degree of accuracy. However, proper propping using cross-check questions was embraced during the survey to counter such challenges.

1.7 Definition of Terms

Market: It is any place where sellers of a good or service can meet with the buyers of that goods and service and there is a potential for a transaction to take place. Markets can be formal or informal depending on the level of regulation and they can also be local or international.

Marketing: The task of creating, promoting, and delivering goods and services to consumers and businesses.

Marketing outlet: It is a place where goods or services that meet customers or consumer needs are provided.

Market chain: Market chain is the term used to describe the various links that connect all the actors and transactions involved in the movement of agricultural goods from the producer to the consumer.

Market participation: Market participation is the ability of a smallholder farmer to participate in a market efficiently and effectively. In this study, it implies the transition by farmers from subsistence farming to a market engagement mode, whereby inputs are increasingly purchased and outputs sold off the farm to traders.

Smallholder carrot farmers: In Kenya they are farmers who are typically operating on small plots of land, often less than 2 hectares in size, to cultivate carrots for subsistence and local markets.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of Carrot Production and Consumption

Carrot (*Daucus carota*) stands out as one of the most significant root vegetables in human diets, belonging to the family *Umbelliferae/Apiaceae*, and originally hailing from Europe and the temperate regions of Asia. Initially utilized solely for its medicinal properties, carrots evolved into a pivotal crop globally following domestication, with its production expanding rapidly (Singh *et al.*, 2021; Yadav *et al.*, 2021). Presently, the annual worldwide production of carrots stands at approximately 371 million tonnes, with leading producing countries including China, Uzbekistan, and the USA (FAO, 2021; Mickiewicz *et al.*, 2022). Notably, China accounts for 66.4% of this total production, yielding around 18.07 tonnes annually. The edible swollen taproots of carrots are commonly consumed raw or cooked, renowned for their high beta-carotene content. Furthermore, carrots play a significant role in the food processing industry and feature prominently in cosmetic products. Additionally, their leaves can be incorporated into salads, while their seeds can be utilized to make herbal tea (Kwiatkowski *et al.*, 2015; Singh *et al.*, 2021).

According to the United States Department of Agriculture (USDA), carrots boast high levels of antioxidants, vitamins, and dietary fiber, containing merely 41 calories per 100 grams, negligible fat, and no cholesterol. They serve as a rich source of carotenes and vitamin A (Singh *et al.*, 2021). Furthermore, fresh carrots are packed with 8285 micrograms of beta-carotene per 100 grams (Varshney & Mishra, 2022). Additionally, carrots harbor a wealth of B-complex vitamins such as folic acid, vitamin B-6 (pyridoxine), and thiamin, serving as co-factors for enzymes involved in substrate metabolism in the body. Carrots also contain essential minerals like copper, calcium, potassium, manganese, and phosphorus. Potassium, for instance, plays a crucial role in regulating heart rate and blood pressure, while manganese acts as a co-factor for the antioxidant enzyme superoxide dismutase. Essential oils extracted from carrots possess potential liver- and digestive system-boosting properties, aid in red blood cell formation, and contribute to the deceleration of the aging process (Singh *et al.*, 2021).

Carrots are cultivated worldwide and are characterized by their moderate requirements for climate and soil. Due to their modest cultivation and storage needs, they can be produced fresh year-round and sold fresh (Mozaffarian *et al.*, 2018). As an erect, biennial crop, carrots are predominantly grown as annuals, with plant heights ranging from 20-100 cm

and featuring a main taproot that becomes swollen and thickened with varying shapes and sizes (Mwangi, 2021). Optimum air temperatures of 16-24°C are ideal for carrot growth, although the crop is relatively sensitive to high soil temperatures exceeding 25°C, resulting in low germination rates, shortened roots, and paler colours. Carrots typically mature for harvesting within 70-85 days, contingent on the desired tuber size and cultivar. Thriving in deep, moist, well-drained, friable, sandy loam soil rich in organic matter, carrots exhibit a diverse colour range including white, yellow, orange, purple, and violet. While numerous varieties exist globally, four common ones include Emperor, Nantes, Danvers, and Chanteney (Mwangi, 2021; Raees-ul & Prasad, 2015).

2.2 Importance of Agricultural Markets

Participation in markets stands as a pivotal determinant of the welfare and progress of smallholder farmers (Dlamini-Mazibuko *et al.*, 2019; Kyaw *et al.*, 2018; Poole, 2017; Yaméogo *et al.*, 2018;). This significance stems from the role markets play in facilitating the exchange of commodities between producers and traders, establishing linkages between local, national, and rural markets, and advancing overarching goals such as food security, poverty alleviation, and sustainable agriculture, particularly among smallholder farmers in developing nations (Fan & Rue, 2020; Jaimovich, 2015; Sabo *et al.*, 2017). The emphasis on smallholder agriculture is paramount, given that up to 80% of the food consumed in developing countries, notably in Africa and Asia, is sourced from smallholder farmers (Gomez *et al.*, 2020). Consequently, any development agenda targeted at smallholder farmers has the potential to significantly enhance living standards in developing nations.

Sustainable access to markets by smallholder farmers, as asserted by Abraham and Pingali (2020), holds the promise of poverty and hunger reduction in low-income countries. Additionally, findings from a study conducted in Uganda by Montalbano *et al.* (2018) affirmatively correlate market participation with farmers' food security, irrespective of the chosen marketing channel. Governments and development partners in developing countries deploy various strategies aimed at increasing output production; however, expanding markets (Aiginger & Rodrick, 2020; Leighland, 2018) serves to mitigate post-harvest losses, thereby improving farmers' incomes. Moreover, markets contribute to increased productivity, as noted by Oduol *et al.* (2017), Olwande *et al.* (2015), and Smita *et al.* (2021). A well-functioning market facilitates efficient resource allocation and enhances societal welfare maximization. Market access, as evidenced by a study on smallholder farmers in South

Africa conducted by Rangoato (2018), significantly enhances farm productivity, thereby catalysing the transition from subsistence to commercial agricultural production.

In the horticultural sector, market access assumes paramount importance due to the perishable nature of horticultural products and the inevitability of post-harvest losses (Kasso & Bekele, 2018; Olwande *et al.*, 2015). Furthermore, findings from a study on market participation by vegetable farmers in Kenya by Kurgat *et al.* (2018) revealed a relatively higher percentage of total vegetable output sold by farmers in peri-urban areas compared to those in rural areas. This underscores the role of population growth in creating expanding markets for fresh vegetables. According to Sellare *et al.* (2020), smallholder farmers can only access certified markets through organization and group certification, as compliance with standards and certification incurs costs that impact farm-gate prices.

2.3 Evaluating Efficiency of Agricultural Marketing Systems.

2.3.1 Market Performance

Market performance refers to the overall outcome or equilibrium evaluated in terms of allocative efficiency (Berman, 2018). It encompasses the impact of the market on its participants, including aspects such as pricing, trading volumes, and marketing costs (Kitatia *et al.*, 2016). The profitability and efficiency of firms within the market serve as indicators of market performance. Profitability, often used as a proxy for assessing market performance, reflects the effectiveness of a market. Additionally, the marketing margin is a commonly utilized measure to evaluate the performance of a marketing channel.

2.3.2 Marketing Margin

Marketing margin represents the disparity between the price paid to the initial seller (farm-gate price) and the price paid by the ultimate buyer (retail price). It serves as a metric for evaluating market performance by examining the efficiency of price formation and transmission within a marketing system (Bargawi & Newman, 2017). The determination of marketing margin is primarily influenced by shifts in retail demand, farm supply, and marketing input prices. Additionally, factors such as the level of processing along the marketing channel, the length of the channel, channel efficiency, timing of sale, technical advancements, and market power also impact marketing margin (Montalbano *et al.*, 2018).

According to Gervias (2015), the magnitude of the marketing margin is contingent upon the combination of both the quality and quantity of marketing services provided, as well

as the associated costs. Perishable goods like fruits and vegetables typically yield higher marketing margins (Ahmed *et al.*, 2017). Broader marketing margins generally signify elevated prices for consumers and reduced prices for producers (Kilambya & Witwer, 2019). Zorinah (2016) highlighted the necessity of distinguishing between two components of the marketing margin: retailer margin and wholesaler margin. The wholesaler margin denotes the difference between the price at which wholesalers sell their products and the price they pay to producers for acquiring the products. Conversely, the retailer margin signifies the difference between the price at which retailers sell the produce acquired from wholesalers and the price they pay to wholesalers.

2.4 Market Participation Decisions by Farmers

Various studies have indicated that smallholder farmers, particularly those with limited resources, are not fully engaged in agricultural markets and marketing activities. For instance, a study conducted on groundnut farmers in Zimbabwe highlighted factors such as land size, access to transport information, distance to the nearest town, age, and education of the household head influenced decisions regarding the marketing of groundnuts (Akrong *et al.*, 2021; Mango *et al.*, 2018). This limited engagement in markets is often attributed to several imperfections prevalent in agricultural markets in developing countries, including a lack of information on prices and technologies, high transaction costs, and credit constraints (Akrong *et al.*, 2020; Chikuni *et al.*, 2018).

Moreover, high transportation costs have been identified as a significant barrier preventing farmers from fully participating in markets, often leading them to sell their produce at informal markets where prices are considerably lower (Khapayi & Ceillers, 2016). Farmers' motivation to engage in markets primarily stems from their need to access services and products that cannot be produced within their farms (Achandi & Mujawamariya, 2016). Similarly, in Tanzania, farmer characteristics such as age, household size, off-farm income, output quantity, and transaction costs were found to influence the intensity of market participation among smallholder rice farmers (Achandi & Mujawamariya, 2016). In Nigeria, household size, distance to the nearest marketing channel, commodity price, and gender were identified as significant determinants of fish marketing participation (Awotide *et al.*, 2016).

Furthermore, studies conducted on market participation in staple food grains in Eastern and Southern Africa revealed significant barriers hindering smallholder farmers' participation in these markets, including limited access to productive assets, finance, and improved technologies (Aiginger & Rodrick, 2020). In Rwanda, larger land sizes and access

to off-farm income were found to increase the probability of market participation for banana sellers, with female-headed households facing limitations due to their lack of access to productive assets (Mbitsemunda & Karangwa, 2017). Additionally, access to market information has been highlighted as crucial for farmers' market participation, enabling them to make informed decisions related to supplying goods, negotiating contracts, and monitoring prices (Boban *et al.*, 2018).

Education has also emerged as a significant influence on market participation, as it enhances farmers' ability to source and analyse information, thus reducing transaction costs and market entry barriers (Abate *et al.*, 2019; Mbitsemunda & Karangwa, 2017). Studies conducted in Kenya have shown that market information plays a crucial role in influencing the intensity of market participation among smallholder farmers (Abate *et al.*, 2019; Olwande *et al.*, 2015). Additionally, factors such as access to electricity and improved technology were found to significantly influence market participation in the Kenyan dairy sector (Burke *et al.*, 2015).

2.5 Market Outlet Choice

The decision of which outlet to use is a crucial one for producers, influenced by various factors and objectives. Market outlet choice not only impacts the price received by farmers but also determines the volume of sales, thus playing a pivotal role in achieving increased market performance. Extensive literature exists on the reasons behind farmers' decisions regarding market outlet choices across different commodities and countries. For instance, Smita *et al.* (2021) and Olwande *et al.* (2015) found institutional factors significant in determining smallholder dairy farmers' adoption of various milk marketing outlets in Kenya, including credit availability, dairy cooperatives, and policy-related interventions such as government extension agents. Boban *et al.* (2018) identified institutional and technical factors such as transaction costs and market information as influential in agricultural marketing channel choices among smallholders and emerging farmers in South Africa. Similarly, Dessie *et al.* (2018) revealed that farmers tend to choose the most convenient market outlet offering the highest returns.

In Benin, Arinloye *et al.* (2015) found that pineapple farmers selected market channels with high values when they had the expertise to cope with quality issues. Additionally, Sharma (2015) highlighted factors such as age, education, and market infrastructure as significant determinants of farmers' marketing choices. Mutura *et al.* (2015)

discovered that land size, dairy cow ownership, access to training, total milk output, and market information significantly influenced the choice of a market outlet among dairy farmers in Kenya. Moreover, Nyaga *et al.* (2019) found that factors such as the gender of the household head, distance to market, marketing cost, and access to extension services significantly influenced farmers' choice of market channel in the Kenyan fish market. Tarekegn (2017) demonstrated that honey producers' market outlet choice in Ethiopia was determined by factors such as the quantity of honey sold, frequency of extension contact, beekeeping experience, and access to market information.

Furthermore, Tray *et al.* (2021) emphasized producer price as a major determinant of market outlet choice by horticultural farmers in Cambodia. Hung *et al.* (2020) identified family size, distance, market information, bargaining power, education, and grape varieties as significant influencers of marketing channel choice among farmers in Vietnam. Similarly, Musara *et al.* (2018) found that market price, number of buyers, distance to the market, dependency ratio, and household income were robust determinants of marketing channel selection among sorghum producers in Zimbabwe. Additionally, organization in markets is crucial for the collective action of producers, as individual marketing of small quantities weakens smallholder farmers' bargaining positions. Through organization, farmers can access more lucrative markets typically utilized by commercial farmers.

In conclusion, the literature reviewed underscores the multifaceted nature of marketing decisions, influenced by internal factors unique to farming households and external factors such as institutional, technical, and political considerations. Notably, there is a dearth of literature on market participation decisions by smallholder carrot farmers in the Eastern African region, particularly in Kenya, highlighting the significance and relevance of this study.

2.6 Challenges Faced by Smallholder Farmers in output markets

Agricultural production by smallholder farmers is characterized by small volumes that are inconsistent in supply due to weather-related challenges, coupled with other factors such as limited access to inputs (Benedek *et al.*, 2018), pests and diseases, and diminishing land sizes (Khapayi & Ceillers, 2016), all which impact production. Moreover, smallholder farmers, as noted by Shiferaw *et al.* (2016) and Muricho *et al.* (2016), are net buyers, implying that high output prices directly affect their household incomes. Despite the significance of market participation for smallholder farmers, various challenges hinder their

ability to engage effectively. For instance, smallholder farmers in most developing countries encounter difficulties participating in markets due to hidden costs that impede access to input and output markets, as highlighted by Shiferaw *et al.* (2016). Transaction costs have also emerged as a significant barrier to market participation for many resource-poor smallholder farmers (Ckikuni *et al.*, 2018; Hagos *et al.*, 2020; Okoye, 2016). Olwande *et al.* (2015) further observed that internal factors such as low literacy levels, small land sizes, low asset values, limited access to credit, and the inability to produce surpluses for the market hinder poor farmers from market participation.

Moreover, smallholder farmers encounter challenges in participating in commercial markets due to a myriad of technical and institutional constraints (Tonui, 2017). Poor infrastructure, lack of market transport, inadequate market information, insufficient expertise on grades and standards, the inability to conclude contractual agreements, and poor organizational capacity are among the factors contributing to these challenges (Olwande *et al.*, 2015). Additionally, smallholder farmers often lack vertical linkages in marketing channels, leading to their exclusion from formal markets (Botreau & Cohen, 2020). Hagos *et al.* (2020) concluded that the adoption of high-yielding varieties, provision of extension services, and insurance can aid Ethiopian farmers in breaking away from subsistence farming. However, smallholder farmers also exhibit weak financial and social capital and limited access to legal recourse, trapping many within market constraints and preventing them from earning rewarding incomes from their agricultural activities (Ochieng *et al.*, 2018).

