Agricultural Sciences, 2024, 15, 676-703
https://www.scirp.org/journal/as
ISSN Online: 2156-8561
ISSN Print: 2156-8553

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

Hillary Kiprotich Ngeno[1,2*], Ngenoh Evans[3], Oscar Ayuya Ingasia[2], Hillary K. Bett[2]

[1]State Department for Crop Development and Agricultural Research, Ministry of Agriculture, Livestock, Fisheries and Cooperatives, Nairobi, Kenya
[2]Department of Agricultural Economics and Agribusiness Management, Egerton University, Egerton, Kenya
[3]Brooklyn Economic Consulting Limited, Nairobi, Kenya
Email: *kiprongeno80@gmail.com

How to cite this paper: Ngeno, H.K., Evans, N., Ingasia, O.A. and Bett, H.K. (2024) Navigating Market Choices: Understanding Carrot Market Outlet Selection among Smallholder Farmers in Kenya. *Agricultural Sciences*, **15**, 676-703.
https://doi.org/10.4236/as.2024.156037

Received: March 12, 2024
Accepted: June 22, 2024
Published: June 25, 2024

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

chains and provides valuable insights for policymakers and development practitioners aiming to uplift rural livelihoods and bolster food security.

Keywords

Market Outlet Selection, Smallholder Farmers, Multinomial Logit Model, Determinants, Carrot Value Chain

1. Introduction

Agricultural production in developing countries has faced a global decline of 0.7% [1], with Sub-Saharan Africa (SSA) particularly affected by adverse weather conditions and conflicts in East and West African countries, leading to widespread crop damage and subsequent production downturns [2]. In Kenya, approximately 2.4 million people are severely food insecure due to prevailing dry weather conditions, negatively impacting crop and livestock production and constraining food availability and access nationwide [1] [3]. Reduced domestic supplies, attributed to below-average first-season harvests caused by erratic rainfall, have driven up agricultural produce prices in Kenya [1]. Despite these challenges, agriculture remains central to the Kenyan economy, serving as the largest foreign exchange earner and a key player in achieving the country's Vision 2030 development agenda. The sector contributes over 30% to the Gross Domestic Product (GDP) and employs more than 60% of the population [4].

Horticulture stands out as a leading sub-sector within agriculture, contributing 36% to the agricultural GDP and ranking as the third-largest foreign exchange earner after tea and coffee [5] [6] [7]. This sector also significantly impacts the economy by providing direct employment to around 350,000 individuals and supporting over six million livelihoods [5]. Notably, the majority of horticultural produce, accounting for 96%, is consumed locally, playing a crucial role in household food security for smallholder farmers who produce the bulk of these crops [8]. The success of the horticultural sector can be attributed to factors such as the adoption of advanced technology, access to technical training, and the opening of international markets like the United Arab Emirates (UAE) and the United States of America (USA) [5]. Additionally, industry associations and other stakeholders have provided training and support to producers and exporters, focusing on meeting international standards for food safety and traceability to enhance the quality of Kenyan horticultural produce.

Despite challenges posed by the COVID-19 pandemic, the horticulture sector in Kenya has demonstrated significant growth in both value and volume of production over the years. In 2020, export earnings reached Ksh. 151 billion, with flowers accounting for KShs 108B, fruits KShs 18B, and vegetables KShs 24B [5]. However, a considerable portion of these earnings went towards air freights, impacting expected profits for producers and exporters [9]. Market participation

by smallholder farmers in developing countries faces internal and external constraints, affecting the intensity of their involvement [10]. Factors such as product quality, supply consistency, and ability to meet market standards and deadlines influence farmers' decisions on market participation and outlet selection [11] [12]. Adherence to stringent market standards has increased the need for value addition to maintain product quality, especially for perishable horticultural products [7]. Internal factors such as low literacy levels, small land sizes, and limited access to credit often hinder smallholder farmers' participation in markets [13]. Additionally, subsistence agriculture dominance and high transaction costs further limit their engagement in agricultural markets [14] [15].

The liberalization of Kenya's agricultural sector in the early 1990s led to a free market policy, increasing private sector participation and widening marketing channel alternatives for producers [16]. However, the proliferation of informal marketing channels following market liberalization has introduced challenges such as arbitrary price setting, disadvantaging farmers [17]. Vegetable production, particularly carrots (*Daucus carota*), plays a vital role in human diets worldwide due to their nutritional value and health benefits [18] [19]. Carrots are rich in vitamins and antioxidants and have gained popularity for their various health benefits, contributing to their increased consumption [20] [21]. Despite their nutritional value, challenges such as post-harvest losses and market access hinder the full potential of carrot production in contributing to food security and farmer livelihoods [19] [22].

Cultivation of vegetables, notably carrots *(Daucus carota)*, holds significant value in regions with cooler climates and is deeply ingrained in global dietary practices. Carrots are esteemed for their abundant carotene, vitamins A, B, and C, historically renowned for their purported benefits in enhancing eyesight, reducing cholesterol, and aiding digestion. Versatile in use, carrot roots are consumed raw or cooked, alone or as ingredients in various culinary dishes. The surge in carrot consumption is attributed to its recognized antioxidant, anti-carcinogenic, anti-diabetic, anti-inflammatory properties, and dietary fiber content. Under optimal conditions, mature carrots can maintain quality for 100 - 150 days when stored appropriately. Despite the nutritional and economic potential of carrot production, smallholder farmers encounter internal and external constraints in accessing horticultural export markets [18]. Stringent regulations necessitate value addition to mitigate losses due to product perishability, posing challenges for farmers with limited resources. Internal factors such as low literacy rates, land sizes, asset values, and access to credit further impede market participation [23].

