EFFECTS OF VERTICAL MARKET LINKAGES ON THE COMMERCIALIZATION OF AFRICAN LEAFY VEGETABLES IN BUNGOMA COUNTY, KENYA

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

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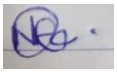
DECLARATION & RECOMMENDATION

Declaration

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

Signature:  Date: 15th August 2023

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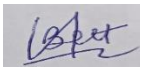
Signature:  Date: 12 August 2024

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DEDICATION

This thesis is dedicated to the Almighty God for walking with me throughout this journey and for always making everything happen in my favor and to my late grandfather Abel Nambafu for always believing in me, being my cheerleader and my encouragement, he would be more than happy to see his dreams coming true, may his soul continue resting in peace.

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ABSTRACT

Smallholder African Leafy Vegetables (ALV) farmers face numerous challenges in accessing output markets, resulting in low levels of ALV commercialization. Among other challenges, are transaction uncertainties, limited access to market information, and high transaction costs such as the cost of searching, bargaining, and market monitoring that hinder the commercialization of ALVs among smallholder farmers. To be competitive in the commercialization of ALVs, there is need for vertical market linkages to be incorporated between African Leafy Vegetables (ALVs) producers and other market actors. Therefore, this study aimed to contribute to improved livelihoods among ALV producers in Kenya by evaluating the effect of vertical market linkages on the commercialization of ALVs. Multistage sampling was used to select 384 respondents in Kimili and Kabuchai sub-counties in Bungoma County. Through a cross-sectional survey, data was collected using a semi-structured questionnaire. The results of the study revealed that smallholder ALV farmers largely participate in producer-to-final consumer vertical market linkage and producer to retailers vertical market linkages at 98.7% and 91.7% levels respectively. Results from the fractional regression revealed that the factors that significantly influenced the commercialization of ALVs among smallholder farmers were, the education level of the farmers, land size, distance to the markets, ALV yields, ALV cost of production, average price and the value-added. The Multinomial Endogenous Switching Regression model revealed that none of the smallholder ALV farmers participates in a single vertical market linkage, instead, they participate in seven (7) different combinations of vertical market linkages. The model further revealed that the highest commercialization is achieved when smallholder ALV farmers participate in producer-processor and producer-final consumer linkages both for the treated and the counterfactual scenarios. The study recommends increasing linkages by considering payment methods that favor farmers and formalizing the relationships between smallholder ALV farmers and processors to maintain a steady demand and ensure the realization of better prices for the ALVs produced. Building the capacity of smallholder farmers to understand the business-related benefits associated with the different combinations of vertical market linkages is critical to enabling g smallholders to increase their involvement in ALV commercialization. Prioritizing interventions and policies that facilitate vertical market linkages through capacity and infrastructure development, market information dissemination and formalization of relationships can further promote the development of vertical market linkages among smallholder farmers.

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LIST OF ABBREVIATIONS AND ACRONYMS

ALVs African Leafy Vegetables

ASL Above Sea Level

ATT Average Treatment on the Treated

GDP Gross Domestic Products

HCDA Horticultural Crops Development Authority.

HCI Household Commercialization Index

MESRM Multinomial Endogenous Switching Regression model

MT Metric Tonnes

SPSS Statistical Package for Social Sciences

TCE Transaction Cost Economics

TVA Transaction Value Analysis

CHAPTER ONE

INTRODUCTION

1.1 Background Information

African leafy vegetables are defined as locally important species for the sustainability of economies, human health, nutrition, and social systems but they have yet to attain global recognition to the same extent as major vegetable commodities such as tomatoes or cabbage (Fang *et al*., 2015). African Leafy Vegetables (ALVs) are vegetable crops whose natural habitat originated in Africa and whose roots, fruits, or leaves are used and largely acceptable by rural and urban communities as vegetables through habit, custom, and tradition (Muhanji et al., 2011). African leafy Vegetables have long been considered staple food crops though their promotion in terms of production and marketing has gained attention just recently (Kebedde & Bokelman, 2017). This is attributed to the fact that they are considered food for rural and poor households only.

The area under ALVs production in Kenya is 45,099 ha with a total volume of 224,751 MT worth USD 56,215,149 (Alulu *et al*., 2019). ALVs in Kenya are about 200 different species (Bokelman *et al.*, 2022). They include; spider plant, vegetable amaranth, black nightshade, cowpea , jute mallow, vine spinach, chlotolaria, pigweed, pumpkin leaves, sunn hemp and many others, (Riziki, 2015). The most widely produced ALV in rural and urban areas of Kenya are African nightshade and cowpeas produced by over 72% and 48% of smallholder farmers respectively, but others include amaranth, and spider plant, (Kebedde & Bokelman, 2017). African leafy indigenous Vegetables are produced by rural smallholders largely in Western Kenya and other parts of the country. They are produced in Kisii, Kakamega, Nakuru, Kiambu, and Kajiado among others. According to Kebedde and Bokelman (2017), it is noteworthy that peri-urban areas account for over 10% of the total national production of African nightshade in Kenya

African Leafy Vegetables have gained attention and high demand in most cities as compared to other leafy vegetables (Henze *et al*., 2021). About 90% of vegetables produced in Kenya are consumed locally (Alulu *et al.*, 2019). The increased consumption of ALVs is attributed to the increased awareness of their nutritional value among Kenyans in urban areas (Chelang'a *et al*., 2013). They are largely supplied to urban areas through informal markets (Bokelman *et al*., 2022). They are predominantly produced and marketed by women. African leafy Vegetables are bought by intermediaries who resell them in urban markets at retail prices.