2.7 Theoretical and Conceptual Framework

2.7.1 Theoretical Framework

This study was grounded in utility maximization theory, which posits that individuals will select the alternative from their set of available options that maximizes their utility. This theory suggests that there exists a function comprising attributes of alternatives and characteristics of individuals, which defines an individual's utility associated with each alternative. According to rational choice theory, we assume that individuals rank mutually exclusive alternative marketing outlets based on utility and will opt for the outlet with the highest expected utility considering their socio-economic and demographic characteristics, as well as relevant resource constraints. The decision-making process of producers regarding market participation and outlet choice can thus be conceptualized using a Random utility model.

The decision of whether to participate in carrot markets falls within the broader framework of utility (Sokolowski, 2020). Within this framework, smallholder carrot farmers will decide to engage in markets if the perceived utility or net benefit from this decision outweighs the alternative. While utility itself is intangible and cannot be directly observed, the actions of carrot farmers are manifested through the choices they make. Suppose that U_j and U_k represent a farmer's utility for the two choices, which are denoted by Y_j and Y_k respectively. The linear random utility model could then be specified as:

$$U_j = \beta_j X_i + \varepsilon_j \text{ and } U_k = \beta_k X_i + \varepsilon_k \dots\dots\dots (1)$$

where U_j and U_k are perceived utilities of participating in the carrot market and not participating, choices j and k , respectively, X_i is the vector of explanatory variables that influence the perceived desirability of each choice and ε_j and ε_k are error terms assumed to be independently and identically distributed (Greene, 2000). In the case of carrot markets, if a farmer decides to use option j , it follows that the perceived utility or benefit from option j is greater than the utility from other options (say k). This can be illustrated as:

$$U_{ij}(\beta_j X_i + \varepsilon_j) > U_{ik}(\beta_k X_i + \varepsilon_k), k \neq j \forall i \dots\dots\dots (2)$$

The probability that a farmer chose to participate in carrot marketing, i.e. choose option j instead of k could be defined as;

$$P(\beta_j X_i + \varepsilon_j - \beta_k X_i + \varepsilon_k) > 0 \mid X) \\ P(\beta_j X_i - \beta_k X_i + \varepsilon_j - \varepsilon_k) > 0 \mid X). \\ P(X^* X_i + \varepsilon^* > 0 \mid X) = F(\beta^* X_i) \dots\dots\dots (3)$$

where P is a probability function, and X_i are as defined above, $\varepsilon^* = \varepsilon_j - \varepsilon_k$ is a random disturbance term, $\beta^* = (\beta_j - \beta_k)$ is a vector of unknown parameters that can be interpreted as a net influence of the vector of independent variables influencing participation, and $F(\beta^* X_i)$ is a cumulative distribution function of ε^* evaluated at $\beta^* X_i$. The exact distribution of F depends on the distribution of the random disturbance term, ε^* . Depending on the assumed distribution that the random disturbance term follows, several qualitative choice models can be estimated (Greene, 2000). Any household/farmer decision on the alternative choices is underpinned by this theoretical framework.

2.7.2 Conceptual Framework

The conceptual framework employed in this study draws upon the sustainable livelihood framework proposed by Chambers and Conway (1992). According to this framework, farming households possess varying levels of resources (capital or assets), and their choice of livelihood strategies, such as crop farming, livestock rearing, and off-farm employment, depends on the availability of these resources. A household's livelihood is considered sustainable if it can enhance key welfare indicators such as food and nutrition security, poverty alleviation, and income generation without depleting natural resources.

In the agricultural context, a carrot farmer's decision to participate in the market, the extent of participation, and the choice of a marketing outlet are conceptualized to be influenced by various socio-economic, household, technical, and institutional factors. Moreover, not all households participate in the market at the same level, indicating variations in market engagement. Therefore, the interaction between different market outlets/channels and their associated profit margins may lead to overlapping participation among smallholder farmers. Smallholder carrot farmers make decisions about selling their produce in different market outlets based on their unique characteristics and the presence of physical and institutional factors. Additionally, the performance of agricultural markets or market outlets is significantly influenced by prevailing technology and natural factors. Considering these factors, it can be assumed that the decision to participate in the market and the extent of participation are determined by multiple factors (see Figure 1). Moreover, increased market participation by smallholder carrot farmers is expected to intensify carrot farm enterprises, leading to enhanced productivity, adherence to product quality standards, and ultimately contributing to improved household food and nutrition security, poverty alleviation, and increased income levels.

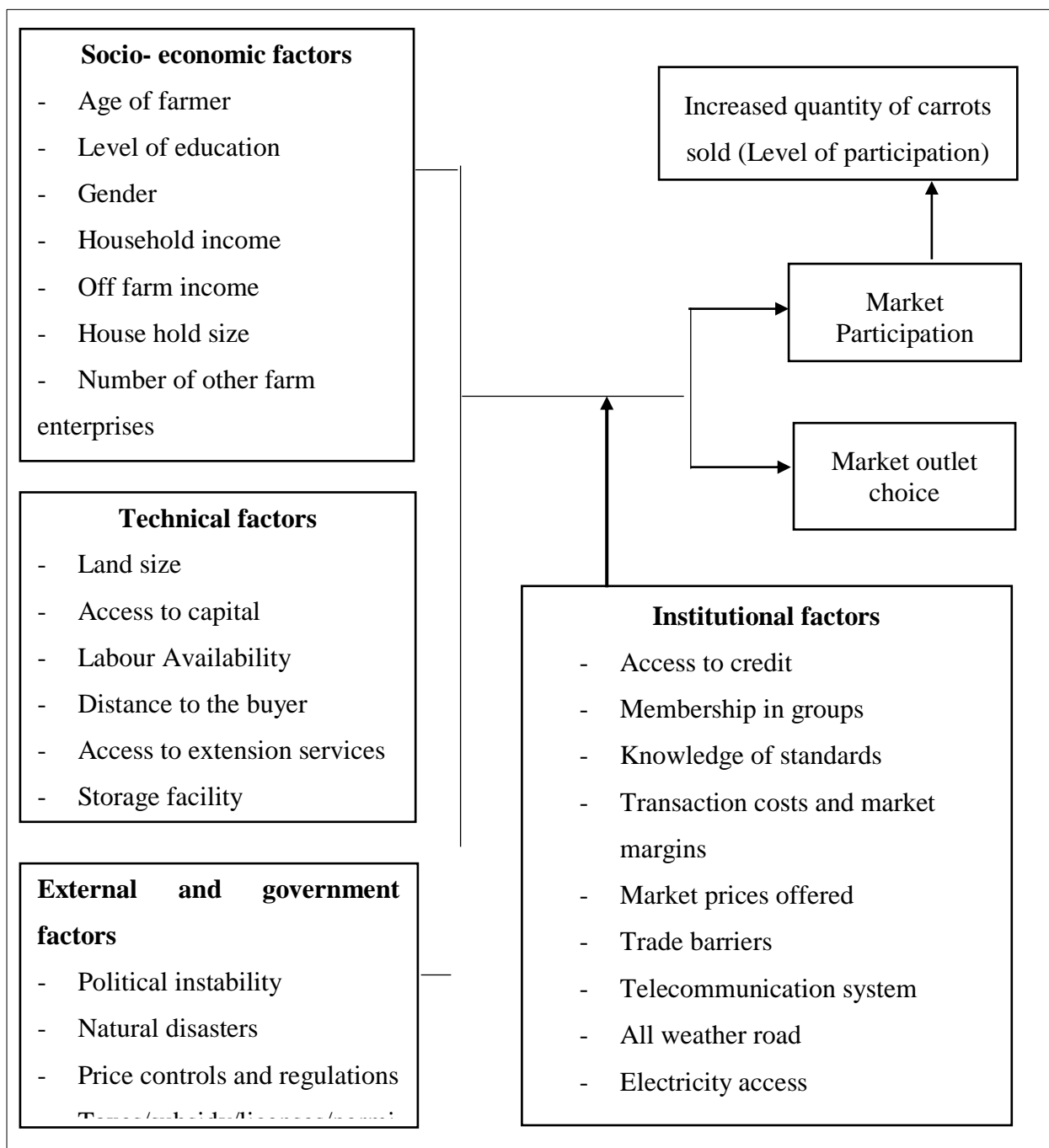


Figure 1: Conceptual Framework.

CHAPTER THREE

METHODOLOGY

3.1 Study Area

The study was carried out in Nakuru County, situated between longitudes 35°28' and 35°36' East, and latitudes 0°13' North and 1°10' South (Figure 2). This region experiences an average altitude ranging from 1520 m to 3098 m above sea level, with annual rainfall varying from 100 mm to 1,900 mm. The climatic conditions in the county are influenced by altitude and physical features such as escarpments, lakes, and mountains. Farming practices in the county are characterized by mixed farming, involving both crop cultivation and animal husbandry. The primary cash crops cultivated include wheat, pyrethrum, and horticultural crops, particularly cut flowers, while common food crops comprise maize, beans, and potatoes. Specifically, the study was done in Njoro Sub- County, which is in the Nakuru County of Kenya. It lies approximately between latitudes -0.2917 and -0.3326, and longitudes 35.9847 and 36.0007. The sub-County is known for its agricultural activities, particularly in horticulture, including the cultivation of carrots, maize, and other crops. It also hosts Egerton University, one of the prominent institutions of higher learning in Kenya, contributing significantly to the educational and socio-economic development of the region.

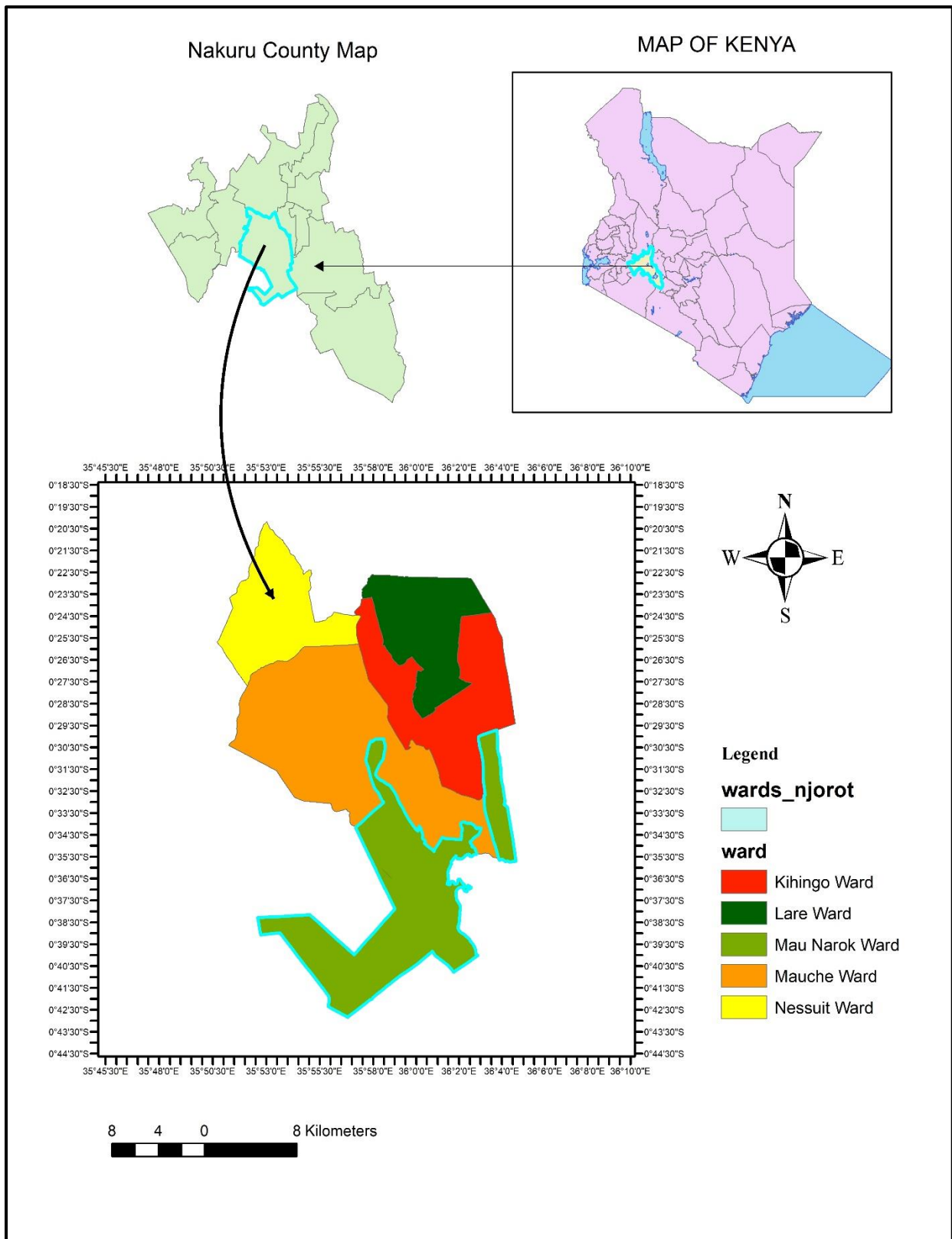


Figure 2: Map of Nakuru County, Kenya.

Horticulture is a significant economic activity in the county, with the production of vegetables, flowers, and fruits catering to both local consumption and export markets. Nakuru

County was chosen due to its favourable climatic conditions for carrot cultivation, its status as one of Kenya's major carrot-producing regions, and its prominence as the fourth-largest town in the country. Additionally, Nakuru town serves as a potential market for carrots, further justifying its selection as the study area. Within Nakuru County, Njoro sub-county was specifically targeted for this study, as it is renowned for its high agricultural productivity and hosts a substantial population of carrot farmers and traders who supply produce to local, regional, and international markets.

3.2 Sampling Frame and Sample Size

The sample unit for this study consisted smallholder carrot farming households in Njoro sub-county as well as carrots traders. Anderson *et al.* (2011) presents a comprehensive approach to sampling that offers several advantages over other methodologies. Their emphasis on representativeness ensures that the sampled population accurately reflects the target population, enhancing the validity and generalizability of study findings. This approach also maximizes efficiency by optimizing resource allocation while maintaining sufficient sample size and coverage. The flexibility of their methodology allows researchers to tailor sampling strategies to the unique characteristics of the study context, promoting inclusivity and minimizing biases. Moreover, their methodology is compatible with various data collection techniques, enabling researchers to choose the most suitable methods for their research objectives and logistical constraints. Overall, Anderson *et al.* (2011) sampling methodology provides a robust framework for researchers to obtain high-quality data and draw reliable conclusions about the population of interest. Therefore, smallholder carrot farmers were randomly selected and the sample size was determined following the formulae that was proposed by Anderson *et al.* (2011) as follows;

$$n = \frac{pqZ^2}{E^2} \dots\dots\dots (4)$$

Where n = sample size, p = population proportion with the characteristic of interest, q = 1-p, Z is the standard variant given at confidence level ($\alpha=0.05$) and E is the acceptable error.

$$n = \frac{0.85 \times 0.15 \times 1.96^2}{0.05^2} = 195 \text{ farmers} \dots\dots\dots (5)$$

This resulted to a sample 195 smallholder carrot farmers.

3.3 Sampling Procedure

The study employed a multistage sampling technique to select the sample because it involves selecting samples in multiple stages, beginning with the random selection of primary sampling units followed by the random selection of secondary units within each primary unit, enabling comprehensive representation of the target population across diverse sections. Firstly, Nakuru Town and Njoro Sub County were purposefully chosen due to the concentration of smallholder carrot farmers and traders. Secondly, Mau-Narok Division within Njoro subcounty was purposefully selected for its significant presence of smallholder carrot farmers. Thirdly, three specific locations Mau, Mwisho wa Lami, and Likia were purposefully chosen based on their high number of smallholder carrot farmers. Finally, a simple random sampling approach was utilized to select 195 smallholder carrot farmers. Additionally, 20 brokers, 34 aggregators, 15 wholesalers, 10 exporters, and 20 retailers were selected based on guidance from the divisional agricultural officer of Mau-Narok Division.