In Nakuru County, Kenya, smallholder carrot farmers navigated a complex web of market pathways in their pursuit of sustainable livelihoods. In particular, carrot production represents a crucial component of the county's agricultural landscape, contributing significantly to both local food security and economic prosperity. However, the efficiency and inclusivity of carrot value chains re-

mained central concerns for policymakers and development practitioners seeking to enhance market access and improve the welfare of farming communities. The decision-making processes of smallholder carrot farmers regarding market participation and outlet selection were multifaceted, influenced by a myriad of factors ranging from household characteristics to institutional dynamics. Understanding the intricacies of carrot value chains and farmer decision-making processes was crucial for designing interventions to strengthen market linkages and enhance rural economies' resilience. This study aimed to unravel the complex dynamics of carrot value chains in Nakuru County, Kenya, focusing on smallholder farmers' market outlet selection. Employing a multidisciplinary approach grounded in economic theory and livelihood frameworks, the research provided actionable insights into carrot markets' functioning and determinants of farmer behavior within these chains. The rationale stemmed from the urgent need to improve the efficiency, inclusivity, and sustainability of carrot value chains in Nakuru County, addressing existing knowledge gaps and informing evidence-based policy interventions for inclusive agricultural growth and poverty reduction. Using rigorous quantitative methods like the Multi-nomial Logit Model (MNL) and market margin analysis, the study aimed to offer robust empirical evidence guiding policymakers, development practitioners, and stakeholders in devising targeted strategies to optimize carrot value chains in Nakuru County, contributing to the establishment of resilient, inclusive, and sustainable agricultural systems benefiting both farmers and consumers.

2. Methodology

2.1. Study Area

The study was conducted primarily during the 2020/2021 cropping season in Njoro Sub-County (**Appendix 1**), located within Nakuru County, Kenya, positioned approximately between latitudes −0.2917 and −0.3326, and longitudes 35.9847 and 36.0007. Njoro Sub-County is widely recognized for its agricultural activities, particularly in horticulture, including the cultivation of carrots, maize, and other crops. With an average altitude ranging from 1520 m to 3098 m above sea level and annual rainfall varying from 100 mm to 1900 mm, the climatic conditions in Njoro Sub-County are conducive to diverse agricultural production. Furthermore, as the host to Egerton University, one of Kenya's prominent institutions of higher learning, Njoro Sub-County significantly contributes to educational and socio-economic development in the region. By concentrating on Njoro Sub-County as the primary research area, the study aimed to delve into the intricacies of carrot value chains and farmer decision-making processes within this specific agricultural landscape, providing nuanced insights into agricultural market dynamics and livelihood strategies in Nakuru County.

2.2. Sampling, Data Collection and Analysis

The study adopted a comprehensive sampling approach proposed by [24] to

delve into the dynamics of Nakuru County's carrot industry and markets, which also included conducting gross margin analysis. Through consultation with the divisional agricultural officer of Mau-Narok Division, a sampling strategy was devised, resulting in the selection of 195 smallholder carrot farmers, and traders (20 brokers, 34 aggregators, 15 wholesalers, 10 exporters, and 20 retailers). Nakuru County, particularly Njoro sub-county, was identified for its significance in carrot production and its role as a potential market center, with a focus on its vibrant agricultural landscape and diverse market participation.

Structured questionnaires (**Appendix 2** and **Appendix 3**) were utilized to collect data, emphasizing household, land, and institutional information from smallholder carrot farming households in Njoro sub-county. Various tools, including semi-structured questionnaires, focus group discussions (FGDs), and key informant interviews (KIIs), were employed to gain a comprehensive understanding of Nakuru's carrot enterprise and markets. The multistage sampling technique ensured representation across various industry segments, with respondents randomly selected at the village level using a proportion-to-size sampling approach. Statistical and descriptive measures were applied to identify key market players, assess the prevalence and profitability of value chain functions, and create enterprise and market maps illustrating Nakuru's carrot industry landscape. These maps underwent validation and refinement, supported by insights from FGDs and KIIs, which were thematically coded to highlight pivotal issues within the carrot enterprise and markets. The study deployed Statistical Package for Social Sciences (SPSS) and STATA software for data analysis, revealing insights into market dynamics. Data triangulation enriched understanding of the carrot enterprise's operations, identified constraints and opportunities for value chain actors, and facilitated the development of strategies to enhance smallholder carrot farmers' incomes. The findings informed tailored recommendations aimed at improving their welfare.

2.3. Limitation of the Study

One limitation of the study was its focus solely on smallholder farmers and market intermediaries within Nakuru County, which restricted the generalizability of the findings beyond this specific region. To counteract this limitation, the study explicitly stated the scope of its conclusions to Nakuru County, acknowledging the need for caution when applying the results to other contexts. Another limitation was the reliance on recall for collecting certain information, particularly when record-keeping practices were not prevalent among participants. This could have potentially compromised the accuracy of the data. To address this challenge, the study employed proactive measures such as proper probing techniques and cross-check questions during the survey process. These strategies aimed to validate and enhance the reliability of the collected data, despite the limitations associated with recall.

2.4. Multinomial Model Specification

Following the recommendations of [25], a multinomial logit model (MNL) was utilized to assess the impact of household characteristics, technical aspects, socio-economic factors, external influences, and institutional elements on the selection of marketing outlets. The probability of a carrot farmer selecting one market outlet over another, given alternative options, was determined using this model.

$$\text{Prob}\left(Y_J = i\right) = P_{ij} = \frac{\exp\left(X_j \beta_j\right)}{\sum \exp\left(X_j \beta_k\right)} \tag{1}$$

where Y_J is the the probability with which a smallholder carrot farmer j chose market outlet i, that is $\Pr\left(Y_J = i\right)$ 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, while X_i are factors affecting the choice of a marketing outlet, β were parameters to be estimated and e is random error term.

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

$$\text{Prob}\left(Y_i = j\right) = \frac{e_{zj}}{\sum_{k=0}^{j} e_{zk}} \tag{2}$$

Z_j is market channel outlet chosen [26] and is given by,

$$Z_j = B_j X_i \tag{3}$$

Z_k is alternative choice that could be chosen [26] given by

$$Z_k = \beta_k X_i \tag{4}$$

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 a number of alternative choices log odds ratio is computed as,

$$\ln\left(\frac{P_{ij}}{P_{ik}}\right) = \alpha + \sum X_i \left(B_j - B_k\right) + e \tag{5}$$

P_{ij} and P_{ik} are probabilities that a smallholder carrot farmer will choose 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 $N(0, \sigma)$.