The marketing of ALVs is influenced by perishability, price and quantity variations, seasonality of the product, and geographic specialization (Riziki, 2015). ALVs are largely marketed while fresh across vegetable species, destinations, and locations. Rural dwellers prefer buying ALVs from local open-air markets while urban dwellers prefer green food markets (Bokelman *et al*., 2022). Most of the ALV smallholder farmers prefer selling their ALVs produce in open-air markets due to immediate payments while some farmers prefer farm gate marketing due to proximity to buyers (Riziki, 2015). Most ALV markets open early in the morning and are open all day (Bokelman *et al.*, 2022). Prices of ALVs are determined by the market forces of supply and demand with prices dropping in the rainy season and skyrocketing in the dry season (Bokelman *et al.,* 2022). According to Wachuka and Majiwa (2019), over 35% of ALV producers in Kenya produce for commercial purposes, and only 30% of the total ALVs produced in Kenya are marketed, implying that there is low commercialization.

The Barriers that were found to influence the commercialization of ALVs include market distance due to the perishability of the products; volatility of the market prices due to seasonality plus opportunistic market behaviour deprives farmers of profits (Bokelman *et al*., 2022). ALV marketing is affected by lack of reliable market information, lack of price-setting mechanisms, poor transport facilities, high perishability, inadequate market linkages, and high post-harvest losses due to a lack of storage facilities (Agbugba *et al*., 2011). ALV farmers lack information on prices and technology, have weak connections with market actors, incur high transaction costs, and face challenging credit constraints (Wachuka & Majiwa, 2019). To overcome the barriers to commercialization, a multidimensional approach that involves increasing smallholder farmers' access to sustainable markets is required (Fangel & Ifeoma, 2021). This can be achieved through close vertical market linkages between farmers and other market actors.

On the other hand vertical market linkage refers to closer vertical coordination that exists between specific players in the supply chain as the agricultural sector moves from commodity spot markets towards a tighter, more specified linkage (Mercy Cops, 2017). Vertical market linkages are the relationships between participants with adjacent roles within the value chain, as the product is enhanced or services are added through the chain (Kibuchi, 2017). Vertical market linkages link farmers to lucrative markets which implies that farmers are made better off with production and marketing risks addressed thus contributing to resilience building. Vertical market linkages enable farmers to bounce back to a normal or better position after facing shocks (Fangel & Ifeoma, 2021). Vertical market linkages enhance information sharing on market prices, and consumer changes, enhancing the delivery of

products on time and desired quality and quantity thus reducing transaction costs (Thongrattana, 2012). According to Kibuchi (2017), in Kenya, vertical market linkages reduce uncertainty and information asymmetry and influence the performance of producers.

Several studies about ALVs that have been conducted in Kenya have largely focused on the nutritional benefits of ALVs, effects of ALVs on household income, food security effects of ALVs, production, consumption and marketing of ALVs, factors for adoption of ALVs, Consumers demand on value-added products of ALVs, challenges to commercialization of ALVs and demand for ALVs (Alulu *et al.,* 2019; Bokelman *et al.,* 2018; Bokelmann *et al.,* 2022; Gido *et al.,* 2017; Gido, 2022; Henze *et al*., 2021; Kebedde & Bokelman, 2017; Musotsi *et al.,* 2018; Riziki, 2015). There is insufficient documented evidence that shows the relationships between vertical market linkages and the commercialization of ALVs. ALVs smallholder farmers need the transformation of ALVs production particularly focusing on vertical linkages in the chain. This expansion provides new channels for ALV commercialization in Bungoma County. Therefore, there is a need to evaluate the different vertical market linkages contributions to the commercialization of African leafy vegetables among smallholder farmers.

1.2 Statement of the Problem

The demand for ALVs in Kenya has tremendously increased due to increased nutritional awareness. However, only 30% of the total ALVs produced in Kenya are marketed thus low commercialization. This is attributed to limited access to market information, high transaction costs and market uncertainties. Vertical market linkages have been widely acknowledged as a means by which smallholder farmers can gain a competitive advantage in the market. However, smallholder ALV producers are not connected to actors beyond their local community. Understanding and facilitating vertical market linkages is needed to provide access to more promising and high-value market opportunities. Studies about ALVs in Kenya have largely focused on the production, marketing, consumption, income, and nutritional benefits of ALVs. Specifically, they have focused on production practices, structure, conduct, and performance of ALV markets, marketing channels, and outlets and the role of ALVs towards improving, food, income, and nutrition security. None of the studies has discussed the effect of vertical market linkages on the commercialization of ALVs. Thus, the study closes the information gap by focusing on the effects of vertical market linkages on the commercialization of ALVs among smallholder farmers.

1.3 General Objectives

To contribute to improved livelihoods among African leafy Vegetable smallholder farmers in Bungoma and Kenya by evaluating the effect of vertical linkages on commercialization of ALVs.

1.3.1 Specific Objectives

i. To determine the vertical market linkages that exist between smallholder ALV farmers and other actors in Kimilili ward in Bungoma County.
ii. To determine the factors that influence the commercialization of African leafy indigenous vegetables (ALVs) among the smallholder farmers in Bungoma County.
iii. To determine the effect of vertical market linkages on commercialization of African leafy vegetables (ALVs) in Bungoma County.

1.4 Research Questions

i. What vertical market linkages exist between smallholder ALV farmers and other value chain actors in Kimilili wards in Bungoma County?
ii. What factors influence the commercialization of African leafy vegetables (ALVs) among smallholder farmers in Bungoma County?
iii. What are the effects of vertical market linkages on commercialization of African leafy indigenous vegetables (ALVs) among smallholder farmers in Bungoma County?

1.5 Justification of Study

The production of leafy vegetables by smallholder farmers is invaluably important in different counties and for different types of economic activities, for example, both subsistence and commercial value and contributes directly to improved livelihood and food security (Momanyi, 2016). The production of leafy vegetables adaptable to the local environment, can in the long run improve the food situation, nutrition, and health of the people by reducing over-reliance on specific crops like maize. This is because the vegetable sub-sector creates a lot of employment opportunities, and affects the GDP and development of the country's economy. The horticulture industry in Kenya employs about 350,000 people directly and supports over 6 million livelihoods (Fresh Produce Exporters Association of Kenya, 2020). Improvement of ALVs such as spider plant, vegetable Amaranthus, cowpeas, African nightshade, and jute mallow marketing and production will result in sustainable income generation for women,

since the production and marketing of ALVs are often the domain of women farmers, whereas men tend to dominate the exotic crop sector.