3.4 Data Collection Method

The collected data were entered into a computer software program, well-coded, and cleaned to ensure accuracy, consistency, uniformity, and completeness. The data collected were analysed using Microsoft Excel for the market margin analysis and STATA computer package for multinomial logit , and double hurdle regression model (StataCorp, 2021)

3.5 Data Collection and Analysis

The collected data underwent thorough coding, entry into a computer software program, and subsequent cleaning to ensure accuracy, consistency, uniformity, and completeness. Market margin analysis was conducted using Microsoft Excel, while multinomial logit and double hurdle regression models were employed for data analysis using the STATA computer package. Gross margins were used because it is a key financial indicator, assessing the profitability of agricultural activities by comparing revenue with production costs, guiding decision-making and resource allocation across different market outlets and practices. Additionally, they enable stakeholders to monitor and improve the financial performance of agricultural enterprises, fostering competitiveness and sustainability in the sector over time. On the other hand, the Double Hurdle model was used because it is advantageous in analysing economic data with excess zeros, as it effectively models both the decision to participate and the level of participation, capturing the complexity of individuals' decision-making processes. This flexible framework offers insights into factors influencing

participation and intensity, providing a robust method for understanding economic behaviour. Finally, the Multinomial Logit model was employed in this study because it is well-regarded for its capacity to analyse categorical outcomes involving multiple discrete choices, offering valuable insights into decision-making processes by estimating probabilities for each choice. Its simplicity and interpretability have made it a staple in various disciplines like economics and sociology, serving as a fundamental tool for understanding human behaviour and decision-making across diverse research contexts.

3.6 Analytical framework

The inferential statistics employed in this study, including double hurdle and multinomial logit models, were pivotal in analysing household-level data from smallholder carrot farmers and traders in Nakuru County, Kenya. These statistical techniques allowed for the examination of relationships between various socio-economic, institutional, and farm characteristics and the decision-making processes related to market participation and outlet selection. The findings revealed significant associations between factors such as gender, age, distance to market, land size, and market outlet choices. Through rigorous statistical analysis, the study illuminated key determinants influencing smallholder farmers' engagement in carrot markets, providing valuable insights for policymakers and stakeholders seeking to enhance market participation and promote sustainable agricultural development in the region.

3.6.1 Objective One: To Delineate the Characteristics of Smallholder Carrot Farmers in Nakuru County

Objective one was addressed through the application of descriptive statistics, encompassing percentages, means, variances, and standard deviations. These statistical analyses were utilized to explore and elucidate the socio-economic, institutional, and technical attributes of the chosen carrot farmers (see Table 3 and 4, as well as Figure 3 and 4 in section 4.2).

3.6.2 Objective Two: To Evaluate and Contrast the Profit Margins of Different Participants Within the Carrot Value Chain in Nakuru County

To examine the marketing margins of the different market outlets, marketing margin analysis was employed. In model specification, Market margin analysis offers the best tools to analyse the performance of a market outlet/channel.

$$\text{Producers' share} = \frac{\text{Producer price}}{\text{Next actor price}} = 1 - \frac{\text{Marketing Margin}}{\text{Actor price}} \dots\dots\dots (6)$$

where the marketing margin was taken as the difference between the producer's price and the next market actor price.

$$GMM = \frac{\text{Actor price} - \text{Producer price}}{\text{Actor price}} \times 100 \dots\dots\dots (7)$$

where *GMM* is the gross marketing margin. Hence, the gross marketing margin of producers represents the share of the price paid by market actors allocated to the producer's income. Conversely, the Net Marketing Margin (NMM) indicates the percentage of the final price obtained by the intermediary as income after subtracting marketing costs. Through the NMM, the allocative efficiency of the market outlets can be assessed. A higher NMM signifies diminished and inequitable income distribution, thereby dampening market participation by

$$\text{smallholder farmers. } NMM = \frac{\text{Gross Marketing Margin} - \text{Marketing costs}}{\text{Actor price}} \dots\dots\dots (8)$$

the marketing margin at a given stage '*i*' (*GMM_i*) was computed as:

$$GMM_i = \frac{\text{Next actor price} - \text{Purchasing price}}{\text{Next actors' price} - \text{Farmer's price}} \times 100 \dots\dots\dots (9)$$

the total gross profit margin (TGPM) was computed as:

$$TGPM = TGMM - TOE \dots\dots\dots (10)$$

where TGMM= Consumer's price – Farmers price

TOE= Total operating expenses

the profit margin at stage '*i*' is given as:

$$\text{Gross profit margin (GPM)} = \frac{\text{Gross Market Margin } i - \text{Operating expenses } i}{\text{Total gross profit margin}} \times 100 \dots\dots (11)$$

3.6.3 Objective Three: To Assess the Factors Affecting Market Participation and the Extent of Involvement in The Market Among Carrot Farmers in Nakuru County

This objective aimed to identify the factors influencing the decision to participate in the market and the level of participation among smallholder carrot farmers. Participation and the intensity of participation are crucial for ensuring sustainable commercialization by smallholder farmers. The decision to participate in the market is followed by the level of participation, typically indicated by the quantity of carrots delivered to a particular marketing outlet. This sequential decision process can be effectively analysed using a double hurdle model. Other suitable alternative methods include the Heckman selection model or a Tobit model. The double-hurdle model, an improvement of the Tobit model proposed by Cragg

(1971), addresses the challenges posed by survey data containing numerous zero observations on a continuous dependent variable. In the double hurdle model, the first hurdle involves the decision of whether to sell carrots, based on various participation challenges faced by the farmer. The second hurdle pertains to the determination of the level of participation, focusing on the quantity of carrots delivered to the market. This model accommodates the dual nature of decision-making in market participation scenarios. The double hurdle model is designed to capture the nuanced dynamics of market participation decisions, allowing for a separate examination of the factors influencing both the decision to participate and the decision regarding the quantity of produce to sell. This approach accounts for the interdependence between the two decisions and offers insights into the determinants of market participation behaviour among smallholder carrot farmers. Mathematically, the double-hurdle model can be represented as:

In the model specification the first decision a carrot farmer makes is whether to sell or not. This is a binary decision since the expected response is expected to be 1 for participation and 0 otherwise. Therefore, a Probit model is appropriate in the analysis. In this case, $Y^* > 0$, if the farmer decides to participate in the market and $Y = 1$ is observed. Otherwise, if $Y^* \leq 0$ the farmer decides not to participate in the market. The latent variable Y^* , which defines the probability for the decision a maker to participate in a market. The variable Y^* is unobservable. What is noted is whether the farmer opts to participate or abstain from market engagement. This can be presented as Y and is linked to Y^* as follows;

$$Y_i^* = \beta X_i + e_i \dots\dots\dots (12)$$

$$Y = 1 \text{ if } Y^* > 0, \dots\dots\dots (13)$$

$$Y = 0 \text{ if } Y^* \leq 0. \dots\dots\dots (14)$$

where:

Y =value of dependent variable which takes the value of 1 for participation in the market and the value of 0 for not participating.

Y^* = the latent variable for market participation

X_i = Vector of independent variables for market participation

β = Coefficient of parameters estimated (quantity of carrot sold)

e_i = the error term

The econometric model specification is as follows:

$$\begin{aligned}
\text{Market participation} = & \beta_0 + \beta_1 \text{Gender}_{farmer} + \beta_2 \text{HH}_{size} + \beta_3 \text{Education}_{farmer} + \\
& \beta_4 \text{Age}_{farmer} + \beta_5 \text{contract} + \beta_6 L - \text{size} + \beta_7 \text{Access finance} + \beta_8 \text{Sellingprice} + \\
& \beta_9 \text{Mem}_{Ogroups} + \beta_{10} \text{Knowledgestandards} + \\
& \beta_{11} \text{A_marketinginfo.} + \beta_{12} \text{Credit_apply} + \beta_{13} \text{D_market} + \\
& \varepsilon_i \dots \dots \dots (15)
\end{aligned}$$

2nd Hurdle: Level of market participation

The second part of the generalized double hurdle model is the Tobit model, originally proposed by Tobin (1958). Unlike linear regression models, the Tobit model is suitable for dependent variables that are bounded within a limited range, typically between 0 and 1. In the context of this study, the Tobit model is employed to estimate the determinants of the level of market participation, which is measured by the cumulative quantity of carrots delivered to the market outlet. The Tobit regression model offers several advantages over Ordinary Least Squares (OLS) regression. It is specifically designed to handle censored data and is more efficient in estimating parameters, thus mitigating the risk of biased and inconsistent parameter estimates. Mathematically, the Tobit model for the level of market participation can be represented as:

$$Y_i^* = \beta' X_i + \varepsilon_i \dots \dots \dots (16)$$

From the above equation, Y_i^* is a vector of the latent variable that is not observed for values less than 0 and greater than 1, X_i , represents vector of explanatory variables (Table 1), which includes household characteristics, socio-economic, technical, governmental, and institutional factors that affects the quantity of carrots sold. β is vector of the unknown parameters, ε_i is vector of the error terms that are distribute normally with mean 0 and variance σ^2 , and $i=1, 2, 3, \dots, n$ represents the number of observations. From Maddala (1992) Y_i is the observed variable representing the proportion of the quantity of carrots delivered to the market outlet, its value is censored from below at $L= 0$ and from above at $U= 1$. Therefore, Y_i^* is observed if:

$$\left\{ \begin{array}{l} Y_i = 0 \text{ if } Y_i^* \leq L \\ = Y_i^* \text{ if } L \leq Y_i^* \leq U \\ = 1 \text{ if } Y_i^* > U \end{array} \right\} \dots \dots \dots (17)$$

where L is the lower bound censored at 0 and U is the upper bound censored at 1. The expected value of the latent variable Y_i^* is given by following equation;

$$E \left(\frac{Y_i^*}{X} \right) = \beta' X \dots \dots \dots (18)$$

the change in probability of dependent variable as an explanatory variable change by a unit is given by: $\frac{\partial E(Y_i^*/X)}{\partial X_i}$ (19)

As the proportion of the quantity of carrot sold by farmer increases, Y_i , is truncated from below at 0 and from above at 1, its conditional expected value is given by equation

$$E(Y/X, L < Y^* < U) = \beta X + \sigma \frac{\phi(Z_L) - \phi(Z_U)}{\Phi(Z_U) - \Phi(Z_L)} \dots\dots\dots(20)$$

where, $Z_L = (L - \beta X)/\sigma$ and $Z_U = (U - \beta X)/\sigma$, $\phi(\cdot)$ and $\Phi(\cdot)$ are the density function and cumulative distribution of a standard normal variable respectively. In the absence of the stated limits, $Z = (\beta X)/\sigma$.

However, the estimated coefficients from the Tobit model do not directly give the marginal effects of the independent variables on the dependent variable. Nevertheless, their signs show the direction of change in the probability of participation and the level of participation as respective independent variables change (Amemiya, 1985). Thus, the econometric specification for the second hurdle on the level of participation is given below:

$$\begin{aligned} LP = & \beta_0 + \beta_1 Gender_{farmer} + \beta_2 HH_{size} + \beta_3 Education_{farmer} + \beta_4 farmer + \\ & \beta_5 Age_{squared} + \beta_6 L_{size} + \beta_7 Access_{extension} + \beta_8 Sellingprice + \beta_9 Group_{memb} + \\ & \beta_{10} T_{prdn} + \beta_{11} info_{acess} + \beta_{12} Credit_{use} + \beta_{13} D_{market} + \beta_{13} contract + \\ & \epsilon_i \dots\dots\dots(21) \end{aligned}$$

Table 1: Description of Variables Used in The Double Hurdle Model

Description	Variable	Unit of measurement
	Dependent variable	
Household participates or otherwise	Market participation	1 = participates in market, 0 otherwise
	Independent variables	
CONTRACT	Signed marketing contract	Dummy (yes= 1 no= 0)
CRDT_USE	Credit use in farming	Dummy (yes= 1 no= 0)
LAND_SZ	land size	Number of Acres
C_LAND_SZ	Carrot land size	Number of Acres
TENURE	Tenure system	Dummy (1=private, 0= other types)
TRANS	Transport equipment	Dummy (own =1, do not own = 0)
GENDERHH	Gender of household head	Dummy (male= 1 female= 0)
YEARSHH	Age of household head	Number of Years
YEARSEDU	Education level of household head	Number of years
HHsize	Household size	Number of members
DISTMRK	Distance to the nearest output market	Km
DISTCLPT	Distance to the nearest carrot cleaning point	Km
EXT_ACCESS	Access to agricultural extension services	Number of times per year
SP	Selling price of carrot	KES
T_PRDN	Total production	Kgs
F_GROUP	Membership to a farmer association	Dummy (yes= 1 no= 0)
C_GROUP	Membership to a carrot farmer group	Dummy (yes= 1 no= 0)

3.6.4 Objective Four: To Identify the Factors that Influence the Selection of Marketing Outlets Among Carrot Farmers in Nakuru County

Objective four was investigated utilizing the Multinomial Logit Model to assess the impact of household characteristics, technical factors, socio-economic variables, external influences, and institutional factors (Table 2) on the selection of a marketing outlet. The multinomial logit model was utilized in this study to analyse the categorical outcome of market outlet choices made by smallholder carrot farmers. Since the decision to select a specific market outlet involves multiple options (such as selling at the farm gate, cleaning point, local market, external market, or export market), the MNL model is well-suited for analysing multinomial outcomes. By employing MNL, the study was able to estimate the probabilities of farmers choosing different market outlets based on various socio-economic and farm characteristics. This statistical approach enabled a comprehensive understanding of the factors influencing farmers' decisions regarding market participation and outlet selection, providing valuable insights for policy formulation and intervention strategies aimed at enhancing market access and livelihoods for smallholder farmers. In the model specification the probability of a carrot farmer choosing one market outlet over the other given other alternatives is:

$$\text{Prob}(Y_j = i) = P_{ij} = \frac{\exp(X_j\beta_j)}{\sum \exp(X_j\beta_k)} \dots\dots\dots (22)$$

where Y_j is the the probability with which a smallholder carrot farmer j chose market outlet i , that is $\text{Pr}(Y_j = i)$ and i represents the marketing channel choices.

P_{ij} takes values 1, 2, 3, 4 and 5 each representing choice of marketing outlet: Neighbour =0, Broker =1, cooperative =2, exporter =3, Local trader =4, 5,

X_i are factors affecting the choice of a marketing outlet, β were parameters to be estimated and e is random error term.

With j alternative choices, probability of choosing a marketing outlet j is given by,

$$\text{Prob}(Y_i = j) = \frac{e_{zj}}{\sum_{k=0}^j e_{zk}} \dots\dots\dots (23)$$

Z_j is market channel outlet chosen (Greene, 2002) and is given by,

$$Z_j = B_j X_i \dots\dots\dots (24)$$

Z_k is an alternative that could be chosen (Greene, 2002) given by

$$Z_k = \beta_k X_i \dots \dots \dots (25)$$

The model estimates are used to determine the probability of choice of a market outlet j given factors that affect the choice, X_i

With several alternative choices log odds ratio is computed as,

$$\ln\left(\frac{P_{ij}}{P_{ik}}\right) = \alpha + \sum X_i (B_j - B_k) + e \dots \dots \dots (26)$$

P_{ij} and P_{ik} are probabilities that a smallholder carrot farmer chose a given channel and alternative outlet, respectively.