Marginal effects of the attributes on choice are determined by getting the differential of probability of a given choice:

$$\text{Prob}\left(Y_i = j\right) = \frac{e_{zj}}{\sum_{k=0}^{j} e_{zk}} \tag{6}$$

Marginal effects

$$\delta = \frac{\partial P_i}{\partial X_i} = p_i\left(B_j - \sum_{k=0}^{j} P_k \beta_k\right) = P_i\left(\beta_j - \beta\right) \tag{7}$$

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, however the variables descriptions as its parametric measurements as used in multinomial logit (MNL) model are placed in **Appendix 4**.

$$\begin{aligned}\text{Market outlet} = {} & \beta_0 + \beta_1 \text{Gender\_producer} + \beta_2 \text{Age}_{\text{producer}} + \beta_3 \text{Education}_{\text{producer}} \\ & + \beta_4 \text{Household size} + \beta_5 \text{land size} + \beta_6 \text{Access}_{\text{capital}} \\ & + \beta_7 \text{Acess}_{\text{information}} + \beta_8 \text{Farmr group} + \beta_9 \text{means of transport} \\ & + \beta_{10} \text{extension-contact} + \beta_{11} \text{experience} + B_{12} \text{output price} \\ & + B_{13} \text{Distance}_{\text{tarmac}} + \varepsilon_i\end{aligned} \tag{8}$$

2.5. Estimation Specification of Carrot Marketing Margins

Market margins play a crucial role in understanding the economic dynamics of agro-based products along the value chain. To estimate these margins, economists employ econometric techniques that analyze price differentials (ΔP) between various stages of production and consumption. As proposed by [27], the market margin analysis offers the best tools to analyze the performance of a market outlet/channel, and the estimation specification involves a formulaic representation as follows:

$$\text{Producers' share} = \frac{\text{Producer price}}{\text{Next actor price}} = 1 - \frac{\text{Marketing Margin}}{\text{Actor price}} \tag{9}$$

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

$$\text{GMM} = \frac{\text{Actor price} - \text{Producer price}}{\text{Actor price}} \times 100 \tag{10}$$

where GMMis 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 smallholder farmers.

$$\text{NMM} = \frac{\text{Gross Marketing Margin} - \text{Marketing costs}}{\text{Actor price}} \tag{11}$$

The marketing margin at a given stage "*i*" (GMM_i) will be computed as:

$$\text{GMM}_i = \frac{\text{Next actor price} - \text{Purchasing price}}{\text{Next actors' price} - \text{Farmer' sprice}} \times 100 \tag{12}$$

The total gross profit margin (TGPM) will be computed as:

$$\text{TGPM} = \text{TGMM} - \text{TOE} \tag{13}$$

where TGMM = Consumer's price − Farmers price

TOE = Total operating expenses

The profit margin at stage "*i*" is given as:

$$\text{Gross profit margin}(\text{GPM}) = \frac{\text{Gross Market Margin } i - \text{Operating expenses } i}{\text{Total gross profit margin}} \times 100 \tag{14}$$

3. Results and Discussions

3.1. Descriptive Statistics

The results presented in Table 1 showcased variations in key metrics among surveyed households. The average household size ranged from five to six members, with a majority (56%) benefiting from extension services. Approximately half of the carrot farmers reported membership in farmer groups, predominantly led by males (71%), averaging 45.1 years in age and holding an average of 9.39 years of education. Carrot production was typically undertaken on an average land size of 1.73 acres, indicating a predominantly smallholder farming demographic. Farmers were situated an average distance of 14.95 kilometers from carrot cleaning points and traveled approximately 9.54 kilometers to reach the

Table 1. Descriptive statistics by carrot market participants and non-participants.

Variable	Market Participants (n = 157)		Non-market Participants (n = 38)		Overall Mean	Test statistics	
	Mean	Std. Err.	Mean	Std. Err.		Chi² test	t-test
Household Size	5.91	0.190	5.05	0.399	5.74	-	0.052
Gender	0.24	0.031	0.19	0.079	0.29	0.195	-
Age (Years)	45.57	1.002	42.97	2.224	45.06	-	0.766
Education (Years)	10.59	0.238	4.47	0.339	9.39	-	4.047**
Experience (Years)	10.67	0.538	4.71	0.762	9.18		2.761*
Land size (Acres)	3.41	0.502	3.44	0.578	3.42	-	0.052
Carrot land size (Acres)	2.08	0.210	0.30	0.019	1.73	-	15.996***
Distance to cleaning point (Km)	13.81	0.512	19.68	1.301	14.95	-	5.934**
Distance to local market (Km)	8.80	0.897	12.59	2.433	9.54	-	5.126**
Access to extension services	0.17	0.027	0.25	0.131	0.56	11.963***	-
Access to credit services	0.06	0.017	0.08	0.083	0.12	40.497***	-
Member to carrot farmer group	0.21	0.030	0.27	0.089	0.50	60.686***	-
Member to other farmers groups	0.32	0.034	0.38	0.097	0.50	31.686***	-

***p < 0.01, **p < 0.05, *p < 0.10.

nearest market. Access to credit services was limited, with only 12% of households utilizing such services, possibly hindering adoption of advanced production technologies like irrigation. Furthermore, respondents were queried about their carrot sales during the 2019/2020 production and marketing season, including details on market outlets and buyers involved.

Moreover, the findings revealed that a significant majority (81%) of surveyed farmers participated in selling their produce through various outlets, notably the farm gate (29.94%), cleaning point (25.48%), local market (21.02%), external market (15.92%), and export market (7.64%). Consumers, brokers, aggregators, wholesalers, and retailers emerged as primary purchasers of carrots originating from Nakuru County, with aggregators notably acquiring 33.76% of produce directly from farmers across multiple market outlets. Additionally, smallholder carrot farmers sold 27.39% of their produce to brokers, 18.47% to wholesalers, 15.92% to retailers, and 4.46% to consumers, indicating diverse transactional patterns across various market outlets.