The study considered ALVs smallholder farmers in Kimilili and Kabuchai sub-counties because they are the locations with major ALVs producers within Bungoma county. The market chain and consumption of ALVs are necessary resources for policy formulation that could impact directly the socio-economic aspects of the country. This can help tackle the challenges of hunger and malnutrition by creating a market structure that does not discriminate against any products that need to be sold. The market chain and consumption of ALVs are necessary resources for policy formulation that could impact directly on the socio-economic, and help tackle challenges of hunger and malnutrition. Justification for this study is based on the proposition that there is an opportunity to improve ALV commercialization through frequent sharing of accurate and relevant information, minimizing transaction costs and uncertainties as well as collaborating among actors by developing vertical linkages.

The study exposes a better understanding of ALV activities since current literature is lacking on expounding the relationship between vertical market linkages and the commercialization of ALVs in Kenya. The study has generated useful information that could be used to formulate policies and guidelines for interventions that would improve the efficiency of vertical market linkages between smallholder ALV farmers and other actors along the ALV value chain. The study contributes to the attainment of the objectives of the Bungoma County Integrated Development Plan (CIDP), the BIG four agenda and SDGS 1,2 and 3 by improving food, income, and nutrition security.

1.6 Scope and Limitations

This study analyzed the effect of vertical market linkages on the commercialization of African leaf Vegetables (ALVs) in Kimilili and Kabuchai sub-counties in Bungoma County. These sub-counties are regarded as the area of major production zones for African Leafy Vegetables. More specifically, the study focused on AIV's vertical market linkages and did not generalize on vertical market linkages of other agricultural products. The study only focuses on 5 ALVs namely Vegetable amaranth, jute mallow, spider plant, African nightshade and cowpea. The 5 AIVs were chosen after reconnaissance in the study area and after confirmation with the respective sub-county agricultural officers.

The study did not include other forms of linkages such the horizontal linkages, partnerships, or governance structures such as full integration. The sample population for this study was smallholder ALV farmers. The way vertical market linkage affects smallholder

farmers may have variations with the way medium and large-scale farmers can be affected. The findings of this study are based on self-reported cross-sectional data and therefore may not reflect the changing situations and nature of relationships between and among actors.

1.7 Definition of Terms

Commercialization - This is the transformation from the production of ALVs for household consumption to production for marketing. It is measured based on the percentage of ALVs sold by a smallholder ALV producer.

Cost incurred - refers to an expense that a Company needs to pay in exchange for the usage of a service, product, or asset.

Formal market - refers to the official ALV marketing system in which the market is controlled by the government.

Informal market - refers to ALVs marketing system in which the government does not intervene in marketing.

Market actor - Someone who is active in the ALVs market such as collectors, wholesalers, cooperatives, unions, and retailers which is the same as a market participant.

Market channel - Group of people or organizations that direct the flow of ALVs from production areas to consumers.

Transaction cost - Transaction costs are expenses incurred when buying or selling a good or service.

Transaction Cost Economics - Cost in making any economic trade when participating in a market.

Transaction Value Analysis - Method to achieve cost reduction by analyzing the utility or value of a product, service, or process about the cost incurred.

Transaction uncertainty - Uncertainty simply means the lack of certainty or sureness of an event. In accounting, uncertainty refers to the inability to foretell consequences or outcomes because there is a lack of knowledge or bases on which to make any predictions.

Information asymmetry - Information asymmetry is an imbalance between two negotiating parties in their knowledge of relevant factors and details.

Vertical market Linkage - Vertical market linkage is the process that provides producers with access to additional information about the requirements of consumers, thereby enhancing the flow of market information back down the supply chain.

On-farm or farmer's market - A physical retail marketplace intended to sell foods directly by farmers to consumers.

Smallholder farmers - A farmer who owns a small farm operating under a small-scale agriculture model.

CHAPTER TWO

LITERATURE REVIEW

2.1 African Leafy Vegetables in Kenya

African Leafy vegetables (ALVs) are a native plant originating from Africa whose leaves are edible and have been used as vegetables in most parts of Africa hence becoming part of the African culture and tradition of some communities (Magogo, 2015). ALVs represent more than 200 species grown in Kenya that are important in traditional diets (Otieno *et al.*, 2019). They include; spider plant, vegetable amaranth, black nightshade, vegetable cowpea, and jute mallow (Magogo, 2015). According to Kebedde and Bokelman (2017), the most widely produced ALV in rural and urban areas of Kenya are African nightshade and cowpeas produced by over 72% and 48% of smallholder farmers respectively. ALVs are produced by rural smallholders largely in Western Kenya and other parts of the country. They are produced in Kisii, Kakamega, Nakuru, Kiambu, and Kajiado among others (Kebedde & Bokelman, 2017). However, ALVs are mainly produced on a subsistence basis (Bokelman *et al.*, 2022). In most cases, they are intercropped and rarely occupy a significant proportion of the farm occupying areas around the house (Otieno *et al*., 2019).

The production and marketing of ALVs is associated with numerous benefits such as contributing to healthy diets, sustainable food production and climate change adaptation, improving smallholder incomes, rural development through job creation most especially for women and acceptance through cultural embeddedness (Bokelman *et al*., 2017). They are known for their nutritional benefits since they contain essential nutrients, proteins, vitamins, and minerals (Omotayo *et al*., 2020). They are rich in vitamins A and C, fiber, and minerals (Henze *et al*., 2021). This presents an enormous opportunity to generate income and provide employment among most smallholder farmers amidst the current skyrocketing population growth in Kenya of 2.3 percent (World Bank Data, 2021). ALVs equally present numerous health benefits since they are used as herbs in rural areas (Agbugba *et al*., 2011).