$\ln\left(\frac{P_{ij}}{P_{ik}}\right)$ is a natural log of probability of choice j relative to probability for choice k , α is a constant, β is a matrix of parameters that reflect the impact of changes in X on probability of choosing a given channel. e is the error term that is independent and normally distributed with a mean zero $N(0, \sigma)$. Therefore, the marginal effects of the attributes on choice are determined by getting the differential of probability of a given choice:

$$Prob(Y_i = j) = \frac{e_{zj}}{\sum_{k=0}^j e_{zk}} \dots \dots \dots (27)$$

Marginal effects

$$(\delta) = \frac{\partial P_i}{\partial X_i} = pi(B_j - \sum_{k=0}^j P_k \beta_k) = P_i(\beta_j - \beta) \dots \dots \dots (28)$$

Every sub-vector of β enters every marginal effect both through probabilities and through weighted average. The econometric specification for the multinomial model is indicated below,

$$\begin{aligned} \text{Market outlet} = & \beta_0 + \beta_1 \text{Gender}_{producer} + \beta_2 \text{Age}_{producer} + \beta_3 \text{Education}_{producer} + \\ & \beta_4 \text{Household size} + \beta_5 \text{land size} + \beta_6 \text{Access}_{capital} + \beta_7 \text{Acess}_{information} + \\ & \beta_8 \text{Farmr group} + \beta_9 \text{means of transport} + \beta_{10} \text{extension} - \\ & \text{contact} + \beta_{11} \text{experience} + B_{12} \text{output price} + B_{13} \text{Distance}_{tarmac} + \\ & \varepsilon_i \dots \dots \dots (29) \end{aligned}$$

Table 2: Description of Variable used in Multinomial Logit Model

Dependent variable marketing outlet choices 1= Farm gate, 2 = Cleaning point, 3 = local Market, 4= External market, 5= Export Markets

Explanatory Variables

Code	Variable	Specification	Exp. Sign
GNDR	Gender	1 if male and 0 if female	+/-
AGE	Age	Age of household head in years	-
EDU-LVL	Education level	Number of years of formal education	+
HH_SIZE	Household size	Number of members of household	+
LAND_SZ	Total land size	Total land size available to household head	+
ACCESS-FIN	Access to financial capital	1 if household received loan and 0 otherwise	+
ACCESS-INFO	Access to information through use of cell phones	1 if household owns a cell phone and 0 otherwise	+/-
GROUP	Farmer Association	1 if household belongs to a farmer association and 0 otherwise	+/-
CEL_OPERATOR	Existence of cell phone operators in the village	1 if there is existence of cell phone operators and 0 otherwise	+/-
MEAN_TRNPT	Means of transport	1 if household owns a motor and 0 otherwise	+/-
NO_EXTENSION	Number of contacts with extension agents	Number of times in a year	+
HH_LOCATION	Location of household	1 if household is in rural area and 0 otherwise	+/-
EXP	Experience	Years	+
SP	Output price	Kenya Shillings	-
DIST_TARMAC	Distance from farm to nearest tarred road	Distance in km from farm to nearest tarmacked road	-

TC	Total transaction cost	Total transaction cost in KES	-
Interactive terms			
AGE_HH	Age of household head and phone access	Age of household head*Access to mobile phone	+
ACCESS_LOCATION	Access to cell phone and location of household head	Access to cell phone * Location of household head	+/-

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the findings of the study, organized into four main sections. The first section provides descriptive statistics of the sampled population. The second section presents the gross margins of the producers at different market outlets and the gross margins of various market actors along the carrot value chain. The third section analyses the factors influencing the choice of marketing outlet. Finally, the fourth section discusses the factors affecting market participation and the extent of market participation among carrot farmers in Nakuru County.

4.2 Descriptive Statistics

4.2.1 Socio-economic Characteristics of the Farmers

The results of the two-tailed t-test comparing the continuous socio-economic characteristics of carrot farmers are presented in Table 3 below. The variables examined include age, distance to the nearest local market, education years, experience, household size, farm size, land size under carrots, and distance to the cleaning point. Apart from distance to the nearest local market, education years, experience, land size under carrots, and distance to the cleaning point, non-market participants and participants exhibited largely homogenous characteristics in terms of age, household size, and farm size. Regarding education level, the mean education years for the sampled farmers was 9.39 years. Non-market participants had a mean education of 4.47 years, while market participants had a mean education of 10.59 years. The results also showed a statistically significant difference in mean education years between the two groups at the 5% level. This implies that farmers with higher levels of education are more likely to participate in marketing activities due to their ability to access, synthesize, and understand market information and dynamics. These findings are consistent with previous studies by Olwande *et al.* (2015) and Jerop *et al.* (2018), which suggest that educated producers are better equipped to engage in market-oriented production and capitalize on market opportunities.

Table 3: Summary of the Distribution of Means of Continuous Variables

Characteristic	Non-Participants (n=38)	Participants (n=157)	Overall mean	t-value
Age (Years)	42.97 (2.224)	45.57 (1.002)	45.06	0.766
Local market distance (Km)	12.59 (2.433)	8.80 (0.897)	9.54	5.126**
Years of Education	4.47 (0.339)	10.59 (0.238)	9.39	4.047**
Experience (Years)	4.71 (0.762)	10.67 (0.538)	9.18	2.761*
Household size	5.05 (0.399)	5.91 (0.190)	5.74	0.050
Farm size (Acres)	3.44 (0.578)	3.41 (0.502)	3.42	0.052
Land size (carrot)	0.30 (0.019)	2.08 (0.210)	1.73	15.996***
Cleaning point distance (Km)	19.68 (1.301)	13.81 (0.512)	14.95	5.934**

*, **, *** denote significance level at 10%, 5% and 1% level respectively

(Standard errors are in parentheses)

The findings regarding carrot farming experience indicate that the mean years of experience for the sampled farmers was 9.18 years. Non-market participants had a mean experience of 4.71 years, whereas market participants had a mean experience of 10.67 years. The results revealed a statistically significant difference in mean experience between the two groups at the 10% level. This suggests that farmers with more experience in carrot farming are more likely to participate in the market, as they can leverage their knowledge gained over time to analyse market dynamics and make informed decisions. These findings are consistent with previous studies (Akrong *et al.*, 2021; Mango *et al.*, 2018), which suggest that experienced farmers are better equipped to engage in market-oriented production. In terms of land size under carrots, the study found that the mean land size under carrots for the sampled farmers was 1.73 acres. Non-market participants had a mean land size of 0.30 acres, while market participants had a mean land size of 2.03 acres. The results indicated a statistically significant difference in land size under carrots between the two groups at the 1% level. This implies that farmers who allocate more land to carrots are more likely to participate in the market. These findings align with previous research by Olwande *et al.* (2015), which suggests that larger land size allocation leads to higher yields and a greater probability of market participation.

With regards physical aspects, distance to the cleaning point, the mean distance to the cleaning point for the sampled farmers' households was 14.95 kilometres. Non-market participants had a mean distance of 19.68 kilometres, while market participants had a mean

distance of 13.81 kilometres. The results showed a statistically significant difference in distance to the cleaning point between the two groups at the 5% level. This suggests that farmers are more likely to participate in the market when the distance to the cleaning point is shorter, as it reduces transaction costs and facilitates access to traders. These findings are supported by Achandi and Mujawamariya (2016), who found that higher transaction costs incurred due to greater distances negatively affect farmers' decisions to participate in the market. Moreover, the summary statistics of categorical variables including gender, credit access, access to extension services, membership to carrot groups, and membership to other groups are presented in Table 4. The results indicate that non-market participants and participants were only homogenous with respect to the gender of the household head. In terms of access to credit, 76.3% of non-market participants did not have access to credit, while 77.7% of market participants accessed credit. The results of the chi-square test showed a statistically significant difference between the two groups in terms of credit access at the 1% level. This suggests that access to credit enables carrot producers to invest in their farming ventures, leading to higher yields and increased participation in markets.

The mean distance to the nearest local market for the sampled farmers was 9.54 kilometres (Km), with non-market participants and market participants having mean distances of 12.59 Km and 8.80 Km, respectively. The results of the two-tailed t-test indicated that the distance to the nearest local market differed significantly between the two groups at the 5% level. This suggests that producers are more likely to participate in carrot marketing when the transportation cost per unit distance is lower. This finding aligns with previous research (Megerssa *et al.*, 2020; Que *et al.*, 2019), which suggests that shorter distances to markets increase the likelihood of producer participation in vegetable marketing.

Accordingly, the institutional aspects, the results on access to extension services, show that 65.8% of non-market participants did not have access to extension services, compared to 35.0% of market participants. The results (Table 4) also indicated a statistically significant difference between the two groups in terms of access to extension services at the 1% level. This highlights the importance of extension services in influencing farmers' decisions to participate in carrot marketing, as effective monitoring and teaching approaches by extension agents enhance market orientation. Membership to carrot groups was also found to influence market participation, with 81.6% of non-market participants not belonging to a carrot group, compared to 17.2% of market participants. The results of the chi-square test showed a statistically significant difference between the two groups in terms of membership

to carrot groups at the 1% level. This suggests that membership in carrot groups provides farmers with access to market information, better prices, and reduced transaction costs, thereby increasing their participation in markets.

Table 4: Summary Statistics of Categorical Characteristics

Characteristics	Category	Non-Participants Participants		Overall Chi square value	
		(n=38)	(n=157)		
Gender	Female	26.3%	22.9%	23.6%	0.1950
	Male	73.7%	77.1%	76.4%	
Credit access	No	76.3%	22.3%	32.8%	40.497***
	Yes	23.7%	77.7%	67.2%	
Extension access	No	65.8%	35.0%	41.0%	11.963***
	Yes	34.2%	65.0%	59.0%	
Member Carrot Group	No	81.6%	17.2%	29.7%	60.686***
	Yes	18.4%	82.8%	70.3%	
Group Membership	No	65.8%	19.7%	28.7%	31.686***
	Yes	34.2%	80.3%	71.3%	

*** denote significance level at 1% level

The results regarding membership to other groups indicate that 65.8% of non-market participants were non-members, while 34.2% were members of other groups. In contrast, 19.7% of market participants were non-members, while 80.3% were members of other groups. The chi-square test results showed a statistically significant difference between the two groups in terms of membership to other groups at the 1% level. This suggests that carrot producers benefit from the capacity and competence of other groups to build market-oriented networks, thereby improving their linkage to marketing outlets/channels. These findings are consistent with those of Sabo *et al.* (2017), who found that women in groups can utilize existing group infrastructure to enhance their participation in marketing.

4.2.2 Description of Market Channels and Primary Purchasers Patronized by Carrot Farmers

The results presented in Figure 4 reveal the main buyers of carrots produced in Nakuru County, as well as the primary market outlets used by carrot farmers. Most carrot farmers are selling their produce at the farm gate (29.94%), followed by the cleaning point

(25.48%), local market (21.02%), external market (15.92%), and export market (7.64%). This distribution of sales outlets reflects the diverse options available to carrot farmers in Nakuru County. On the other hand, aggregators emerge as the primary buyers of carrots, purchasing 33.76% directly from farmers, with additional purchases made at the cleaning point (13.38%), farm gate (12.1%), and local market (8.28%). Brokers are the second-largest buyers, acquiring 27.39% of the produce, with significant purchases at the farm gate (13.38%), cleaning point (8.28%), and local market (5.73%). Besides, wholesalers purchase 18.47% of the produce, with smaller proportions bought from the export market (7.64%), external market (7.01%), and cleaning point (3.82%). Retailers directly buy 15.92% of the carrot produce from farmers, with additional purchases made at the local market (7.01%) and export market (8.92%). Consumers directly purchase only 4.46% of the carrot produce, all of which are bought at the farm gate. Further analysis reveals that the distribution of sales outlets varies among carrot farmers. For those selling at the farm gate, the majority sell to brokers (44.68%) and aggregators (40.43%), with a smaller proportion selling to consumers (14.89%). At the cleaning point, most sales are to aggregators (52.5%), followed by brokers (32.5%) and wholesalers (15%). In the local market, sales are predominantly to aggregators (39.39%), retailers (33.33%), and brokers (27.27%). In contrast, farmers using the external market outlet primarily sell to wholesalers (44%) and retailers (56%). Finally, those utilizing the export market sell exclusively to wholesalers, who then access export markets themselves, enabling them to obtain higher premiums in a sustainable manner. These findings underscore the importance of understanding the dynamics of market outlets and buyer preferences in shaping farmers' marketing decisions and outcomes.

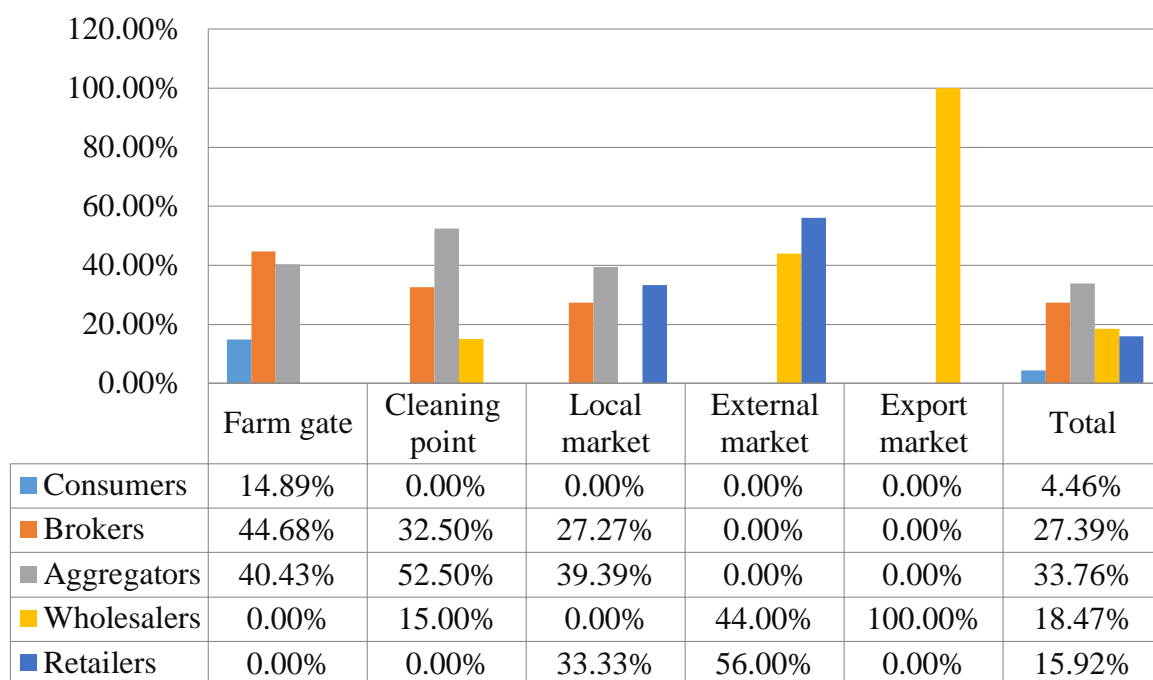


Figure 3: The market Outlet and Main Buyers of Carrot Produce by Smallholder Farmers

4.2.3 Description of Main Carrot Marketing Channels

Figure 3, illustrates the various marketing channels used by carrot value chain actors in Nakuru County. It reveals that most carrot producers rely heavily on traders to reach end users, highlighting the significant role intermediaries play in the marketing process. This finding aligns with previous studies that have observed a reliance on traders among potato and carrot producers (Maestre, 2017; Que *et al.*, 2019). Among the identified channels, Channel 1 emerges as the shortest, with less than 5% of producers utilizing it. This suggests that many producers opt for longer marketing channels that involve intermediaries. Understanding the prevalence and structure of these marketing channels is crucial for stakeholders in the carrot value chain, as it informs strategies for improving market access, reducing transaction costs, and enhancing efficiency. By identifying and analysing these marketing channels, stakeholders can develop targeted interventions to support producers in accessing more direct and efficient routes to market. This may involve initiatives such as strengthening producer organizations, improving infrastructure and logistics, and enhancing market information systems. Ultimately, enhancing the efficiency and effectiveness of marketing channels can contribute to increased incomes and livelihoods for carrot producers in Nakuru County.