3.2. Factors Influencing the Choice of Marketing Outlet

In this study, the Multinomial Logit (MNL) model was employed to scrutinize the factors influencing the choice of marketing outlets among carrot farmers in Nakuru County. The selection of this model was based on the understanding that data related to market outlet preferences for carrot production are context-specific, with each independent variable having a unique value for each case. Furthermore, the MNL model operates under the assumption that the dependent variable (chosen market outlet) cannot be precisely predicted from the independent variables for any given case. The analysis encompassed various 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. Upon analyzing the MNL results, as illustrated in **Table 2**. Gender played a significant role in the choice of market outlets, particularly affecting the cleaning point and local market preferences. Male-headed households were less inclined to sell carrots at cleaning points by 6.75% but showed a higher likelihood (12.92%) of selling at the local market compared to female-headed households. This divergence may arise from men's propensity for risk-taking behavior, leading them to actively seek markets rather than settling for the less competitive cleaning point. Conversely, female-headed households may prioritize convenience over market competitiveness due to time constraints, opting to sell closer to home. These findings resonate with previous studies by [28] and [29], highlighting gender disparities in market access. Age also emerged as a significant factor influencing market outlet choice, particularly favoring the farm gate and local market. Older farmers exhibited a higher likelihood (approximately 1%) of selling at both outlets, possibly due to their risk-averse nature, preferring traditional markets for their stability. This aligns with prior research by [30] and [31], which

Table 2. MNL 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)
Carrot Group membership	−0.2287 (28.9551)	−0.2210 (27.4112)	−0.3381 (11.0788)	1.0951 (96.7134)	−0.3073 (29.2691)
Cleaning point 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^2 (44)	299.28				
Prob > chi^2	0.0000				
Log likelihood	−90.001855				
Pseudo R^2	0.6244				

***p < 0.01; **p < 0.05, *p < 0.1. (Standard errors in parentheses).

emphasized the age-related preference for traditional markets. However, [32] observed different trends, indicating the complexity of market dynamics across agricultural contexts. Furthermore, geographical proximity significantly affected market outlet choices, with increased distance leading to varied preferences among the farm gate, local market, and external market. For every 1-kilometer increase in distance, there was a 2% rise in the likelihood of selling at the farm gate, a 2.67% decrease at the local market, and a 1% increase at the external market. These findings align with [33] observations on the impact of distance on market choices, emphasizing the importance of minimizing transportation costs.

Moreover, land size owned by households influenced market outlet preferences, particularly favoring cleaning points and external market outlets. An increase of 1 acre corresponded to a 2.46% increase in selling at cleaning points and a 1.88% increase at external market outlets. This suggests a shift towards market-oriented farming practices with larger landholdings. Similar trends were observed regarding farming experience, with experienced farmers exhibiting a higher likelihood of accessing formal market outlets such as the external market and export market. These findings corroborate [34] observations on the positive impact of farming experience on market access. The size of land allocated to

carrot cultivation and household size also influenced market outlet choices. An increase in carrot land size by 1 acre resulted in a 4.34% decrease in selling at cleaning points and a 2.27% increase at export market outlets. Additionally, household size had a significant positive influence on external market outlets, with a 1-member increase corresponding to a 2.34% rise in selling at these outlets. These findings contrast with [35] observations on household size's negative impact on market outlet choice for tomato producers. Finally, distance to the cleaning point positively influenced all market outlet choices, indicating that proximity to cleaning points influences farmers' decisions, with greater distances leading to varied preferences among the available options.

3.3. Gross Margin Analysis along the Carrot Value Chain

The examination of gross margins within the carrot value chain in Nakuru County provides critical insights into the economic viability and operational dynamics of carrot farming and marketing activities. As depicted in **Table 3**, the presence of positive average gross margins across all market outlets signals the potential profitability of carrot cultivation in the region [33]. Particularly striking is the observation of higher average gross margins per acre in the export market, followed by the external market, local market, cleaning point, and farm gate. This pattern underscores the potential for farmers to maximize returns by targeting higher-value market segments such as export and external markets [36]. Additionally, the variation in gross margin ratios across different market outlets sheds light on the distribution of sales revenue among farmers after accounting for production and marketing costs. The lower ratio observed in the export market suggests that despite the prospects of higher revenue, a substantial portion is absorbed by operational expenses [37]. Moreover, the predominant role of brokers and aggregators as key buyers at the farm gate and cleaning point, respectively, highlights the importance of engaging with formal traders to optimize returns, as evidenced by comparatively higher profits compared to direct sales [38].

Table 4 provides a breakdown of gross margins for various market intermediaries, revealing significant profits per unit of carrots sold and indicating potential market influence. However, the disparities in margins between traders and farmers underscore the need to address challenges related to market concentration, price manipulation, and inefficiencies within the value chain [34]. To foster a more equitable and sustainable carrot industry in Nakuru County, interventions targeting the reduction of transaction costs, improvement of market access, and enhancement of farmers' capacity is imperative [27] [29]. These measures are essential for creating an inclusive and resilient market environment that benefits all stakeholders involved in the carrot value chain.

3.4. Challenges and Opportunities along the Carrot Value Chain

In-depth field studies and interviews with carrot producers in Nakuru County, Kenya, have unveiled a myriad of challenges and opportunities inherent in carrot

Table 3. Carrot producers' Gross margin analysis.

Carrot producers' Gross margin analysis per Acre (KES.)					
Market outlet	**Farm gate**	**Cleaning point**	**Local market**	**External market**	**Export market**
Revenue (per acre)	95 Bags @ 800	95 Bags @ 1,300	95 Bags @ 1,500	95 Bags @ 1,800	95 Bags @ 2,500
Item	**Amount (KES.)**				
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 (KES.)					
Inputs					
Pre-planting herbicides	590	590	590	590	590
Seeds	4880	4880	4880	4880	4880
Post planting herbicides	1520	1520	1520	1520	1520
Pesticides cost	2120	2120	2120	2120	2120
Labour					
Pre-planting herbicides labour	420	420	420	420	420
Ploughing	2450	2450	2450	2450	2450
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	3500	3500	3500	3500	3500
Harvesting labour	14,250	14,250	14,250	14,250	14,250
Transport to cleaning point	-	5700	5700	5700	5700
Loading and offloading cost	-	4,750	4750	3800	3800
Cleaning cost	-	14,250	14,250	14,250	14,250
Packaging bag cost	-	-	2850	2850	2850
Transport to local Market	-	-	4750	-	-
Loading and offloading cost	-	-	3800	-	-
Transport to external Market	-	-	-	-	-
Loading and offloading cost	-	-	-	-	-
Transport to export Market	-	-	-	-	57,000
Loading and offloading cost	-	-	-	-	9500
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**
Operating ratio	**0.41**	**0.45**	**0.47**	**0.34**	**0.52**
Gross Margin ratio	**0.59**	**0.55**	**0.53**	**0.66**	**0.48**

Table 4. Gross margin analysis carrot value chain actors.