A study conducted by Alulu *et al*. (2019) notes that the production and marketing of ALVs face numerous challenges. The challenges include high input costs resulting in high production costs, sustained low output prices, unreliable markets, poor infrastructure, seasonality, high transaction costs due to limited access to market information, limited access to financial services and poor institutional environment. Agbugba *et al*. (2011) agree that ALV marketing is affected by unreliable market information, inadequate of price setting mechanism,

poor transport facilities, high perishability, inadequate market linkages and high post-harvest losses due to limited access to storage facilities.

African Leafy Vegetables (ALVs) are largely marketed while fresh across vegetable species, destinations, and locations. Rural dwellers prefer buying ALVs from local open-air markets while urban dwellers prefer green food markets (Bokelman *et al*., 2022). Most of the ALV farmers prefer selling their produce in open-air markets due to immediate payments while some farmers prefer farm gate marketing due to proximity to buyers (Riziki, 2015). Most ALV markets open early in the morning and are open all day (Bokelman *et al.*, 2022). Prices of ALVs are determined by the market forces of supply and demand with prices dropping in the rainy season and skyrocketing in the dry season (Bokelman *et al*., 2022). Agbugba *et al*. (2011) divide the markets in which ALVs are sold into formal and informal. Formal markets include supermarkets, wholesale markets, free markets, and retail shops while informal markets include door-to-door and road side markets.

2.2 Vertical Market Linkages that Exist Between Smallholder ALVs Farmers and Other Actors.

Vertical market linkages refer to market and non-market relationships between firms operating at different levels of the value chain (Odunze, 2015). According to Castro (2021), vertical market linkages are explored as a broader marketing channel involving out-grower schemes and mostly other vertical integration forms between agricultural production and the agro-processing industry and marketing. According to Pingali *et al.* (2019), Vertical market linkages are modes of exchange in which producers and buyers bypass existing marketing channels to ensure the supply of quality agricultural goods, in demanded quality at a stipulated time. Vertical market linkages represent channels for the transfer of learning, information, and technical, financial, and business services from one firm to another along the chain (USAID, 2021). Kibuchi (2016) defines vertical market linkages as the relationships between participants with adjacent roles within the value chain, as the product is enhanced or services are added through the chain. According to Uddin (2011), vertical market linkages refer to how the structure of producers, processors and retailers are organized in the food supply chain so that each successive stage in the production, processing and marketing of a product is appropriately managed and interrelated. The nature of the relationships and the efficiency of the transactions among firms that are vertically linked in a value chain affect the competitiveness of the entire industry. However, the specific effect of vertical market linkages on the effectiveness of commercialization of ALVs in Kenya is not known.

Morover, the relationships between buyers and their suppliers are often indicative of the larger economic order and closely related to the relative size and resources of each player (Odunze, 2015). There are vertical market linkages between farmers and other market actors, traders, processors, agrifood companies, and retailers (Zhang, 2014). The most common forms of vertical market linkages according to Odunze (2015) include contract farming, production contracts and marketing contracts. Contract farming is a contractual arrangement between producers and buyers of a farm product. The contract can either be oral or written and will specify one or more conditions of production and marketing of an agricultural product. A marketing contract is an agreement between a contractor and a grower that specifies some form of a price or pricing system and outlet ex-ante. Production contracts are more extensive forms of coordination and typically include detailed production practices, inputs supplied by the contractor, specifications regarding the quantity and quality of a commodity and a price or pricing system. Contractors between ALV smallholder farmers may be with supermarkets, processors, hotels, restaurants, and institutional buyers. Other forms of vertical linkages include franchising, strategic alliances, joint ventures, and full vertical integration (Young & Hobbs, 2003). The studies reviewed largely focus on high-level vertical linkages such as joint ventures, alliances and franchises; There is a need to understand the informal vertical linkages that exist within the ALV supply chain.

A key issue to ponder is which type of vertical market linkage is better for smallholder farmers on behalf of their interests while helping them to access markets (Zhang, 2014). Odunze (2015) argues that vertically linked farmers can access markets that were formerly out of reach for them. She added that vertical linkage is linked with increased incomes, reduction in the risk of price fluctuations, and opportunities for lending to farmers who would otherwise be ineligible for credit. Other advantages are the timely provision of inputs and products to markets; managing the productivity of smallholder farmers; reducing their risk in the event of crop failure; improved awareness of the need for collective efforts for farmers' common good; and promotion of group and farmer association development. Vertical market linkages are equally associated with improved food security, which results from the adoption of improved husbandry methods, improved access to extension advice and other technical assistance that would, otherwise, not be available to farmers under normal circumstances. Production contracts offer support such as the provision of credit, technical assistance, and/or transportation. There is still a need to understand extra benefits and support received by producers engaged in vertical linkages specifically focusing on ALVs.

According to Chaudhuri and Dwibedi (2014), vertical linkages ensure a lower interest rate in the informal credit market and ensure better-borrowing terms. Kibuchi (2016) reveals that vertical market linkages would enhance the sharing of information on market prices, and consumer changes, thus reducing the need to inspect quality and enhance the delivery of products on time in the quality and quantity desired. Young and Hobbs (2003) argue that vertical market linkages reduce transaction costs, uncertainty, and information asymmetry. Sharing of accurate and timely as well as relevant information reduces the need for buyers to monitor supplier deliveries and the quality of inputs as well reduces the need to enforce penalties in the case of lower-quality inputs (Cuong *et al.,* 2011). Vertical market linkage relationship is associated with improved product quality which ultimately rewards supplier involvement in quality (Hansman *et al.,* 2020). Vertical relationships are important in moving knowledge and benefits down the chain (Korir, 2018). According to Pingali *et al*. (2019), vertically coordinated markets where the intermediaries are bypassed and reduced transaction costs mitigate supply risks and establish grades and standards. There is a need to understand how factors affecting commercialization are mitigated by an individual's participation in vertical linkages.