The analysis of marketing channels in Nakuru County reveals a variety of pathways through which carrot producers distribute their produce to consumers. Among these channels, selling directly to consumers at the farm gate emerges as a common practice due to the proximity between producers and consumers. This direct approach allows producers to bypass intermediaries and capture more value from their sales. In Channel 2, producers sell directly to retailers, who then distribute the carrots to consumers. Channel 3 involves producers selling to aggregators, who then supply exporters. Channel 4 sees producers delivering to wholesalers, who then cater to exporters. Channel 5 and Channel 6 both involve producers selling to brokers, who then pass the produce on to retailers or aggregators, respectively. Furthermore, Channel 7, Channel 8, and Channel 9 all illustrate variations of producer-to-wholesaler-to-retailer-to-consumer pathways. Channel 10 depicts brokers purchasing from producers and selling to aggregators, who then distribute to retailers. Channels 11, 12, and 13 showcase different combinations of producers, brokers, aggregators, wholesalers, and retailers in the distribution process. Finally, Channel 14 emerges as the longest pathway, involving multiple intermediary steps from producers to consumers. In this channel, brokers, aggregators, wholesalers, and retailers all play distinct roles in the distribution chain. Overall, Channels 12 and 14 are the most prevalent in Nakuru County, with aggregators serving as key intermediaries in the distribution process. These findings underscore the importance of understanding and optimizing marketing channels to enhance efficiency and value capture for carrot producers. By streamlining distribution pathways and minimizing reliance on intermediaries, producers can potentially increase their profitability and market access.

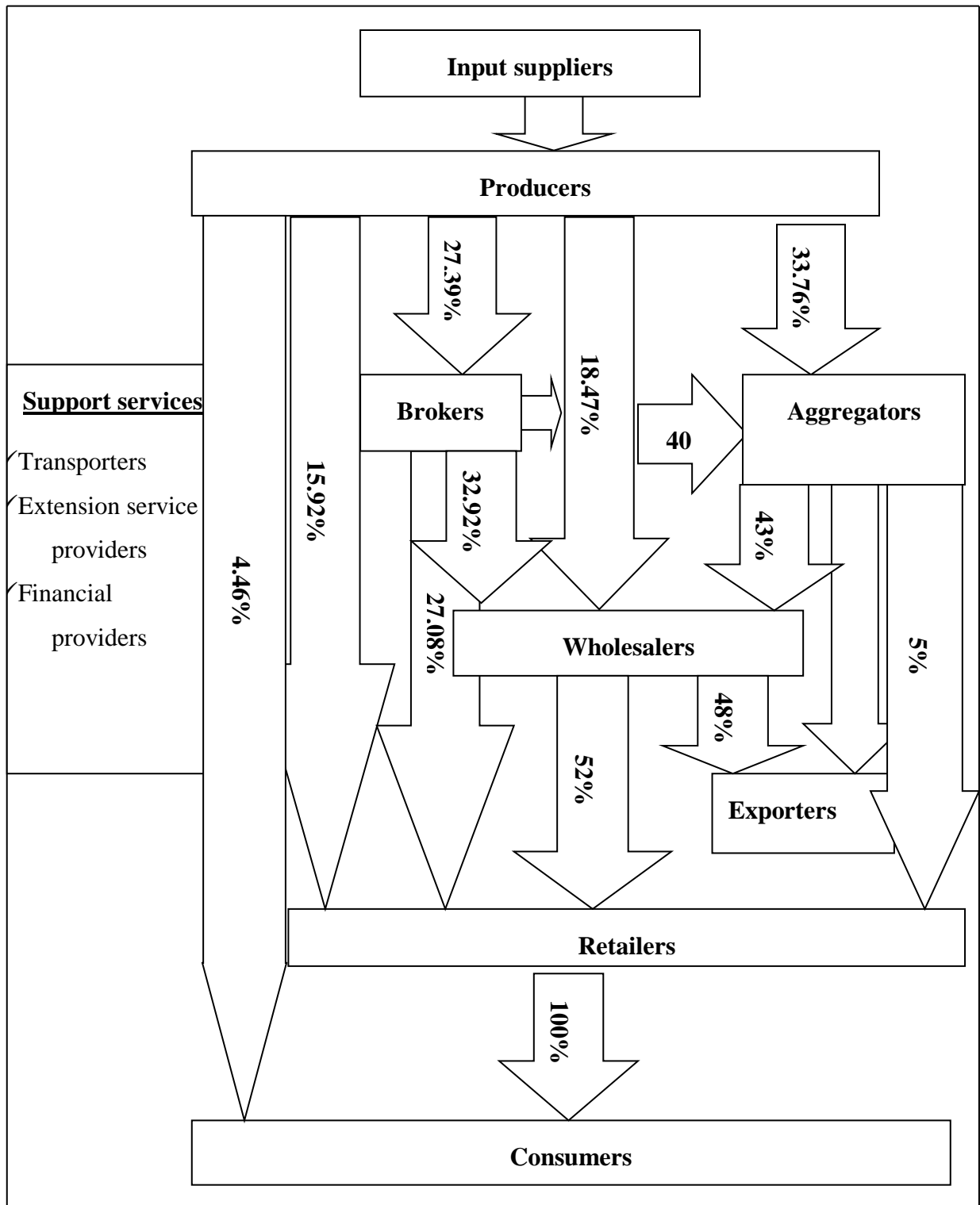


Figure 4: Carrot Value Chain Map

4.3 Gross Margin Analysis of Carrot Market Actors

The analysis of gross margins for carrot farmers and other market actors provides valuable insights into the profitability and dynamics of the carrot value chain in Nakuru

County. Table 5 illustrates the gross margins for carrot farmers selling their produce at various market outlets. The results show positive average gross margins across all outlets, indicating that carrot farming can be profitable in the region. Notably, the export market offers the highest average gross margin per acre, followed by the external market, local market, cleaning point, and farm gate. This suggests that farmers can achieve higher returns by targeting higher-value markets such as export and external markets. Furthermore, the gross margin ratios indicate the proportion of sales revenue retained by farmers after accounting for production and marketing costs. The ratios vary across different market outlets, with the export market having the lowest ratio. This implies that although farmers may earn higher revenue from the export market, a significant portion is absorbed by production and marketing expenses.

Additionally, the results highlight the role of brokers and aggregators as dominant buyers at the farm gate and cleaning point, respectively. Farmers may benefit from engaging with formal traders, as evidenced by higher returns compared to selling directly to consumers or other intermediaries. Table 6 below presents the gross margins for brokers, aggregators, wholesalers, exporters, and retailers in the carrot value chain. These market actors achieve substantial profits per bag of carrots sold, indicating potential market power and pricing influence. However, the margins obtained by traders are significantly higher than those received by farmers for the same product, suggesting disparities in value distribution along the supply chain. Overall, the findings underscore the importance of understanding market dynamics and exploring strategies to enhance farmers' profitability and market access. Addressing issues such as market concentration, price manipulation, and value chain inefficiencies could contribute to a more equitable and sustainable carrot industry in Nakuru County.

The findings regarding the gross margins and operating costs of market actors in the carrot value chain provide valuable insights into the distribution of profits and cost structures within the market. The results suggest that while brokers, aggregators, wholesalers, exporters, and retailers can earn significant returns from selling carrots, they also incur substantial operating costs.

Table 5: Carrot Producers' Gross Margin Analysis

Carrot producers' gross margin analysis per acre in (KES.)					
Market outlet	Farm gate	Cleaning	Local	External	Export
Revenue (per acre)	95 Bags @ 800	95 Bags @	95 Bags	95 Bags @	95 Bags
Carrot sales	76,000	123,500	142,500	171,000	237,500
Total revenue	76,000	123,500	142,500	171,000	237,500
Variable costs per acre in (KES.)					
Inputs					
Pre-planting herbicides	590	590	590	590	590
Seeds	4,880	4,880	4,880	4,880	4,880
Post planting herbicides	1,520	1,520	1,520	1,520	1,520
Pesticides cost	2,120	2,120	2,120	2,120	2,120
Labour					
Pre-planting herbicides labour	420	420	420	420	420
Ploughing	2,450	2,450	2,450	2,450	2,450
Planting labour	540	540	540	540	540
Post-planting herbicides labour	450	450	450	450	450
Pesticide application labour	480	480	480	480	480
Weeding labour	3,500	3,500	3,500	3,500	3,500
Harvesting labour	14,250	14,250	14,250	14,250	14,250
Transport to cleaning point		5,700	5,700	5,700	5,700
Loading and offloading cost	-	4,750	4,750	3,800	3,800
Cleaning cost	-	14,250	14,250	14,250	14,250
Packaging bag cost	-	-	2,850	2,850	2,850
Transport to local Market	-	-	4,750	-	-
Loading and offloading cost	-	-	3,800	-	-
Transport to export Market	-	-	-	-	57,000
Loading and offloading cost	-	-	-	-	9,500
Total Variable costs	31,200	55,900	67,300	57,800	124,300
Gross Margin per Acre	44,800	67,600	75,200	113,200	113,200
Gross Margin per bag	471.58	711.58	791.58	1191.58	1191.58
Gross Margin ratio	0.59	0.55	0.53	0.66	0.48

These costs, which include various marketing expenses such as cleaning, sorting, grading, packaging, transportation, and levies, contribute to the overall expenses borne by traders in the value chain. It is noteworthy that exporters and retailers earn the largest returns compared to other traders, indicating that they capture a significant share of the value generated in the market. However, their high operating costs, ranging from 76% to 84% of total revenue, underscore the challenges and complexities associated with operating in the

carrot value chain. Comparatively, carrot producers selling at the farm gate have lower operating costs, representing only 41% of total revenue. This suggests that while farmers may receive a smaller share of the final selling price, they bear relatively lower marketing expenses compared to downstream traders. The findings align with previous research by Mwangi and Crewett (2019), which highlighted the challenges faced by producers in bargaining for fair prices and avoiding exploitation during transactions. The disparity in operating costs between producers and traders underscores the need for interventions to empower farmers and improve their bargaining power within the value chain. Therefore, the results emphasize the importance of addressing cost inefficiencies and ensuring equitable value distribution across all stakeholders in the carrot value chain. Strategies aimed at reducing transaction costs, improving market access, and enhancing farmers' capacity could contribute to a more inclusive and sustainable market environment for all participants.

4.4 Factors Influencing the Decision to Participate in the Carrot Market and the Extent of Market Participation

The double hurdle model was employed to assess factors influencing both market participation and the extent of participation. Results from Tables 7 and 8 reveal significant determinants affecting these aspects. Regarding market participation, findings indicate that education level and carrot land size were statistically significant factors. A positive and statistically significant coefficient for the education level of the household head at 5% suggests that higher education levels increase the likelihood of carrot farmers participating in markets. This aligns with studies by Mbitsemunda and Karangwa (2017), which highlighted how education enhances human capital and managerial skills, reducing transaction costs and promoting commercialization. Similarly, Akrong *et al.* (2021) and, Mango *et al.* (2018) found that higher education levels correlate with increased market participation among households. This underscores the role of education in

Table 6: Gross Margin Analysis Carrot Value Chain Actors

Market actors' carrot gross margin analysis (95 bags per acre)										
Market actors	Broker (Middlemen)		Aggregators		Wholesalers		Exporters		Retailers	
Item	Unit	Cost Amounts	Unit	Amountn	Unit	Amounts	Unit	Amounts	Unit	Amounts
Tota Revenue per Acre (95 bags)										
Carrot Sales	1,300	123,500	1,800	171,000	2,600	247,000	3,150	299,250	3,200	304,000
Total Revenue		123,500		171,000		247,000		299,250		304,000
Variable costs per acre (95 bags)										
Purchases	800	76,000	1,300	123,500	1,800	171,000	1,800	171,000	2,600	247,000
Transport to cleaning point	40	3,800	-	-	-	-	-	-	-	-
Loading and offloading cost	40	3,800	-	-	-	-	-	-	-	-
Cleaning cost	150	14,250	-	-	-	-	-	-	-	-
Packaging	30	2,850	-	-	-	-	-	-	-	-
Charges/levies	30	2,850	60	5,700	80	7,600	100	9,500	100	9,500
Transport to external Market	-	-	-	-	220	20,900	-	-	-	-
Loading and offloading cost (External	-	-	-	-	80	7,600	-	-	-	-
Transport to export Market	-	-	-	-	-	-	500	47,500	-	-
Loading and offloading cost (Export	-	-	-	-	-	-	100	9,500	-	-
Total Variable Costs	-	103,550	-	129,200	-	207,100	-	237,500	-	256,500
Gross margin	-	19,950	-	41,800	-	39,900	-	61,750	-	47,500
Gross margin per bag	-	210	-	440	-	420	-	650	-	500
Operating ratio	-	0.84	-	0.76	-	0.84	-	0.79	-	0.84

facilitating farmers' decision-making abilities and incentivizing engagement in market activities.

Moreover, the factors influencing the extent of market participation include the education level of the household head, household size, land size, experience of the household head in years, and land size under carrots. These variables collectively shape the depth of farmers' involvement in market activities. Notably, the positive and statistically significant coefficient for the education level of the household head suggests that education is critical in enhancing the commercialization of farm produce. This finding is consistent with studies emphasizing the importance of education in empowering farmers to participate in collective action, contract farming, and certification (Mbitsemunda & Karangwa, 2017; Nwafor *et al.*, 2020; Olwande *et al.*, 2015; Que *et al.*, 2019). In summary, these findings underscore the pivotal role of education and land size in driving both market participation and the extent of participation among carrot farmers. Policymakers and stakeholders should prioritize interventions aimed at improving access to education and enhancing agricultural productivity to foster greater market engagement among smallholder farmers.

The positive and significant influence of household land size dedicated to carrot production on market participation underscores the pivotal role of agricultural output in driving farmers' involvement in marketing activities. An expansion in the area allocated to carrot cultivation serves as a proxy for increased carrot production, which in turn facilitates surplus generation for marketing. This finding resonates with the conclusions drawn by Ahmed *et al.* (2016) in their analysis of the potato sector, where heightened potato production significantly influenced market participation among smallholder potato farmers in Ethiopia. As potato production increased, so did the surplus, compelling farmers to actively engage in marketing their produce.

Besides, the study's findings align with those of Olwande *et al.* (2015), who investigated market participation among smallholder farmers across various commodity groups, including maize, vegetables, fruits, and dairy. They observed that impoverished smallholder farmers with limited production capacities were less inclined to participate in markets compared to their more affluent counterparts. This reluctance stemmed from a multitude of factors, including restricted access to high-quality seeds and fertilizers, low levels of education, limited land holdings, minimal assets, and constrained access to credit. These socioeconomic constraints impede the ability of poor farmers to engage effectively in market activities, perpetuating a cycle of limited market participation and economic vulnerability.

Table 7: Factors Influencing Market Participation by the Carrot Farmers

Variable	Coefficients	Standard errors
Gender	1.1566	1.1785
Age	0.0245	0.0361
Education level	0.8834**	0.4298
Household size	-0.0004	0.2125
Market distance	-0.0849	0.0748
Experience	0.1875	0.1288
Carrot land size	9.4170*	5.4120
Carrot Group membership	0.6830	1.1296
Cleaning point Distance	-0.0745	0.0985
Constant	-11.9304*	6.1705

*, ** denote significance level at 10%, and 5% level respectively

Thus, the findings underscore the critical importance of agricultural productivity, particularly land size devoted to crop cultivation, in influencing farmers' participation in agricultural markets. Addressing barriers to production, such as improving access to inputs, enhancing educational opportunities, and facilitating credit access, is essential for empowering smallholder farmers to increase their production capacities and actively participate in markets, thereby enhancing their livelihoods and contributing to overall economic development.