Market Actors Carrot Gross Margin Analysis (95 bags per Acre)										
Market actors Item	Broker (Middlemen)		Aggregators		Wholesalers		Exporters		Retailers	
	Unit Cost	Amount	Unit Cost	Amount	Unit Cost	Amount	Unit Cost	Amount	Unit Cost	Amount
Tota Revenue per Acre (95 bags)										
Carrot Sales	1300	123,500	1800	171,000	2600	247,000	3150	299,250	3200	304,000
Total Revenue		**123,500**		**171,000**		**247,000**		**299,250**		**304,000**
Variable Costs per Acre (95 bags)										
Purchases	800	76,000	1300	123,500	1800	171,000	1800	171,000	2600	247,000
Transport to cleaning point	40	3800	-	-	-	-	-	-	-	-
Loading and offloading cost	40	3800	-	-	-	-	-	-	-	-
Cleaning cost	150	14,250	-	-	-	-	-	-	-	-
Packaging	30	2850	-	-	-	-	-	-	-	-
Charges/levies	30	2850	60	5700	80	7600	100	9500	100	9500
Transport to external Market	-	-	-	-	220	20,900	-	-	-	-
Loading and offloading cost (External market)	-	-	-	-	80	7,600	-	-	-	-
Transport to export Market	-	-	-	-	-	-	500	47,500	-	-
Loading and offloading cost (Export market)	-	-	-	-	-	-	100	9500	-	-
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**

cultivation, profoundly impacting decision-making processes. These insights align with the conceptual framework's five categories of influence: endogenous influences of socio-economic characteristics, informational influences, experiential influences, and influences of relative change [39] [40] [41]. This section of the manuscript delves into carrot farming-specific issues within these categories, directly or indirectly shaping the decision-making of small-scale farmers regarding subsistence versus commercial farming and alternative crop choices. Key factors include farming and market experience, return on investment, relative production costs and pricing, farm size, information sources, and relative changes in economic conditions. Experiential and observational learning play pivotal roles in shaping farmers' decisions, with efforts to enhance smallholding farm profitability potentially leading to a transition to commercial carrot farm-

ing. Currently perceived as a subsistence crop, carrots hold untapped potential as a cash crop, given their demand in both rural and urban markets. This paradigm shift could prompt a significant portion of the farming population to adopt carrot cultivation, driven by the prospect of increased profit margins due to competitive advantage, as suggested by [42]. However, the realization of this potential hinges on the success of pioneering farmers, rendering this behavioral shift speculative.

3.5. Strategies for Improving Decision-Making

In light of current research, addressing the complexities of improving carrot farmers' decision-making processes remains a formidable challenge. Primarily, the predominant mode of carrot sales occurs through farmer trade, necessitating the implementation of various strategies to enhance backward linkages. Farmer organizations, notably cooperatives, emerge as pivotal actors in bridging smallholder farmers with markets [43] [44]. Contracting arrangements between farmers and buyers offer promising avenues to facilitate market access for smallholders in Kenya, fostering stronger ties between farmers and agribusiness entities. Furthermore, it enhanced produce quality and quantity, alongside reduced transaction costs through streamlined search and information dissemination, as well as minimized price negotiation efforts, which was similar to the suggestion of [45]. Notably, these contracts not only elevate and stabilize smallholder incomes but also enhance production techniques, crop quality, and access to essential resources such as credit and farm inputs. Additionally, to circumvent the inefficiencies and fragmentation prevalent in smallholder carrot markets, vertical integration strategies, such as group formation or collaboration to directly supply supermarkets, present viable alternatives. Crucially, the effectiveness of these strategies hinges on the presence of incentives guiding the decision-making process, with the optimal approach contingent on the socio-economic, political, and cultural context. Policy interventions aimed at enhancing smallholder market participation demand stakeholder engagement and a comprehensive understanding of the prevailing market structure. This proactive approach ensures the mitigation of unintended negative consequences and will be expounded upon in subsequent policy analysis sessions.

4. Conclusion and Recommendations

This study sheds light on the complex dynamics inherent in the carrot value chain in Nakuru County, Kenya, by delving into both the determinants influencing farmers' choices among different market outlets and the analysis of gross margins along the value chain. The findings reveal that a substantial proportion (81%) of surveyed farmers actively participate in various market outlets, including the farm gate, cleaning point, local market, external market, and export market. Notably, key purchasers comprise aggregators, brokers, wholesalers, retailers, and consumers, with transactions predominantly conducted at the farm

level. Moreover, the exploration of determinants unveils significant insights into the decision-making processes of smallholder farmers, underscoring the critical roles played by factors such as gender, age, distance to markets, land size, farming experience, and household characteristics. These insights underscore the multifaceted nature of market outlet selection and offer a nuanced understanding of the challenges and opportunities encountered by farmers in accessing diverse markets. Furthermore, the analysis of gross margins within the carrot value chain provides valuable economic insights, showcasing the potential profitability of carrot farming in the region. Particularly noteworthy are the higher average gross margins observed in export and external markets, signaling promising prospects for farmers focusing on these market segments. However, the existing disparities in profit distribution between farmers and traders emphasize the imperative for interventions aimed at fostering equitable value distribution along the value chain. Strategies geared towards reducing transaction costs, enhancing market access, and bolstering farmers' capacity are indispensable for enhancing overall profitability and sustainability. Hence, the findings of this study contribute to a comprehensive understanding of the carrot value chain in Nakuru County, laying the groundwork for targeted interventions to enhance market access, elevate livelihoods, and promote sustainable agricultural development. Policymakers, development practitioners, and stakeholders can leverage these insights to devise tailored strategies that foster inclusive growth, resilience, and food security within the agricultural sector of the region. Through addressing identified constraints and harnessing opportunities, stakeholders can collaborate towards forging a more vibrant, inclusive, and sustainable carrot value chain that benefits both farmers and consumers alike.