2.3 Factors Influencing the Commercialization of ALVs

Commercialization is defined as a process involving the transformation from production for household subsistence to production for market purposes (Adeniyi, 2021). Banor *et al*. (2022) defined agricultural commercialization as the proportion of agricultural production that is marketed while APRA (2017) defines agriculture commercialization as the reliance of agricultural enterprises and/or the agricultural sector increasingly on the market for the sale of produce and the acquisition of production inputs, including labor. It involves raising the earnings of smallholder agricultural-related enterprises, increasing units of output, raising the value added and producing for domestic and foreign markets. However, the degree of participation in the output market is a conventional way to measure commercialization which acts as a contingent through which the availability of input and output markets, Agro-climatic conditions and risks, infrastructure, community, and household resource and asset endowments; development of local commodities, input, laws, and institutions are the determinant factors (Akinlade *et al.,* 2016).

Further, the production that is oriented towards the market can respond to remunerative opportunities resulting in consumers willing to pay much more for a product than the producers themselves are willing to pay, due to differences in income levels, preferences, etc (APRA (2017). The condition for benefits that are gained is that the transportion and transaction costs

are lower than the price differential that can be achieved through trade. Production that is oriented toward the market has the potential to make the most efficient use of smallholders' resources, if they can specialize in production activities in which they have a comparative advantage. Where production for the market does increase the profits from farming, this permits a dynamic process of asset accumulation to occur. Commercialization is often associated with increased productivity in agricultural production through increased use of capital inputs and good agricultural practices. Smallholder commercialization can lead to expansion of demand for manufactured goods and services produced in major urban centers, and rapid expansion of 'rural towns' can be observed in periods of sustained high prices or productivity increase.

Tobit model was used in this case to reveal that ownership of livestock, gender, land size, access to credit, household size, off-farm income, membership in farmer organization and distance to markets were very important for effective crop commercialization. Seyom *et al.* (2011) used OLS to indicate that farm size allocated, access to irrigation and access to market information are significant in affecting the degree of commercialization. Nnandi *et al.* (2018) used the Ordinary Least Square Multiple Regression Technique to indicate that commercialization was influenced by farm size, age of the cooperative, expenditure on the seed, extension education campaign and access to the export market. Sharma and Wardhan (2015) further identified high market prices, changing demand, preferences for high-value agricultural products, adoption of new agricultural technologies, increased investment in agriculture, and export opportunities, etc. as drivers of agricultural commercialization.

Further, Heckman maximum likelihood sample selection model concluded that cooperative membership and land tenure security raises the commercialization Lawin & Zongo, 2016). Zondi *et al*. (2021) employed the Household commercialization index (HCI), T-test, description analysis, and a double hurdle model with a quasi-maximum likelihood fractional response model were employed to demonstrate that a farmer's decision to participate in the market is highly dependent on gender, off-farm income, access to market information, and a family member being infected by HIV. Chirwa and Matita (2012) demonstrated that the extent to which smallholder farmers commercialize depends on many factors including the age of household heads, household size, food security, access to fertilizers, and benefits derived from participation in farmer organizations.

On the other hand, farming systems was classified as subsistence, semi-commercial, and commercially based on market orientation (Banor *et al.,* 2021). Under subsistence farming, farmers solely produce for household consumption, semi-commercial farmers produce for both

household consumption and market while commercial farming is entirely concerned with production for the market. Seyom *et al.* (2011) note that agricultural production in Africa is at subsistence level and the degree of commercialization is both low and varies across the continent. According to Zondi *et al.* (2021), about half of the farmers (51%) in SSA are still operating almost at the subsistence level, and a large number (31%) of the farmers are still at low-medium levels while the rest (18%) are high -level market participants. This is supported by Krowse and Grote (2019) who explained that 63 % of agricultural output in Kenya is still generated by small-scale farmers who are simultaneously producers and consumers.

Smallholder farmers in developing countries are faced with a multitude of challenges that hinder their participation in commercialization of indigenous crops (Nnandi *et al.*, 2018). The constraints include lack of production and marketing knowledge, information and skills, poor quality infrastructure, inadequate storage facilities, high transaction costs, and over-reliance on traditional social networks and mechanisms for marketing their produce (Zondi *et al.*, 2021). This results in relatively high costs of investments in inputs, labour and machinery (Saha *et al.*, 2021). In Kenya, older people know more about ALV production and consumption than the younger population who consider them as weeds and inferior to exotic cabbage, although this knowledge is known to be for subsistence farming only (Krowse & Grote, 2019). An increase in smallholder commercialization can be achieved through increased incentives in their investments in farm productivity (Bokelman *et al.*, 2022).

Additionally, Ojong *et al*. (2022) in there study, they indicated a positive impact of agricultural commercialization on assets, livestock ownership and income. Janssen (2018) found that commercialization had a positive impact on food security in Vietnam. Muricho (2015) demonstrates that agricultural commercialization significantly reduces food insecurity and poverty in commercialized and non-commercialized households. According to Qaim and Oguttu (2018), commercialization significantly reduces multidimensional poverty and the share of multiple deprivations in education, healthcare, and living standards and income poverty gap. Cazuffi *et al.* (2020) found a significant positive relationship between commercialization with household asset accumulation.

An increase in household market participation impacts the commercialization of smallholder agriculture which has a direct and usually positive impact on value chain actors such as input suppliers, output traders, transporters, processors, finances, and others (Jaleta 2009). The positive impacts could be a result of economies of scale created from increased demand and supply that tends to decrease the average cost per unit of operation. Increased income in the agricultural sector increases the demand for manufactured goods and services in

the other sectors of the economy, thus stimulating further growth hence increasing employment, especially when labour demanding high-value commodities is targeted.

2.4 Transaction Cost, Transaction Uncertainty, and Information Sharing.

2.4.1 Transaction Costs

Transaction cost involves common cost such as costs of searching for information on potential buyers or sellers, product prices, costs of negotiating such as writing contracts, hiring lawyers, investment in machinery, intermediary auctioneers, monitoring cost or enforcing pre-agreed terms of transaction such as ensuring the quality of goods, and behaviour of the parties and eventually transferring the product to its destination (Riziki, 2015). Arumgum *et al.* (2022) reveal that farmers in SSA have weak or non-existent markets due to a lack of coordination among the community and high costs of transactions.