The results from Table 8 highlight the significance of the age of the household head in influencing the intensity of market participation, revealing a negative effect on the volume of carrots marketed by the household across various marketing channels. This suggests that as the age of the household head increases by 1 year, there is a corresponding decrease in the quantity of carrots marketed. This trend can be attributed to older individuals being less inclined to actively participate in the carrot market compared to their younger counterparts. This finding resonates with the observations of Mbitsemunda and Karangwa (2017), who noted that younger farmers are more inclined to take risks, possess the energy to transport produce to markets, and are more receptive to adopting new ideas and technologies, leading to higher levels of market participation compared to older farmers. Similarly, the findings align with studies by Akrong *et al.* (2021) and Abate *et al.* (2019), which found that younger farmers exhibit greater intensity of market participation compared to older farmers.

Conversely, the results regarding household size demonstrate a positive and significant influence on the volume of carrots marketed by the household. This suggests that an increase in household size by 1 productive member corresponds to an increase in the probability of the household intensifying the marketing of its produce. However, these results contradict the findings of Achandi and Mujawamariya (2016), who observed in Tanzania that an increase in household size leads to greater market participation with higher levels of produce. Furthermore, the double hurdle model results reveal that the land size owned by carrot farmers significantly influences market participation, albeit with a negative effect at a significance level of 1%. This unexpected negative relationship between the volume of carrots marketed and farm size suggests that enhanced market participation may be linked to land production efficiency. Similar findings were reported by Mbitsemunda and Karangwa (2017) among smallholder bean farmers in Rwanda's Nyanza district, where a negative correlation between land size and market participation was observed. However, Belete and Yilma (2020) found a positive relationship between land size and market participation, indicating that an increase in farm size corresponds to a higher intensity of market participation.

The variable representing the farming experience of carrot producers proves significant at a 5% level, exhibiting positive effects on the level of market participation. This significance suggests a direct correlation between farming experience, the expansion of marketing networks, and enhanced bargaining skills or power. The result indicates that for every additional year of farming experience, there is an increase in the volume of carrots marketed. This finding is consistent with the observations of Hung and Khai (2020), who noted that households led by individuals with extensive experience in chili farming are more likely to engage with other farmers and traders, thereby identifying trading opportunities and reducing the associated costs, consequently leading to increased market participation. It implies that farmers with more years of experience in agriculture are better equipped to sell larger quantities of produce in the market.

Moreover, this study's findings align with those of Hagos *et al.* (2020) and Chikuni *et al.* (2018), highlighting the challenges within agricultural markets such as information asymmetry, high transaction costs, and limited access to credit, which ultimately hinder the volume of marketed produce. Consequently, efforts to address these challenges, particularly through enhanced farming experience, can lead to improved market participation, particularly among smallholder farmers. Furthermore, the significant positive effect of land size under carrot cultivation at a 1% significance level indicates that an increase in carrot land size by

one acre corresponds to an increase in the volume of carrots marketed at the household level. This relationship can be attributed to the direct impact of increased land size on carrot production quantity, thereby resulting in a higher volume supplied to the market by smallholder farmers. This finding is supported by Muthini *et al.* (2017), who observed that an expansion in land allocated to mango trees led to an increase in the quantity of mangoes sold in the market. Similarly, Onyango (2016) found that an increase in acreage devoted to cut flowers improved the performance of cut flower exporting firms in Kenya. Identifying key factors influencing market participation and its intensity underscores the importance of access to pertinent market-related information, which accelerates the commercialization of smallholder agriculture. Additionally, it facilitates the selection of efficient and effective market outlets, ultimately enhancing the profitability of smallholder carrot farmers, thereby contributing to increased household incomes and food security.

Table 8: Factors Influencing the Extent of Market Participation by Carrot Farmers

Variable	Coefficients	Standard errors
Gender	-0.0543	0.0982
Age	-0.0089***	0.0034
Education level	0.0073	0.0127
Household size	0.0297*	0.0166
Market distance	-0.0019	0.0033
Land size owned	-0.0424***	0.0123
Experience	0.0123*	0.0069
Carrot land size	0.3904***	0.0309
Carrot group membership	0.0857	0.0976
Credit access	0.0668	0.1071
Cleaning point Distance	0.0024	0.0063
Constant	9.0102***	0.2669

*, *** denote significance level at 10% and 1% level respectively

4.5 Factors Influencing the Choice of Marketing Outlet among Carrot Farmers

The Multinomial Logit model was utilized in this study to assess the determinants shaping the selection of marketing outlets among carrot farmers in Nakuru County. The model selection was predicated on the premise that data pertaining to the choice of market

outlets for carrot production are case-specific, with each independent variable possessing a singular value for each case. Additionally, the MNL model assumes that the dependent variable (chosen market outlet) cannot be perfectly forecasted from the independent variables for any given case. The estimation process encompassed a range of independent variables, including gender, age, education level, distance to the market, land size, years of experience, land allocated to carrots, household size, access to credit, membership in carrot groups, and distance to the carrot cleaning point. Analysis of the MNL results, as presented in Table 9, yielded a Chi-square value of 299.28 and a statistically significant likelihood ratio of -90.00 ($P < 0.000$), indicative of the model's robust explanatory capacity. The pseudo-R square stood at 0.6244, implying that the explanatory variables accounted for approximately 62.44% of the variability in the choice of market outlets. Given that the coefficients merely denote the direction of the effect, marginal effects were calculated to ascertain the actual magnitude of the change in probabilities.

The study revealed that the gender of the household head exerted a significant influence on the choice of market outlets, particularly the cleaning point and local market. Specifically, households headed by males exhibited a lower propensity to sell carrots at the cleaning point by 6.75%, whereas they demonstrated a higher likelihood of selling carrots at the local market by 12.92%. This pattern may stem from the tendency of men to embrace risk-taking behaviour, prompting them to seek markets actively rather than settling for selling at the cleaning point after harvest, which is perceived as less competitive. Conversely, female-headed households may opt to sell carrots closer to their homes to accommodate other household responsibilities, thereby prioritizing convenience over market competitiveness. These findings align with previous research by Olwande *et al.* (2015), which noted that female farmers often face time constraints that limit their ability to access distant markets, leading them to settle for local options. Similarly, Ochieng *et al.* (2018) found that male-headed households were less inclined to sell produce at the farm gate, preferring instead to utilize local markets for their sales.

The findings regarding the age of the household head suggest that age exerted a positive and significant influence on the choice of market outlets, particularly the farm gate and local market. Older farmers demonstrated a higher likelihood of selling their produce at the farm gate and local market, with an increase of about 1% in both outlets. This trend may be attributed to the risk-averse nature of older farmers, who may prefer the familiarity and stability offered by traditional markets over the uncertainties associated with seeking out external markets. This aligns with previous research by Tarekegn *et al.* (2017) and Dlamini-

Mazibuko *et al.* (2019), which found that an increase in the age of the household head corresponded to a higher likelihood of selling produce in traditional markets. Conversely, Kilambya and Witwer (2019) observed a significant negative relationship between the age of the household head and the market choice of sorghum in Kenya, indicating a complex interplay of factors across different agricultural contexts.

Furthermore, the study revealed that the distance to the market from the household significantly influenced the choice of market outlets, including the farm gate, local market, and external market. An increase in the distance to the market by 1 kilometre was associated with a 2% increase in the likelihood of selling carrot produce at the farm gate, a 2.67% reduction in the likelihood of selling at the local market, and a 1% increase in the likelihood of selling in the external market. This underscores the impact of geographical proximity on market choice decisions, wherein farmers may opt for closer markets to minimize transportation costs and logistical challenges. These findings resonate with the research by Mwangi and Crewett (2019), who observed that an increase in the distance to urban markets reduced the likelihood of selling to aggregators and retailers while increasing the probability of selling to wholesalers.

The analysis of land size owned by households revealed a significant influence on the choice of market outlets, particularly cleaning points and external market outlets. An increase in household land size by 1 acre corresponded to a 2.46% increase in the likelihood of selling produce at cleaning points and a 1.88% increase in the likelihood of selling at external market outlets. Moreover, this increase in land size was associated with a reduced likelihood of engaging in subsistence farming, indicating a shift towards market-oriented farming practices. This finding aligns with previous research by Dijkstra (2018), Mango *et al.* (2018), Mmbando *et al.* (2017), and Olwande *et al.* (2015), which underscored the importance of land size in shaping farmers' market behaviour. Regarding the farming experience of the household head, the results demonstrated a positive and significant influence on the choice of market outlets, including the farm gate, local market, external market, and export market outlets. Farmers with higher levels of carrot farming experience exhibited a lower likelihood of selling at the farm gate by 1.18% and in the local market by 2.37%. However, they had a higher probability of selling their produce in the external market by 1.93% and approximately 1% probability of selling at export market outlets. This finding is consistent with the research by Nwafor *et al.* (2020), which highlighted the positive impact of farming experience on accessing formal market outlets. Experienced farmers are likely to have established networks

and acquired the necessary knowledge and skills to meet stringent safety and quality requirements, thereby facilitating their entry into higher-value market segments.

The analysis of land size devoted to carrot cultivation revealed notable effects on the choice of market outlets. The Multinomial Logit model results indicated a negative significant influence on the choice of cleaning points and a positive significant influence on export market outlets. Specifically, an increase in the size of land under carrots by 1 acre was associated with a 4.34% decrease in the probability of selling produce at cleaning points and a 2.27% increase in the probability of selling at export market outlets. Additionally, the study examined the effects of household size on the choice of carrot market outlets, revealing a significant and positive influence on external market outlets. An increase in household size by 1 productive member corresponded to a 2.34% increase in the probability of selling carrot produce at external market outlets. This finding contrasts with the conclusion of Mohammed *et al.* (2019), who reported that household size negatively affects the choice of market outlet for tomato producers, likely due to greater land demand for food crops like cereals. Finally, the results regarding the distance to the cleaning point showed a significant and positive influence on the choice of all five carrot market outlets (farm gate, local market, cleaning point, external market, and export market) in Nakuru County. An increase in the distance to the carrot cleaning point by 1 kilometre was associated with a 1.59% increase in the probability of selling produce at the farm gate, a 2.43% increase at the local market, a 5.74% increase at cleaning points, a 1.12% increase at external market outlets, and approximately 1% increase at export market outlets. These findings suggest that proximity to cleaning points influences farmers' decisions on market outlets, with greater distances leading to varied preferences among the available options.

Table 9: Multinomial Logit Model Estimates of Factors Influencing the Choice of Marketing Outlet among Carrot Farmers

Variable	Farm Gate	Local Market	Cleaning Point	External Market	Export Market
Gender	-0.0221 (0.0652)	0.1292 (0.0683) *	-0.0675 (0.0387) *	0.0313 (0.0521)	-0.0709 (0.0440)
Age	0.0066 (0.0023) ***	0.0065 (0.0025) ***	-0.0020 (0.0019)	-0.0054 (0.0033)	-0.0057 (0.0036)
Education level	-0.0013 (0.0096)	0.0087 (0.0091)	-0.0055 (0.0066)	-0.0071 (0.0094)	0.0052 (0.0059)
Market distance	0.0189 (0.0027) ***	-0.0261 (0.0048) ***	0.0007 (0.0018)	0.0078 (0.0025) ***	-0.0013 (0.0026)
Land size owned	-0.0344 (0.0244)	-0.0023 (0.0223)	0.0246 (0.0098) **	0.0188 (0.0109) *	-0.0068 (0.0095)
Experience	-0.0118 (0.0070) *	-0.0237 (0.0066) ***	0.0064 (0.0040)	0.0193 (0.0038) ***	0.0097 (0.0037) ***
Carrot land size	0.0047 (0.0248)	0.0085 (0.0257)	-0.0434 (0.0155) ***	0.0074 (0.0145)	0.0227 (0.0094) **
Household size	0.0014 (0.0126)	-0.0190 (0.0123)	0.0069 (0.0073)	0.0236 (0.0120) **	-0.0130 (0.0138)
Credit access	0.0672 (9.9907)	-0.1161 (11.9313)	-0.0983 (7.1147)	-0.3839 (42.5183)	0.5311 (71.5543)
Group membership	-0.2287 (28.9551)	-0.2210 (27.4112)	-0.3381 (11.0788)	1.0951 (96.7134)	-0.3073 (29.2691)
Distance	0.0159 (0.0041) ***	0.0243 (0.0038) ***	-0.0574 (0.0053) ***	0.0112 (0.0037) **	0.0060 (0.0032) *

Regression diagnostics for MNL model

Number of observations	157
LR chi-square (44)	299.28
Prob > chi2	0.0000***
Log likelihood	-90.0018
Pseudo R Squared	0.6244

*, **, *** denote significance level at 10%, 5% and 1% level respectively

(Standard errors in parentheses)

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Kenya, grappling with poverty and food insecurity, especially among rural smallholder farmers, faces significant challenges in its agricultural sector. Carrot farmers, in particular, encounter obstacles in resource allocation and market engagement, hampering their productivity. Despite a demand for carrots, the current supply falls short, highlighting an opportunity for enhanced market participation among farmers. This study sheds light on crucial insights into carrot market dynamics, delineating key outlets, margins, and factors shaping farmers' decisions. The participation of over two-thirds of carrot-producing households in markets underscores the pivotal role of market-oriented production in bolstering household welfare and agricultural development. Household socio-economic, institutional, and farm-specific characteristics emerge as pivotal factors shaping farmers' decisions to engage in carrot marketing. These factors encompass the gender of the household head, age, proximity to markets, land size, farming experience, household size, and distance to cleaning points.

The analysis of gross margins unveils positive average returns for carrot producers across various market outlets, underscoring the potential benefits of vertical integration within carrot value chains. This integration not only enables farmers to capture greater value from their produce but also enhances market access and resilience to market fluctuations. Socio-economic variables such as the age of the household head, household size, farming experience, and land size under carrot cultivation significantly influence the extent of market participation. Moreover, these socio-economic factors exert a pronounced influence on the selection of market outlets, reflecting nuanced preferences and strategic decisions among farmers.

Harnessing these insights, policymakers and stakeholders can devise targeted interventions to bolster market-oriented carrot production, thereby fostering agricultural growth, improving food security, and advancing rural livelihoods. In conclusion, addressing the challenges faced by smallholder carrot farmers in market participation is crucial for enhancing agricultural productivity, food security, and poverty alleviation in Kenya. These efforts align with Kenya's development goals and contribute to the realization of the Sustainable Development Goals, particularly those related to poverty reduction and food security. Moving forward, sustained collaboration among policymakers, agricultural

extension services, farmer groups, and other stakeholders will be essential to ensure the effective implementation of these recommendations and the long-term success of smallholder carrot farming in Kenya.