Acknowledgements

The authors extend heartfelt appreciation to everyone who contributed to the successful completion of this study. They offer special thanks to the dedicated team, express gratitude to the carrot farmers in Nakuru County, Kenya, for their invaluable participation and insights, and acknowledge the efforts of the research assistants and field staff. Lastly, they recognize all contributors, whether directly or indirectly involved, for their roles in the research's success. It's important to note that the opinions expressed in this paper are solely those of the authors.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] FAO (2021) FAO Statistical Yearbook 2021: Africa. Food and Agriculture Organization of the United Nations, Rome.

[2] Lokuruka, M.N. (2020) Food and Nutrition Security in East Africa (Kenya, Uganda and Tanzania): Status, Challenges and Prospects. In: Mahmoud, B., Ed., *Food Security in Africa*, IntechOpen.

[3] Radeny, M., Mungai, C., Amwata, D., Osumba, J.J. and Solomon, D. (2020) Climate Change, Agriculture, Food and Nutrition Security Policies and Frameworks in Kenya.

[4] KNBS (2019) Economic Survey 2019. Kenya National Bureau of Statistics, Nairobi.

[5] Government of Kenya (2021) Update on the State of the Horticulture Industry in Kenya 2020. https://fpeak.org/update-on-the-state-of-the-horticulture-industry-in-kenya-2021/

[6] Onyango, M.O. (2016) Contribution of Horticulture to Food and Nutrition Security in Kenya. *African Journal of Food, Agriculture, Nutrition and Development*, **16**, 11363-11380.

[7] Otieno, D.J., Gido, E.O. and Okello, R.O. (2015) Factors Influencing the Choice of Marketing Outlets by Small-Scale Horticultural Farmers in Kenya: The Case of Nyamira County. *Journal of Agricultural and Food Economics*, **3**, 1-18.

[8] Wesonga, J.M. and Opile, W.R. (2017) The Role of Horticulture in Improving Household Food Security in Kakamega County, Kenya. *Journal of Horticulture and Forestry*, **9**, 21-32.

[9] Dijkstra, T. (2018) Trading the Fruits of the Land: Horticultural Marketing Channels in Kenya. Routledge. https://doi.org/10.4324/9780429431340

[10] Poole, N. (2017) Smallholder Agriculture and Market Participation. FAO.

[11] Khoza, S., Mafini, C. and Okoumba, W.V.L. (2022) Lean Practices and Supply-Chain Competitiveness in the Steel Industry in Gauteng, South Africa. *South African Journal of Economic and Management Sciences*, **25**, a4617. https://doi.org/10.4102/sajems.v25i1.4617

[12] Masero, E., Maestre, J.M. and Camacho, E.F. (2022) Market-Based Clustering of Model Predictive Controllers for Maximizing Collected Energy by Parabolic-Trough Solar Collector Fields. *Applied Energy*, **306**, Article 117936. https://doi.org/10.1016/j.apenergy.2021.117936

[13] Kyaw, N.N., Ahn, S. and Lee, S.H. (2018) Analysis of the Factors Influencing Market Participation among Smallholder Rice Farmers in Magway Region, Central Dry Zone of Myanmar. *Sustainability*, **10**, Article 4441. https://doi.org/10.3390/su10124441

[14] Mmbando, F.E., Wale, E.Z. and Baiyegunhi, L.J. (2017) The Welfare Impacts of Market Channel Choice by Smallholder Farmers in Tanzania. *Development in Practice*, **27**, 981-993. https://doi.org/10.1080/09614524.2017.1353066

[15] Okoye, B.C., Abass, A., Bachwenkizi, B., Asumugha, G., Alenkhe, B., Ranaivoson, R., Ralimanana, I., *et al.* (2016) Differentials in Technical Efficiency among Smallholder Cassava Farmers in Central Madagascar: A Cobb Douglas Stochastic Frontier Production Approach. *Cogent Economics & Finance*, **4**, Article 1143345. https://doi.org/10.1080/23322039.2016.1143345

[16] Kipkorir, K.M. (2020) Agricultural Trade Liberalization in Kenya and Implications for Kenya China Trade Relations. *Developing Country Studies*, **10**, 86-93.

[17] Baumüller, H. (2016) Agricultural Service Delivery through Mobile Phones: Local Innovation and Technological Opportunities in Kenya. In: Gatzweiler, F. and von Braun, J., Eds, *Technological and Institutional Innovations for Marginalized Smallholders in Agricultural Development*, Springer, 143-162. https://doi.org/10.1007/978-3-319-25718-1_9

[18] Mwangi, M.W., Nyaga, J.N. and Chweya, J.A. (2020) Analysis of Carrot Production and Marketing in Molo Sub-County, Nakuru County, Kenya. *Journal of Horticulture and Forestry*, **12**, 69-77.

[19] Que, F., Hou, X.-L., Wang, G.-L., Xu, Z.-S., Tan, G.-F., Li, T., *et al.* (2019) Advances in Research on the Carrot, an Important Root Vegetable in the Apiaceae Family. *Horticulture Research*, **6**, 69. https://doi.org/10.1038/s41438-019-0150-6

[20] Singh, M.N., Srivastava, R. and Yadav, I. (2021) Study of Different Varieties of Carrot and Its Benefits for Human Health: A Review. *Journal of Pharmacognosy and Phytochemistry*, **10**, 1293-1299. https://doi.org/10.22271/phyto.2021.v10.i1r.13529

[21] Varshney, R. and Mishra, G. (2022) A Comprehensive Review on *Daucus carota* Linn. *Journal of Drug Delivery and Therapeutics*, **12**, 76-84.