Further, high transaction costs as the embodiment of market access barriers has agreater influence among resource-poor smallholders (Riziki 2015). These high transaction costs result from individual produce transportation and selling, difficulties in getting trading partners and poor bargaining power. Sometimes transaction costs are too high for farmers to get any meaningful benefits from potential trading activities, discouraging farmers from participating in marketing activities and thus low commercialization. According to Bokelman *et al*. (2017), the unavailability of reliable private transport increases transport costs, which in turn increases transaction costs for ALV farmers in Kenya. These high costs equally reduce the incentive to move away from farm gate sales.

2.4.2 Transaction Uncertainty

Uncertainties on the other hand, are risks that are derived from unexpected changes that may occur in a transaction (Guo *et al.,* (2016). According to Kibuchi (2016) transaction uncertainty may include aspects such as product quality fluctuations, product quantity fluctuations, and time fluctuations. There are different types of uncertainty which are: production uncertainty which includes the limited predictability of the quantity and quality of outputs with the use of a given bundle of inputs, environmental uncertainty which shows the limited predictability of contingencies surrounding exchanges, and behavioural uncertainty that represent the limited predictability of the performance of transaction actors in the presence of asymmetric information (Sniahzko, 2019). Aditya (2020) identified yield uncertainty, price uncertainty tenurial uncertainty and uncertainty related to price and quality of inputs as the major uncertainties in agriculture.

Additionally, the inability to predict the quantity and quality of outputs due to uncontrollable factors such as weather effects and pests and rapid market changes increases uncertainty (Mugwagwa *et al.*, 2020). Agricultural transactions also involve high uncertainty due to the perishability and seasonality of products. Furthermore, rapidly changing consumer tastes increase uncertainty in output markets. Food safety and quality standards which are constantly changing and becoming more stringent are contributing to more uncertainties. These negatively contribute to the commercialization of ALVs.

2.4.3 Information Sharing

Information sharing involves sharing information across firm boundaries which guides inter-linked firms so that they can compete effectively in their environment (Kibuchi (2016). The information flows right from the retailers who have the most information about the market, consumers' demand, and price, while the producers have the most information about the safety, quality, quantity, and varieties of the produce. If only these two groups can be able to establish a transparent, fluent, and clear information channel, the information system will be clear hence the information asymmetry will be controlled to the lowest, safety and quality of the product in the market will be guaranteed.

Consequently, buyer–seller information asymmetry causes problems in economic exchanges between farmers and the consumers of agricultural produce, makes it difficult to ascertain the utility or quality of produce, limits consumers' ability to assess competitive offerings and identify, and differentiate between; products and buy superior products (Kapoor & Kumar (2021),). Michelson *et al.* (2018) assert that unclear market information often results in the reduction of the amount of output offered for sale by smallholder farmers. Asymmetry of information between input dealers and smallholders can lead to a low-cost, low-quality-inputs equilibrium and, in turn, to suboptimal productivity levels (Kapoor & Kumar, 2021). Suboptimal productivity directly translates to low commercialization.

2.5 Effects of Vertical Market Linkages on Commercialization.

Conversely, supply chain management through vertical coordination in the vegetable industry in India and established that entrepreneurs adopt vertical linkages to curb demand and supply uncertainties associated with perishability, wastage, uncertain yields, non-seasonal availability assurance, control price fluctuation, quality control, risk reduction, grade standard improvement, and support technology (Singh & Mishra (2014). The mitigation of these barriers is thus associated with increased commercialization. A study on the contracts, trust, and market environment in apple farmer-buyer relationships in Shandong and vegetable growers in Hubei

provinces established that, cooperation and coordination increase in a highly uncertain input/output or competitive sector as marketing channel dyads tend to protect themselves by being better organized (Zhang & Hu, 2009). They continued to reveal that in a high degree of uncertain market demand, buyers and sellers are trying to work together during the difficulty times, such as using vertical coordination to safeguard their enterprises and minimize the impacts of the turbulence from the markets. Uddin (2010) studied the inter-firm relationships and performance factors in the Australian beef supply chain and concluded that supply chain management relates to all the linkage from the primary producers to the final consumers such as input suppliers, producers, processors, wholesalers, and retailers.

For instance, a customer-driven strategic alliance can meet the issues of multidimensional customer demand, quality, and profitability with a better cost structure and firm performance (Emami *et al.*, 2021). A study by Sopha *et al.* (2021) supported the proposition that small food enterprises engage in vertical market linkages to deal with market uncertainty. All the members identified uncertainty as an important factor influencing their decision to join the consortium, while only 27% of the rest identified uncertainty as important (Sarath & Pardede, 2018). The study revealed that the potential long-term reduction in information costs may be greater than the short-term search costs that must be incurred. Similarly, the negotiation costs associated with a delay in payment may be less than the overall gain associated with reduced negotiations over the long term under a vertically aligned system. In other words, a vertically integrated system is associated with reduced transaction costs in the long run thus increasing commercialization.

A study on developing sustainable food value chains reveals that vertical market linkages increase food safety and quality, reduce costs and waste, build customer and stakeholder value required in the whole food chain (FAO, 2014). FAO (2021) study on alternatives to improve market access capabilities of rural SMEs in Latin Americas crop and livestock established those stronger linkages between producers and processors and between producers and buyers of crops and livestock enhance strong, trusting relationships that foster win-win situations through risk reduction for both processors and Smallholder farmers, or cost savings by better production planning and cash flow management. A better understanding by farmers of the quality requirements of processors and consumers, as well as increased and more stable incomes from guaranteed market outlets for their products, are some of the direct results of improved linkages.

2.6 Theoretical Framework

To better describe the relationship between vertical market linkages and commercialization of ALVs, the study was based on three theories namely transaction cost economics, inter-organizational communication, and transaction value theory.