5.2 Recommendations

Before detailing practical recommendations, it is essential to underscore the significance of addressing these challenges comprehensively. By prioritizing targeted interventions based on the study's findings, policymakers and stakeholders can effectively enhance market participation among smallholder carrot farmers. Implementing these recommendations will not only optimize carrots productivity but also contribute to broader socio-economic development goals. Therefore, based on the findings of this study, the following recommendation are suggested;

- i. Tailored Training Initiatives These initiatives should prioritize enhancing farmers' understanding of market dynamics, including pricing mechanisms and negotiation skills, enabling them to make informed decisions about participating in carrot marketing.
- ii. Improving access to relevant market information empowers farmers to strategically plan their marketing activities, ultimately boosting market participation and economic outcomes.
- iii. Effective training programs and workshops should be provided to equip carrot producers with skills in vertical integration strategies, such as processing and direct marketing, aimed at maximizing profits.
- iv. Facilitating the formation of carrot producer cooperatives fosters collective action among farmers, enabling them to pool resources, share knowledge, and invest collectively in value-added activities like processing facilities. By working together, farmers can leverage economies of scale, negotiate better prices, and strengthen their market position, enhancing profitability and resilience.
- v. Encouraging land consolidation initiatives among smallholder farmers promotes increased production scale and market participation. Facilitating land-sharing agreements or cooperative farming arrangements optimizes land use efficiency and resource utilization, ultimately enhancing market engagement.
- vi. Implementing tailored programs addressing specific socio-economic factors can help farmers overcome barriers to market participation and improve overall productivity. These programs should be designed to address the unique needs of different demographic groups,

such as women and young farmers, to enhance their access to market outlets and improve market engagement.

vii. Prioritizing infrastructure investment, particularly in transportation networks and cleaning points, in areas with limited market access, can reduce logistical barriers for farmers and lower transaction costs. This enables easier access to a wider range of market outlets, increasing market participation.

5.3 Recommendation for future studies

Based on the study findings coupled with observation during the entire study period, future research should explore strategies for enhancing market access and mapping the carrot value chain in Nakuru County, Kenya. Strengthening institutional support, facilitating information dissemination, encouraging youth involvement, promoting market-oriented production, and addressing infrastructural gaps are vital recommendations based on the Kenyan context. Additionally, assessing the impact of market outlet choices on household welfare, particularly through a gender lens, is crucial for future studies to inform targeted interventions effectively.

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APPENDICES

Appendix A: Producers/Farmers Questionnaire

Questionnaire Code _____

Name of Enumerator _____

Date of Interview _____

Division _____

Location _____

Sub-location _____

SECTION A: SOCIO-DEMOGRAPHIC

1. Respondent's name _____

2. Fill the respondents' relevant information where applicable in the table below.

Gender (Tick)		Age (Years)	Marital Status (Tick)				Household size
Male	Female		Single	Married	Separated	Divorced	

3. What is the highest level of education of the respondent? Fill in the number of years in each

	None	Primary	Secondary	College/Tertiary	University
Level (Tick)					
No. of years attended					

4. Are you the head of the household?

1=Yes 0 = No

5. If no please provide the information below regarding the household head

a) Name of Household Head _____

b) Fill the demographic characteristics of the household head in the tables below

Gender (Tick)		Age (Years)	Marital Status (Tick)				Household size
Male	Female		Single	Married	Separated	Divorced	

--	--	--	--	--	--	--	--

Education level (years)				
None	Primary	Secondary	College/Tertiary	University

6. When did you start carrot production? *Please state the year you began.*

7. Please, fill the following table with the information regarding the household members.

No.	Name of household member	Relation to HH head. <i>0=Head 1= Spouse 3=Brother/Sister 4= Child 5= other</i>	Sex 1=M 2=F	Year of birth	Educational level <i>0=None 1=primary, 2=secondary 3=college/tertiary 4=university</i>	Experience in carrot production (Years)
1						
2						
3						
4						
5						
6						
7						
8						

SECTION B: INCOME SOURCES

8. Please list the top three sources of income for the household.

Income sources:	Tick	Rank
1= Production/sale of crops	<input type="checkbox"/>	<input type="checkbox"/>
2= Production/sale of livestock & livestock products	<input type="checkbox"/>	<input type="checkbox"/>
3= Agricultural output trading,	<input type="checkbox"/>	<input type="checkbox"/>
4= Agricultural input trading	<input type="checkbox"/>	<input type="checkbox"/>
5= Salaried employment	<input type="checkbox"/>	<input type="checkbox"/>
6= Casual labourer	<input type="checkbox"/>	<input type="checkbox"/>
7= Pension	<input type="checkbox"/>	<input type="checkbox"/>
8= Remittances (income from relatives/friends etc)	<input type="checkbox"/>	<input type="checkbox"/>
9 Others (specify).....	<input type="checkbox"/>	<input type="checkbox"/>

SECTION C: CARROT PRODUCTION

9. How much total land do you have? Please state in acres. _____

10. Indicate the land tenure system on the land in use? _____

1 = Communal 2 = Rented/lease 3 = Privately owned

11. If you do not own land, are you satisfied with the arrangement on the land that you are using? Explain

12. How much of this land was under carrot last season? _____

13. Did you use any inputs (fertilizers, manure, pesticides) in carrot production last season?__

1 = Yes 0 = No

	Input used	Quantity used	Place you get it	Distance (Km)	Cost (KES)	Reason for getting there
1						
2						
3						
4						

5						
6						
7						
8						

14. If yes which ones, did you use and how much? KES _____

SECTION D: CARROT MARKET PARTICIPATION

15. Do you participate in Carrot marketing?

1=Yes 0 = No

16. What is the main reason for selling carrots?

- 1= I need cash for home consumption*
- 2= I need money for input purchases*
- 3= I need money to pay school fees*
- 4= I want to repay loan*
- 5= Other (Specify) _____*

17. Do you perform price surveys, before selling? _____

1=Yes 0 = No

18. How do you rate the availability of labour used in carrot production? _____

0=unavailable 1=easily available 2=Available

19. How did you sell your carrots _____

1= individually 2= through a group

20. Where was your point of sale (outlet)?

- 1= Sold at home (Farm gate) 2= Cleaning point 3=Local market (nearest market/town within the County)*
- 4= External market (main markets/towns outside Nakuru County)*
- 5=Export market (Markets outside Kenya)*
- 6= Other (Specify) _____*

21. How is a price set during the sales? _____

1= we negotiate 2= It is market driven 3= It is set by buyers
4= Other (Specify) _____

22. State the buyer you use to sell your carrots, level of satisfaction and the most rewarding carrot channel in your area in the table below.

Outlet	Tick	Distance (KM)	Level of Satisfaction			Most Rewarding Channel
			Satisfied	Less satisfied	Not satisfied	
						Tick
Consumers						
Middlemen/Broker						
Aggregators						
Wholesalers						
Retailers						
Processor						
Other (specify).....						

23. In terms of the outlet, you use regularly, what are the main benefits? _____

1= high prices 2= understand the contract 3= nearer

4= provide inputs 5= come for produce in the farm

6= Other Specify.....

24. What was the payment duration from your preferred buyer?

1= cash on the spot 2= 2- 7 days 3= 8- 14 days

4= 14-30 days 5= After 30 days

25. Do you have any contractual agreements or a guaranteed/ready market (formal or informal) with any agribusiness outlet e.g. Hotels, Supermarkets etc? _____

1=Yes 0 = No

26. Do you have regular customers, who always buy from you? _____

1=Yes 0 = No

27. If yes, how long have you been trading with these customers? _____ years

28. Before selling your produce what value adding activities do you perform?

Activity	Cost per 90 kg bag
1= Washing	_1= _____
2= Packaging	_2= _____
3= Processing	_3= _____
4= Other (Specify) _____	_4= _____

29. How much did you sell in the past season? _____(Kgs)

30. How much per kilogram did you get in KES _____

31. Have you ever declined a selling price and ended up not selling? _____

1=Yes 0 = No

32. What type of transport do you use?

1= Manpower 2= Wheelbarrow 3 = Vehicle

4= Donkey 5= Other Specify _____

33. How much did you pay for transport in KES _____

34. What general problem do you experience when moving your carrots?

1= Small size transport

2= Lack of transport means

3= High transport cost

4= Other specify _____

35. When selling, do you combine your carrots with that of other farmers? _____

1=Yes 0 = No

36. If no, state the main reason _____

1= you don't sell at the same time

2= you don't sell at the same market

3= you have a conflict with them

4= Other (Specify) _____

37. Do you receive market information prior to sales? _____

1=Yes 0 = No

38. If yes, what is/are your source(s) of information? _____

1= Radio 2= TV 3= Extension officers 4= Extension publications

5= Co-farmers 6= Middlemen/women 7= Development partners

8= Other (Specify) _____

39. In what form would you like the price information to be delivered?

1= Price per bag _____ 2= Price per kilogram _____ 3= Other

(Specify) _____

40. Do you receive extension services?

1=Yes _____ 0= No _____

If yes, how many times did they visit in a production and marketing season?

1= Once 2= Twice 3=Three 4= More than three _____

41. What services does he/she provide? _____

1= Advise on crop husbandry

2= Advise on carrot marketing

3= Advice on record keeping

4= Advice on good variety

5= Other (Specify) _____

42. Did you access any credit financial services in the last production season? _____

1=Yes 0 = No

If yes, name the source

1= Commercial banks _____ 2= AFC _____ 3= Agricultural cooperatives _____

4= Credit unions (merry-go-round) 5 = Family and friends

6= Other (Specify) _____

43. Has anyone in the household attend a farmer training last year?

1=Yes _____ 0= No _____

If yes, how many times for the whole year? _____

44. What was the training about? _____

1= Soil erosion

2= Fertilizer/input use

3= Carrot production and marketing

4= Safety and quality standards

5= record keeping

6= Other (Specify) _____

45. Does any member of the household belong to a local or external organization?

1=Yes 0= No

46. If yes, what type of group? _____

1=Self-help group 2= Welfare group 3 = Cooperative society

4= Other (Specify) _____

47. What are the main activities of the group? _____

1= Farming 2= Business 3= Advocacy

4= Other (Specify) _____

48. List what you consider to be the major problems you face in marketing your carrots

49. Suggest ways in which such problems can be addressed

Appendix B: Traders Questionnaire

1. Name of business enterprise _____
2. Type of trader _____ {1}. Rural broker {2}. Aggregator {3} Wholesaler {4} Exporter {5} Retailer {6} Other [specify] _____
3. Location province _____
{1} Coast {2} Eastern {3}North Eastern {4} Central {5} Rift Valley {6}Nairobi {7} Nyanza {8} Western (9)Outside Kenya
4. District: _____
5. Division: _____
6. Location: _____
7. Sub-location: _____
8. Market/town _____
9. Address of the business enterprise _____ Postal code _____
10. TEL. _____
11. E-Mail _____
12. Name of respondent: _____ Date _____
13. Gender of respondent _____ {1} Male {2} Female
14. Age of the respondent _____ (Year of Birth.....)
15. Name of business owner: _____: gender _____ {1} Male {2} Female
16. Relationship of respondent to the owner of business: _____
{1} Self {2} Spouse {3} Son {4} Daughter {5} Other Relatives
17. Position of respondent in the business. _____
{1} Owner {2} Hired manager {3} Other [specify] _____
18. Main occupation of respondent _____
{1} Farming {2} Employed {3} Self-employed {4} Others
Specify _____
19. Level of education? _____ 1. Primary 2. Secondary 3. Tertiary

20.

	Variety	Reason	Quantity per month	Selling price per unit (KES)	Buying price per unit (KES)
1					
2					
3					
4					
5					

21. Where did you source the produce from between Jan – Dec 2017?

Month bought	Variety	Quantity sourced (Kg)	Price (KES/Kg)	Source <i>1. Local Shops</i> <i>2. Super markets</i> <i>3. Intermediaries</i> <i>4. Local market vendors</i> <i>5. Exporters</i> <i>6. Processors</i> <i>7. Major towns</i> <i>8. Other specify</i>	Distance to source (Km)	Mode of transport <i>1. Donkey</i> <i>2. Camel</i> <i>3. Pick-up</i> <i>4. Lorry</i> <i>5. Wheel burrow</i> <i>6. Hand cut</i> <i>7. Oxen</i> <i>8. Manpower</i> <i>9. Other specify</i>	Actual transport cost (KES)
Jan							

Feb							
March							
April							
May							
Jun							
Jul							
Aug							
Sept							
Oct							
Nov							
Dec							

22. Where did you sell your product to?

Month sold	Variety	Quantity sold (Kg)	Price (KES/Kg)	Buyer <i>1. Consumers</i> <i>2. Aggregators</i> <i>3. wholesalers</i> <i>4. Exporters</i> <i>5. Processors</i> <i>6. Retailers</i> <i>7. Other specify</i> _____	Distance to selling point (Km)	Mode of transport <i>1. Donkey</i> <i>2. Camel</i> <i>3. Pick-up</i> <i>4. Lorry</i> <i>5. Wheel burrow</i> <i>6. Hand cut</i> <i>7. Oxen</i> <i>8. Manpower</i> <i>9. Other specify</i> _____	Actual transport cost including sale tax (KES)
Jan							
Feb							
March							
April							
May							
Jun							
Jul							
Aug							
Sept							
Oct							
Nov							
Dec							

23. For how long have you been trading in the following? _____ (Years)

24. Did you access any credit financial services for carrot trading? _____

1 = Yes 0 = No

25. If yes, name the source

1 = Commercial banks

2 = AFC

3 = Agricultural cooperatives

4 = Credit unions (Merry-go-round)

5 = Family and friends

6 = Other (Specify) _____

26. Are you aware of any quality standards in the carrot trading? _____

1 = Yes

0 = No

If yes, which ones?

27. Do you follow any standards / regulation in the trading of carrots

28. Please provide estimates of the costs that you incur in your carrot business?

Cost item per bag of carrot	Number of times incurred per month	Amount KES
Transport		
Information sourcing		
Licensing		
Cess		
Permit		
Insurance		
Training		
Marketing		
Packaging		
Others (specify)		

29. What major problems do you encounter in carrot trading?

	Problem	Rank	Recommended Solution
1	Rejection of product		
2	Spoilage and breakage		
3	Lack of market		
4	Transportation		
5	Market information		
	Any others (specify)		

Appendix C: Descriptive Stata Output

```

did you participate in carrot marketing
is the main decision maker male or female?

```

marketing	is the main decision maker male or female?		Total
	female	male	
no	10 26.32	28 73.68	38 100.00
yes	36 22.93	121 77.07	157 100.00
Total	46 23.59	149 76.41	195 100.00

Pearson chi2(1) = 0.1946 Pr = 0.659

. tabulate marketpart creditaccess, chi2 row

Key
frequency
row percentage

```

did you participate in carrot marketing
did you access any credit financial services in the last production season

```

marketing	did you access any credit financial services in the last production season		Total
	no	yes	
no	29 76.32	9 23.68	38 100.00
yes	35 22.29	122 77.71	157 100.00
Total	64 32.82	131 67.18	195 100.00

Pearson chi2(1) = 40.4968 Pr = 0.000

. tabulate marketpart extensionaccess, chi2 row

Key
frequency
row percentage

```

did you participate in carrot marketing
did you receive any extension visits or training related to carrot farming?

```

marketing	did you receive any extension visits or training related to carrot farming?		Total
	no	yes	
no	25 65.79	13 34.21	38 100.00
yes	55 35.03	102 64.97	157 100.00
Total	80 41.03	115 58.97	195 100.00

Pearson chi2(1) = 11.9629 Pr = 0.001

. tabulate marketpart membercarotgroup, chi2 row

Key
frequency
row percentage

```

did you participate in carrot marketing
are you or your spouse a member of a carrot cooperative/farmer organization?

```

marketing	are you or your spouse a member of a carrot cooperative/farmer organization?		Total
	no	yes	
no	31 81.58	7 18.42	38 100.00
yes	27 17.20	130 82.80	157 100.00
Total	58 29.74	137 70.26	195 100.00

Pearson chi2(1) = 60.6864 Pr = 0.000

. tabulate marketpart member_othergroup, chi2 row

Key
frequency
row percentage

```

did you participate in carrot marketing
are you (or any member of your household) a member of any kind of organization?