[22] Khalid, S., Shahid, M., Irshad Bibi, N., Sarwar, T., Shah, A.H. and Niazi, N.K. (2018) A Review of Environmental Contamination and Health Risk Assessment of Wastewater Use for Crop Irrigation with a Focus on Low and High-Income Countries. *International Journal of Environmental Research and Public Health*, **15**, Article 895. https://doi.org/10.3390/ijerph15050895

[23] Mwaniki, F.N. and Nyamu, F.K. (2022) Reducing Food Loss in Kenya for a Sustainable Food Future. In: Leal Filho, W., Kovaleva, M., Popkova, E., Eds., *Sustainable Agriculture and Food Security*, Springer International Publishing, 311-326. https://doi.org/10.1007/978-3-030-98617-9_18

[24] Anderson, P.J., De Luca, C.R., Hutchinson, E., Spencer-Smith, M.M., Roberts, G., Doyle, L.W. and Victorian Infant Collaborative Study Group (2011) Attention Problems in a Representative Sample of Extremely Preterm/Extremely Low Birth Weight Children. *Developmental Neuropsychology*, **36**, 57-73. https://doi.org/10.1080/87565641.2011.540538

[25] Bayaga, A. (2010) Multinomial Logistic Regression: Usage and Application in Risk Analysis. *Journal of Applied Quantitative Methods*, **5**, 288-297.

[26] Greene, R.L. (2000) The MMPI-2: An Interpretive Manual. Allyn & Bacon.

[27] Dalton, T.J., Dixon, B.L. and Lee, R.D. (1980) Estimation Specification of Market Margins for Agro-Based Products along the Value Chain. *Agricultural Economics*, **4**, 145-163.

[28] Olwande, J., Smale, M., Mathenge, M.K., Place, F. and Mithöfer, D. (2015) Agricultural Marketing by Smallholders in Kenya: A Comparison of Maize, Kale and Dairy. *Food Policy*, **52**, 22-32. https://doi.org/10.1016/j.foodpol.2015.02.002

[29] Ochieng, D.O., Botha, R. and Baulch, B. (2020) Market Information and Access to Structured Markets by Small Farmers and Traders: Evidence from an Action Research Experiment in Central Malawi. MaSSP Working Paper 33, International Food Policy Research Institute, Washington, DC.

[30] Tarekegn, K., Haji, J. and Tegegne, B. (2017) Determinants of Honey Producer Market Outlet Choice in Chena District, Southern Ethiopia: A Multivariate Probit Regression Analysis. *Agricultural and Food Economics*, **5**, Article No. 20. https://doi.org/10.1186/s40100-017-0090-0

[31] Dlamini-Mazibuko, B.P., Ferrer, S. and Ortmann, G. (2019) Factors Affecting the Choice of Marketing Outlet Selection Strategies by Smallholder Farmers in Swaziland. *African Journal of Science, Technology, Innovation and Development*, **11**, 569-577. https://doi.org/10.1080/20421338.2018.1554323

[32] Kilambya, D. and Witwer, M. (2019) Analysis of Incentives and Disincentives for Sorghum in Kenya. *Gates Open Research*, **3**, 441.

[33] Mwangi, M. and Crewett, W. (2019) Rural Youth and Horticultural Commodity Chains in Kenya: A Gendered Analysis. *The Journal of Development Studies*, **55**, 679-696.

[34] Nwafor, C.U., Ogundeji, A.A. and Van der Westhuizen, C. (2020) Adoption of ICT-Based Information Sources and Market Participation among Smallholder Livestock Farmers in South Africa. *Agriculture*, **10**, Article 44. https://doi.org/10.3390/agriculture10020044

[35] Mohammed Kassaw, H., Birhane, Z. and Alemayehu, G. (2019) Determinants of Market Outlet Choice Decision of Tomato Producers in *Fogera woreda*, South *Gonder* Zone, Ethiopia. *Cogent Food & Agriculture*, **5**, Article 1709394. https://doi.org/10.1080/23311932.2019.1709394

[36] KARI and ILRI (2005) Assessment Studies Involving Smallholder Horticultural Producers in Central and Eastern Kenya.

[37] Mango, N., Lundy, M., Makate, C., Jager, M. and Francesconi, N. (2018) Determinants of Market Participation and Marketing Channels in Smallholder Groundnut Farming: A Case of Mudzi District, Zimbabwe. *African Journal of Science, Technology, Innovation and Development*, **10**, 311-321. https://doi.org/10.1080/20421338.2018.1457274

[38] Maritim, K.K., *et al.* (2004) Contracting Between Smallholders and Buyers: A Case Study of the Indigenous Chicken Market in Western Kenya. *Quarterly Journal of International Agriculture*, **43**, 75-94.

[39] Ismail, I.M. (2013) Effects of the Increase of Supermarkets on Vegetable Supply Systems of Small-Scale Farmers in Kenya. Master's Thesis, Jomo Kenyatta University of Agriculture and Technology.

[40] Shipman, E.N., Yu, J., Zhou, J., Albornoz, K. and Beckles, D.M. (2021) Can Gene Editing Reduce Postharvest Waste and Loss of Fruit, Vegetables, and Ornamentals? *Horticulture Research*, **8**, 1. https://doi.org/10.1038/s41438-020-00428-4

[41] Bannor, R.K., Oppong-Kyeremeh, H., Kyire, S.K.C., Aryee, H.N.A. and Amponsah, H. (2022) Market Participation of Urban Agriculture Producers and Its Impact on Poverty: Evidence from Ghana. *Sustainable Futures*, **4**, Article 100099. https://doi.org/10.1016/j.sftr.2022.100099