2.6.1 Transaction Cost Economics (TCE) Theory

The transaction cost theory proposed by Williamson (1985), has long been used to understand why linkages emerge among supply chain actors. A transaction occurs when a product moves from different stages under production, processing, or distribution. Thus, the costs incurred in conducting such transactions are referred to as transaction costs. Such costs include searching costs (costs that smallholders incur in search for information about product prices, inputs, and potential buyers of their produce and increased demand for intangible product quality aspects), negotiation costs (costs associated with the actual transaction incurred while negotiating contracts or agreements and use of intermediaries to access the market), monitoring costs (costs incurred when monitoring the quality of produce, sincerity of other actors and the behaviour of other parties) (Khoi, 2011).

In instances where the actors involved are not certain about prices, product quality and actions of other actors within the market, transaction costs tend to rise. These costs directly impact the commercialization of agricultural produce including ALVs. According to Hobbs (2004), the size and nature of the transaction cost determine the nature of vertical market linkage pursued by smallholder farmers. Thus, economic activities are organized in a way that can minimize the costs of transactions in the long run. Information asymmetry and the possibility of opportunistic behaviour among actors can lead to increased incorporation of vertical market linkages within the coordination system to minimize the transaction costs involved. TCE posits that relational mechanism and choice of coordination are derived from economic rationality. When transaction costs of using the spot market system rise, it is efficient to carry out the transaction by a strategic alliance with closer vertical coordination (Hobbs, 2004; Williamson, 1985).

According to the study, uncertainty was considered a central theme within the Transaction Cost Economics (TCE) which directly affects the size of transaction cost and the commercialization of ALVs (Hobbs & Young, 2000; Williamson, 1985). Uncertainty can arise due to changes in the economic or market environment and changes in supplier-buyer relationships or behaviour (Yang *et al.*, 2018). According to Spiller and Theuvsen (2006), the growing importance of uncertainty and transaction costs within the food industry is the major

reason for closer vertical linkages to minimize costs associated with inter-actor transactions. Lack of vertical coordination and a lack of a stable market may lead to high price volatility in the food industry, especially for the upstream industries where price uncertainty is a major factor. Due to the natural variations in quality, seasonal patterns, and high perishability, the uncertainty may propagate in the food supply chain through the variation in demand and supply and can be worse if there is incomplete or imperfect information between the participants. The study assumed that vertical linkages lower the transaction cost problem by reducing the uncertainties associated with the ALV supply chain.

2.6.2 Theory of Inter-organization Communication

The performance of an enterprise and a supply chain is largely embedded in how actors and organizations at different levels of the nodes interact (Carr & Kaynak, 2007). This greatly applies to value chains such as ALVs which is characterized by perishability, shelf-life constraints, and food safety issues. These characteristics necessitate the flow of real-time, reliable, relevant, and adequate information in the ALVs supply chain. Therefore, to enable frequent flow of information within the ALV supply chain, inter-organization and inter-actor communication needs to be frequently detailed and well-regulated. This may thus require sharing relevant information that may affect a given party within the chain, providing helpful information, and regularly communicating the needs. This form of communication enables resource sharing among actors, informed and collective decision-making, better preparation for uncertainties in the market and transmission of information to those who require it the most (Sorensen *et al.*, 2009).

The oscillations in the flow of demand information and delays affect the production and inventory levels of food-based industries (Opoku *et al.*, 2021). Thus, success within any food industry depends on how information flows and its interaction with other factors of production. The flow of information in such a case involves the media used, contents of the information being shared, intensity of communication, actors involved, direction of information, quality of information, formality of communication and actors' satisfaction with the process through which information is shared (Dwivedi *et al.*, 2021). Direct results of information flow among actors within the supply chain include amicable problem resolution, reduction of costs, and improved profitability in the long run (Fawcette *et al.*, 2010). The study assumed that the flow of information influences how actors within the ALV supply chain interact thus influencing the commercialization of ALVs.

2.7 Conceptual Framework

In this study, it was assumed that vertical market linkages influence the commercialization of ALVs. The factors that influence the commercialization are farm characteristics (size, tenure, water availability, and crops grown) and farmer characteristics (age, gender, education, marital status, experience, access to training, access to credit, and access to irrigation). The study further assumed that commercialization of ALVs is affected by transaction cost (searching and bargaining costs), transaction uncertainty (demand uncertainties, supply uncertainties, and grade uncertainties), and information sharing (communication behaviour, information quality and direction of information flow). The study assumed four main vertical market linkages which were producer to retailer linkages, producer to wholesaler, producer to processor, and producer to final consumer, which can exist either formally or informally. These relationships were assumed to lower transaction costs, lower market risks, increase profitability and flow of information. These were finally assumed to result in increased commercialization of ALVs which was measured using Household Commercialization Index (HCI).