```

marketing	are you (or any member of your household) a member of any kind of organization?		Total
	no	yes	
no	25 65.79	13 34.21	38 100.00
yes	31 19.75	126 80.25	157 100.00
Total	56 28.72	139 71.28	195 100.00

Pearson chi2(1) = 31.6859 Pr = 0.000

Summary statistics: mean
by categories of: marketpart (did you participate in carrot marketing)

marketpart	agehh	distmkt	experhh	eduhh	hhsiz	landsi-d	landsz-t	distcl-t
no	42.97368	12.59211	4.710526	4.473684	5.052632	3.447368	.3039474	19.68421
yes	45.56688	8.799682	10.26115	10.58599	5.910828	3.410828	2.075159	13.80892
Total	45.06154	9.538718	9.179487	9.394872	5.74359	3.417949	1.73	14.95385

. tab marketoutlet mainbuyer, column row cell nofreq

Key
row percentage
column percentage
cell percentage

what was the point of sale?	whom did you sell maost of your carrots to?					Total
	consumers	brokers	aggregato	wholesale	retailer	
farm gate	14.89	44.68	40.43	0.00	0.00	100.00
	100.00	48.84	35.85	0.00	0.00	29.94
	4.46	13.38	12.10	0.00	0.00	29.94
cleaning point	0.00	32.50	52.50	15.00	0.00	100.00
	0.00	30.23	39.62	20.69	0.00	25.48
	0.00	8.28	13.38	3.82	0.00	25.48
local market	0.00	27.27	39.39	0.00	33.33	100.00
	0.00	20.93	24.53	0.00	44.00	21.02
	0.00	5.73	8.28	0.00	7.01	21.02
external market	0.00	0.00	0.00	44.00	56.00	100.00
	0.00	0.00	0.00	37.93	56.00	15.92
	0.00	0.00	0.00	7.01	8.92	15.92
export market	0.00	0.00	0.00	100.00	0.00	100.00
	0.00	0.00	0.00	41.38	0.00	7.64
	0.00	0.00	0.00	7.64	0.00	7.64
Total	4.46	27.39	33.76	18.47	15.92	100.00
	100.00	100.00	100.00	100.00	100.00	100.00
	4.46	27.39	33.76	18.47	15.92	100.00

Appendix D: Variance Inflation Factor (VIF)

Variable	VIF	1/VIF
Experience of house head	1.42	0.702253
Education level	1.27	0.784414
Age of household head	1.23	0.812324
Member to carrot group	1.16	0.859478
Land size under carrots	1.16	0.865369
Distance to cleaning point	1.13	0.885423
Gender of household head	1.07	0.931648
Household size	1.07	0.933938
Distance to local market	1.06	0.943587

Appendix E: Correlation Matrix

```
. correlate agehh distmkt experhh eduhh hhsizelandsizeowned landszcarot distcleanpoint genderhh creditaccess extensionaccess membercarotgroup
(obs=195)
```

	agehh	distmkt	experhh	eduhh	hhsizelandsizeowned	landszcarot	distcleanpoint	genderhh	creditaccess	extensionaccess	membercarotgroup	
agehh	1.0000											
distmkt	-0.1024	1.0000										
experhh	0.3608	-0.0773	1.0000									
eduhh	-0.0700	-0.0341	0.2274	1.0000								
hhsizelandsizeowned	0.1709	-0.1241	0.1507	0.0800	1.0000							
landszcarot	-0.0478	-0.0388	0.0202	0.0443	-0.0483	1.0000						
distcleanpoint	0.0501	-0.0947	0.3080	0.2261	0.0383	0.6616	1.0000					
genderhh	-0.0384	0.1365	0.0903	-0.1948	0.0226	-0.0266	-0.0255	1.0000				
creditaccess	-0.0352	0.0317	0.0632	0.1696	0.1012	0.1096	0.0904	0.1000	1.0000			
extensionaccess	0.0838	-0.0630	0.3054	0.2889	0.0841	0.1099	0.2452	-0.1381	0.1004	1.0000		
membercarotgroup	0.0939	-0.1388	-0.1943	0.1560	0.0064	-0.0269	-0.0342	-0.1271	0.0523	-0.1611	1.0000	
membercarotgroup	0.0409	0.0312	0.2320	0.2866	0.0657	0.0250	0.1633	-0.1320	-0.0444	0.2858	0.0047	1.0000


```

. margins, dydx(*) predict(outcome(cleaning_point))

Average marginal effects      Number of obs   =      157
Model VCE      : OIM

Expression   : Pr(marketoutlet==cleaning_point), predict(outcome(cleaning_point))
dy/dx w.r.t. : genderhh agehh eduhh distmkt landsizeowned experhh landszcarot hhszize creditaccess membercarotgroup distcleanpoint

```

	Delta-method		z	P> z	[95% Conf. Interval]	
	dy/dx	Std. Err.				
genderhh	-.0674993	.0387356	-1.74	0.081	-.1434197	.0084212
agehh	-.0019707	.0018778	-1.05	0.294	-.0056512	.0017097
eduhh	-.0055118	.0066095	-0.83	0.404	-.0184662	.0074426
distmkt	.0007093	.0018498	0.38	0.701	-.0029161	.0043348
landsizeowned	.0246334	.0098312	2.51	0.012	.0053647	.0439022
experhh	.0064097	.0039957	1.60	0.109	-.0014217	.0142411
landszcarot	-.0433569	.0154929	-2.80	0.005	-.0737223	-.0129915
hhszize	.0069445	.0072816	0.95	0.340	-.0073271	.0212161
creditaccess	-.0983322	7.114656	-0.01	0.989	-14.0428	13.84614
membercarotgroup	-.3380788	11.07875	-0.03	0.976	-22.05203	21.37587
distcleanpoint	-.0574468	.0052684	-10.90	0.000	-.0677726	-.047121

```

. margins, dydx(*) predict(outcome(local_market))

Average marginal effects      Number of obs   =      157
Model VCE      : OIM

Expression   : Pr(marketoutlet==local_market), predict(outcome(local_market))
dy/dx w.r.t. : genderhh agehh eduhh distmkt landsizeowned experhh landszcarot hhszize creditaccess membercarotgroup distcleanpoint

```

	Delta-method		z	P> z	[95% Conf. Interval]	
	dy/dx	Std. Err.				
genderhh	.1291936	.0683428	1.89	0.059	-.0047558	.2631429
agehh	.0065108	.0024908	2.61	0.009	.0016289	.0113926
eduhh	.0087547	.0091264	0.96	0.337	-.0091327	.0266421
distmkt	-.0261297	.0047836	-5.46	0.000	-.0355053	-.016754
landsizeowned	-.0022658	.0222732	-0.10	0.919	-.0459205	.0413889
experhh	-.023655	.0065919	-3.59	0.000	-.0365749	-.0107352
landszcarot	.0084846	.0256839	0.33	0.741	-.0418549	.0588242
hhszize	-.0189905	.0122985	-1.54	0.123	-.043095	.0051141
creditaccess	-.1160519	11.93127	-0.01	0.992	-23.50092	23.26881
membercarotgroup	-.2209896	27.41115	-0.01	0.994	-53.94586	53.50388
distcleanpoint	.0242932	.0038355	6.33	0.000	.0167758	.0318107

```

. margins, dydx(*) predict(outcome(external_market))

Average marginal effects      Number of obs   =      157
Model VCE      : OIM

Expression   : Pr(marketoutlet==external_market), predict(outcome(external_market))
dy/dx w.r.t. : genderhh agehh eduhh distmkt landsizeowned experhh landszcarot hhszize creditaccess membercarotgroup distcleanpoint

```

	Delta-method		z	P> z	[95% Conf. Interval]	
	dy/dx	Std. Err.				
genderhh	.0312602	.052109	0.60	0.549	-.0708717	.1333921
agehh	-.0054143	.0033428	-1.62	0.105	-.0119661	.0011375
eduhh	-.0071292	.0094366	-0.76	0.450	-.0256247	.0113662
distmkt	.007817	.0024774	3.16	0.002	.0029614	.0126726
landsizeowned	.0187825	.0108963	1.72	0.085	-.0025739	.0401389
experhh	.0193302	.0038088	5.08	0.000	.011865	.0267954
landszcarot	.0074444	.0145125	0.51	0.608	-.0209996	.0358884
hhszize	.0236236	.0119724	1.97	0.048	.0001581	.0470891
creditaccess	-.3838966	42.51833	-0.01	0.993	-83.71829	82.95049
membercarotgroup	1.095087	96.71335	0.01	0.991	-188.4596	190.6498
distcleanpoint	.0111937	.0037236	3.01	0.003	.0038955	.0184919

```

. margins, dydx(*) predict(outcome(export_market))

Average marginal effects      Number of obs   =      157
Model VCE      : OIM

Expression   : Pr(marketoutlet==export_market), predict(outcome(export_market))
dy/dx w.r.t. : genderhh agehh eduhh distmkt landsizeowned experhh landszcarot hhszize creditaccess membercarotgroup distcleanpoint

```

	Delta-method		z	P> z	[95% Conf. Interval]	
	dy/dx	Std. Err.				
genderhh	-.070892	.0440272	-1.61	0.107	-.1571837	.0153996
agehh	-.0057225	.003567	-1.60	0.109	-.0127137	.0012688
eduhh	.0052073	.0058589	0.89	0.374	-.006276	.0166907
distmkt	-.0013102	.00262	-0.50	0.617	-.0064454	.0038249
landsizeowned	-.0067657	.0094798	-0.71	0.475	-.0253458	.0118144
experhh	.0096674	.0036501	2.65	0.008	.0025133	.0168214
landszcarot	.0226901	.0094487	2.40	0.016	.004171	.0412093
hhszize	-.0130248	.0137776	-0.95	0.344	-.0400284	.0139788
creditaccess	-.5310854	71.55428	0.01	0.994	-139.7127	140.7749
membercarotgroup	-.3073129	29.26906	-0.01	0.992	-57.67361	57.05899
distcleanpoint	.0060299	.0032167	1.87	0.061	-.0002746	.0123344

Appendix G: Double Hurdle Stata Output

```

Probit regression                               Number of obs   =       195
                                                LR chi2(9)      =       176.47
                                                Prob > chi2     =       0.0000
Log likelihood = -7.94113                     Pseudo R2      =       0.9174
    
```

marketpart	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
genderhh	1.156641	1.178457	0.98	0.326	-1.153092	3.466375
agehh	.0244975	.0360649	0.68	0.497	-.0461884	.0951834
eduhh	.8833721	.4297593	2.06	0.040	.0410594	1.725685
hssize	-.0004055	.212543	-0.00	0.998	-.4169822	.4161711
distmkt	-.0849019	.0748193	-1.13	0.256	-.2315451	.0617412
experhh	.1874808	.1288253	1.46	0.146	-.065012	.4399737
landszcarot	9.41699	5.411935	1.74	0.082	-1.190207	20.02419
membercarotgroup	.6929715	1.12961	0.61	0.540	-1.521023	2.906966
distcleanpoint	-.074467	.0985021	-0.76	0.450	-.2675275	.1185936
_cons	-11.9304	6.170473	-1.93	0.053	-24.02431	.1635014

Note: 12 failures and 115 successes completely determined.

```
. ztnb qttysold genderhh agehh eduhh hssize distmkt landsizeowned experhh landszcarot creditaccess membercarotgroup distcleanpoint
```

Fitting Zero-truncated poisson model:

```

Iteration 0: log likelihood = -14039045
Iteration 1: log likelihood = -5111265.9
Iteration 2: log likelihood = -3523171.9
Iteration 3: log likelihood = -474638.4
Iteration 4: log likelihood = -401921.85
Iteration 5: log likelihood = -400786.52
Iteration 6: log likelihood = -400785.87
Iteration 7: log likelihood = -400785.87
    
```

Fitting constant-only model:

```

Iteration 0: log likelihood = -1741.1647
Iteration 1: log likelihood = -1739.2789
Iteration 2: log likelihood = -1739.2627
Iteration 3: log likelihood = -1739.2627
    
```

Fitting full model:

```

Iteration 0: log likelihood = -1690.3603
Iteration 1: log likelihood = -1632.5696
Iteration 2: log likelihood = -1625.3609
Iteration 3: log likelihood = -1622.9199
Iteration 4: log likelihood = -1622.9185
Iteration 5: log likelihood = -1622.9185
    
```

```

Zero-truncated negative binomial regression   Number of obs   =       157
                                                LR chi2(11)    =       232.69
Dispersion = mean                           Prob > chi2     =       0.0000
Log likelihood = -1622.9185                 Pseudo R2      =       0.0669
    
```

qttysold	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
genderhh	-.0542719	.0981855	-0.55	0.580	-.246712	.1381682
agehh	-.0088967	.0033751	-2.64	0.008	-.0155119	-.0022816
eduhh	.0072786	.0127217	0.57	0.567	-.0176554	.0322127
hssize	.0296808	.0166211	1.79	0.074	-.002896	.0622575
distmkt	-.0018569	.0033474	-0.55	0.579	-.0084177	.004704
landsizedowned	-.0424392	.0123119	-3.45	0.001	-.0665701	-.0183082
experhh	.0122512	.0068594	1.79	0.074	-.0011931	.0256954
landszcarot	.3903567	.0308802	12.64	0.000	.3298325	.4508809
creditaccess	.085728	.0975543	0.88	0.380	-.1054749	.2769309
membercarotgroup	.0667905	.1071356	0.62	0.533	-.1431913	.2767724
distcleanpoint	.0024244	.0062687	0.39	0.699	-.009862	.0147107
_cons	9.01024	.266936	33.75	0.000	8.487055	9.533425
/lnalpha	-1.497539	.1089608			-1.711098	-1.28398
alpha	.22368	.0243723			.1806673	.276933

Likelihood-ratio test of alpha=0: chibar2(01) = 8.0e+05 Prob>=chibar2 = 0.000

Appendix H: Research Permit



NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

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Date: **23rd April, 2019**

Hillary Kiprotich Ngeno
Egerton University
P.O. Box 536-20115
NJORO.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on “*Determinants of market participation and outlet choices among smallholder carrot farmers in Nakuru County*” I am pleased to inform you that you have been authorized to undertake research in **Nakuru County** for the period ending **23rd April, 2020**.

You are advised to report to **the County Commissioner and the County Director of Education, Nakuru County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit a **copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

DR. STEPHEN K. KIBIRU, PhD.
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Nakuru County.

The County Director of Education
Nakuru County.

National Commission for Science, Technology and Innovation is ISO9001:2008 Certified

Navigating Market Choices: Understanding Carrot Market Outlet Selection among Smallholder Farmers in Kenya

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Abstract

This research delves into the hurdles and strategies aimed at augmenting the market involvement of smallholder carrot farmers in Nakuru County, Kenya. Employing a Multinomial Logit (MNL) model, it scrutinizes the factors influencing the selection of marketing outlets among carrot farmers. The findings unveil that a significant majority (81%) of surveyed farmers actively participate in diverse market outlets, encompassing the farm gate, cleaning point, local market, external market, and export market. Notably, pivotal buyers include aggregators, brokers, wholesalers, retailers, and consumers, with transactions predominantly occurring at the farm level. Additionally, the analysis discerns substantial influences of socio-economic characteristics, experiential factors, and geographical proximity on farmers' choices of market outlets. Specifically, gender, age, land size, farming experience, and distance to markets emerge as critical determinants. Moreover, the study delves into the examination of market margins along the carrot value chain, shedding light on the potential profitability of carrot farming in the region. Remarkably, higher average gross margins are identified in export and external markets, signaling lucrative prospects for farmers targeting these segments. However, disparities in profit distribution between farmers and traders underscore the necessity for interventions to ensure equitable value distribution throughout the value chain. These findings underscore the imperative for tailored interventions to tackle challenges and foster inclusive agricultural development. Strategies such as farmer organizations, contracting, and vertical integration are advocated to enhance market access and profitability for smallholder carrot farmers. Thus, this study enriches our comprehension of the dynamics within carrot value