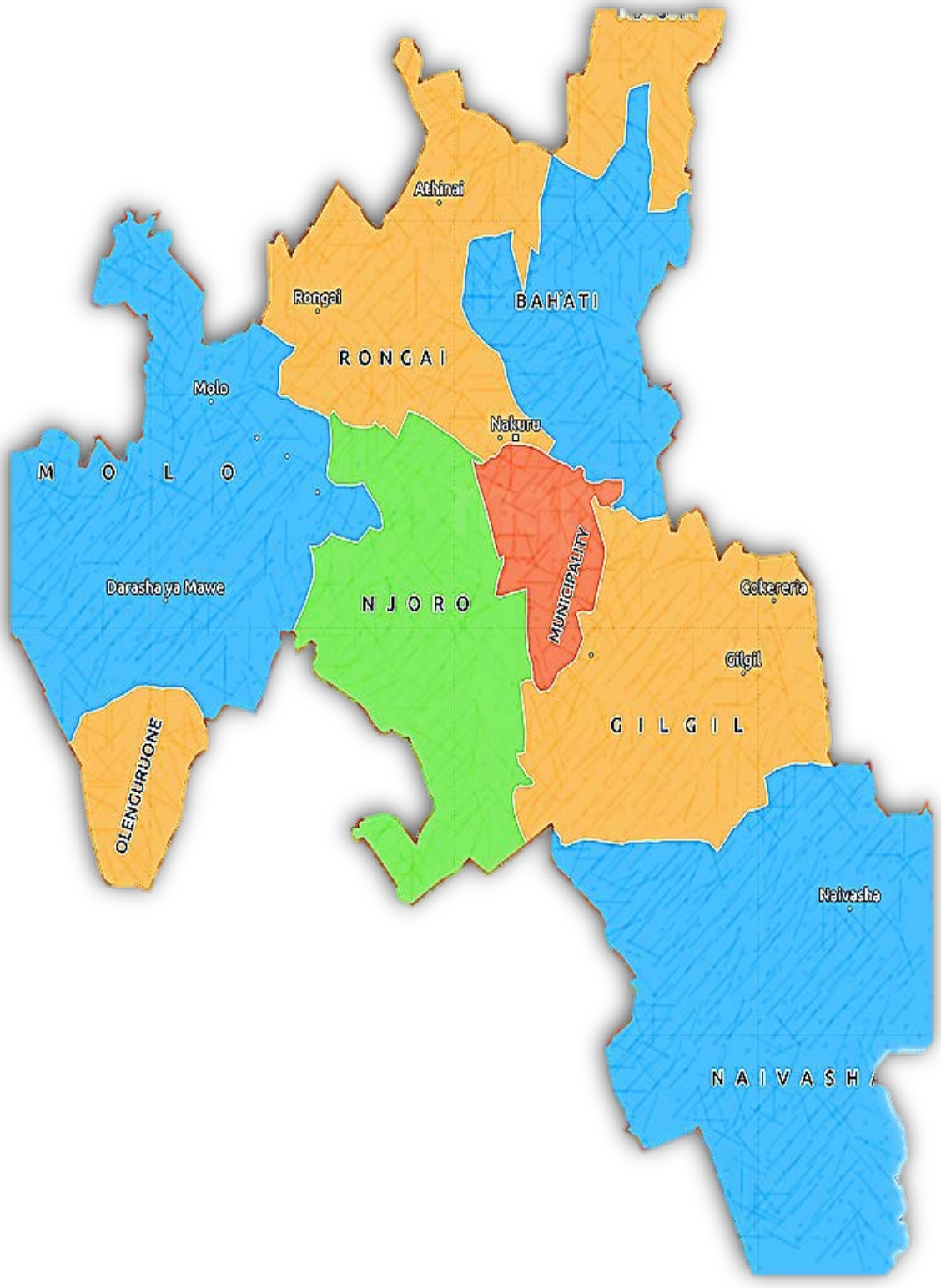
[42] Sanganza, H. (2021) A Competitive Advantage Analysis of South African Vegetable Sector: Tomatoes, Carrots and Onions. Ph.D. Thesis, Stellenbosch University.

[43] Muriithi, B.W. and Matz, J.A. (2015) Welfare Effects of Vegetable Commercialization: Evidence from Smallholder Producers in Kenya. *Food Policy*, **50**, 80-91. https://doi.org/10.1016/j.foodpol.2014.11.001

[44] Meador, J.E., O'Brien, D.J., Cook, M.L., Grothe, G., Werner, L., Diang'a, D. and Savoie, R.M. (2016) Building Sustainable Smallholder Cooperatives in Emerging Market Economies: Findings from a Five-Year Project in Kenya. *Sustainability*, **8**, Article 656. https://doi.org/10.3390/su8070656

[45] Abouaziza, M. (2022) Farmer Constraints and Relational Contracts: Evidence from Agricultural Value Chains in East Africa. Ph.D. Thesis, University of Sussex.

Appendix 1. Map of Study Area



Appendix 2.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. *0 = Head* *1 = Spouse* *3 = Brother/Sister* *4 = Child* *5 = other*	Sex 1 = M 2 = F	Year of birth	Educational level *0 = None* *1 = primary, 2 = secondary* *3 = college/tertiary* *4 = university*	Experience in carrot production (Years)
1						
2						
3						
4						
5						
6						

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		
2 = Production/sale of livestock & livestock products		
3 = Agricultural output trading,		
4 = Agricultural input trading		
5 = Salaried employment		
6 = Casual laborer		
7 = Pension		
8 = Remittances (income from relatives/friends etc)		
9. Others (specify)…….		

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 Tick
			Satisfied	Less satisfied	Not satisfied	
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 farmers 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 3. 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. What variety of carrots do you trade in?

	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 *1. Local Shops* *2. Super markets* *3. Middlemen* *4. Local market vendors* *5. Exporters* *6. Processors* *7. Major towns* *8. Other specify* _____	Distance to source (Km)	Mode of transport *1. Donkey* *2. Camel* *3. Pick-up* *4. Lorry* *5. Wheel burrow* *6. Hand cut* *7. Oxen* *8. Manpower* *9. Other specify* _____	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 *1. Consumers* *2. Aggregators* *3. wholesellors* *4. Exporters* *5. Processors* *6. Retailers* *7. Other specify* _____	Distance to selling point (Km)	Mode of transport 1. *Donkey* *2. Camel* *3. Pick-up* *4. Lorry* *5. Wheel burrow* *6. Hand cut* *7. Oxen* *8. Manpower* *9. Otherspecify* _____	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 4. Description of Variable Used in Multinomial Logit (MNL) Model

Marketing outlet Choice (Dependent variable)		*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	+
ACESS-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 located in rural area and 0 otherwise	+/−
EXP	Experience	Years	+
SP	Output price	Ghana cedi	−
DIST_TARMAC	Distance from farm to nearest tarred road	Distance in km from farm to nearest tarred 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	+/−