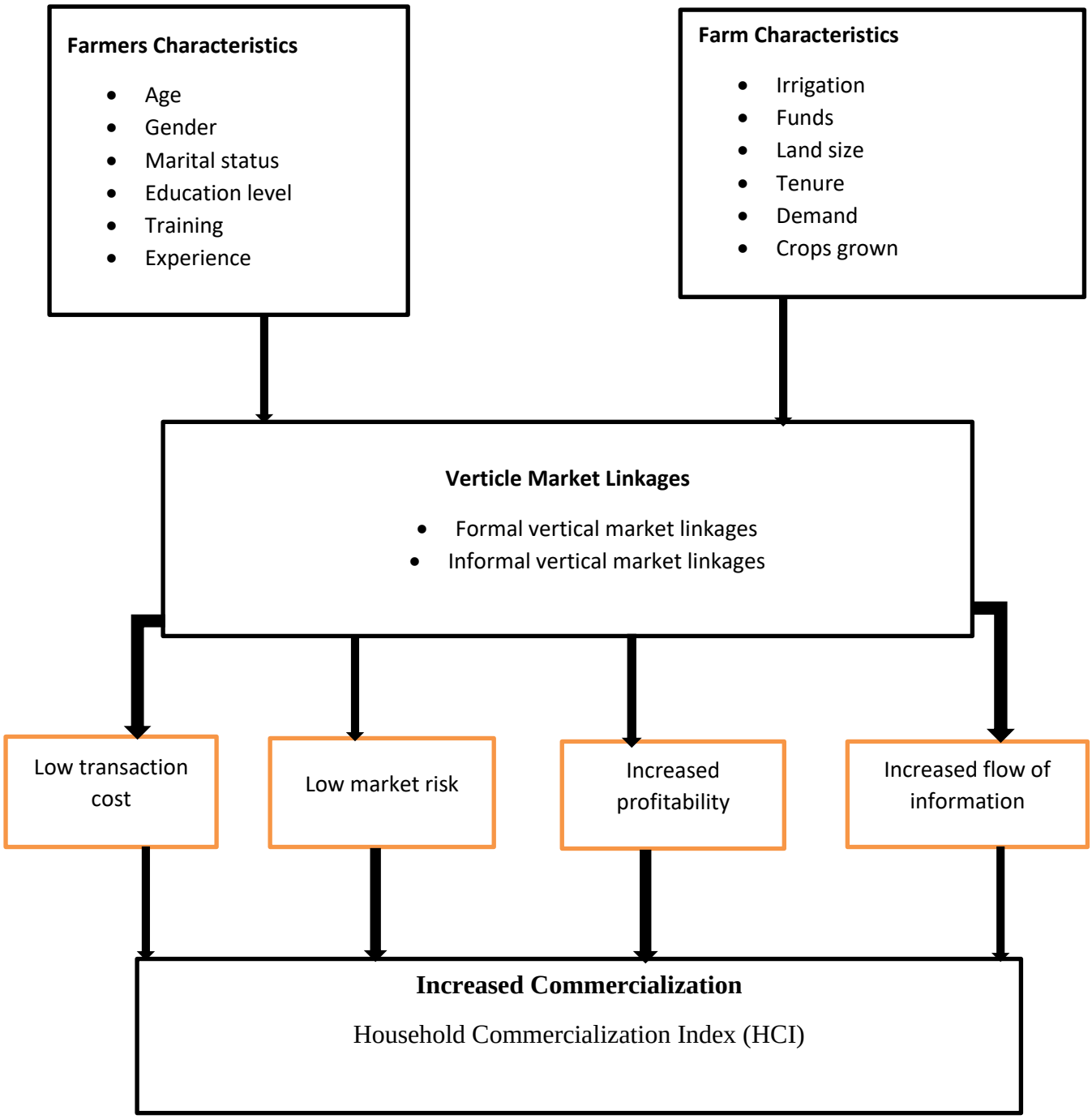

Figure 2.1 Conceptual Framework

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

3.1.1 Study Area

The study was conducted in Kimilili and Kabuchai sub-counties which are in Bungoma County. The Kimilili Sub-County Borders Mount Elgon Sub-County to the North, Tongaren Sub-County to the East, Webuye East and Webuye West Sub-Counties on the South and to the West it borders Kabuchai Sub-County. The Sub-County covers an area of 181.20 Km^2 divided into two wards that are Kimilili 94.00 Km^2 and Kamukuywa 87.20 Km^2 each having two wards. Kimilili division has Kibingei 51.90 Km^2 and Kimilili 42.10 Km^2 wards, while Kamukuywa division has Maeni 41.00 Km^2 and Kamukuywa 46.20 Km^2 (GoK, 2010). The sub-county has a population of 162,038 (males 78560 and females 83475). The Sub-County is rural with headquarters at Kimilili town with one of the largest open-air markets in the Western region, the Kimilili old market. Other busy markets are new Kimilili, Makwata, Kamukuywa, Sosio, Matili, Chebukwabi, Kapkateny, Chesamisi, Maeni and Kibingei markets. Kabuchai sub county is one of the rural sub counties in Bungoma county and covers an area of 232.3km^2. It is made up of five wards including, west Nalondo, Chwele, South Bukusu, Mukuyuni, and Bwake. Chwele ward has the second largest open-air market in Kenya. Agriculture is the main economic activity in the area with cereals and traditional farming dominating.

Bungoma County is characterized by fertile volcanic soils and well-developed annual average rainfall of 1200-1800mm annually. Bungoma County is approximated about 2,068.5 square kilometers with a population of roughly estimation of 1,630,934 people and a population density of 482 persons per square kilometer (Gido, 2012). The county is situated at the longitude of 34 º 21.4` and 35 º 04` East and latitude 0 º 25.3 and 0º 53.2` North, with a bimodal rainfall pattern which includes (March–July) long rainfall pattern and (August-October) short rain pattern with a range of between 1250 and 1800mm rainfall received annually. According to Oloo *et al.* (2013). Bungoma County has altitude ranges between 1200 and 2000 meters above Sea Level (A.S.L) and temperature ranges from 21-250C during the year (Oloo *et al.*, 2013). The county has the endowment advantages of well-drained, rich, and fertile arable soils but poor husbandry methods and the increased population have resulted in declining yields, deforestation and leading to soil erosion. The county mostly practices small-scale crop and livestock production which has been an integral component of agricultural activity in this area.

Commonly grown crops in Bungoma county include; maize, sunflower, sugarcane, coffee, tobacco, potatoes, beans, kales, groundnuts, and bananas. Livestock production includes; dairy cattle, goats, sheep, and chicken (NPCK, 2021).

Bungoma County was chosen for the study because about 52% of the people are engaged in agricultural production which provides 60% of all household incomes out of the total labor force of about 565,000 people (Oloo *et al.*, 2013). Bungoma county is known to produce ALVs which are common household food and contribute substantially to the food security of rural people in Bungoma county. Households in Bungoma own on average 2.7 acres of land on which ALVs are intercropped with other crops (Wabwoba *et al.*, 2015). The practice of intercropping ALVs with other crops is done by over 61% of the female smallholder farmers in Bungoma county (Pincus *et al.*, 2018).

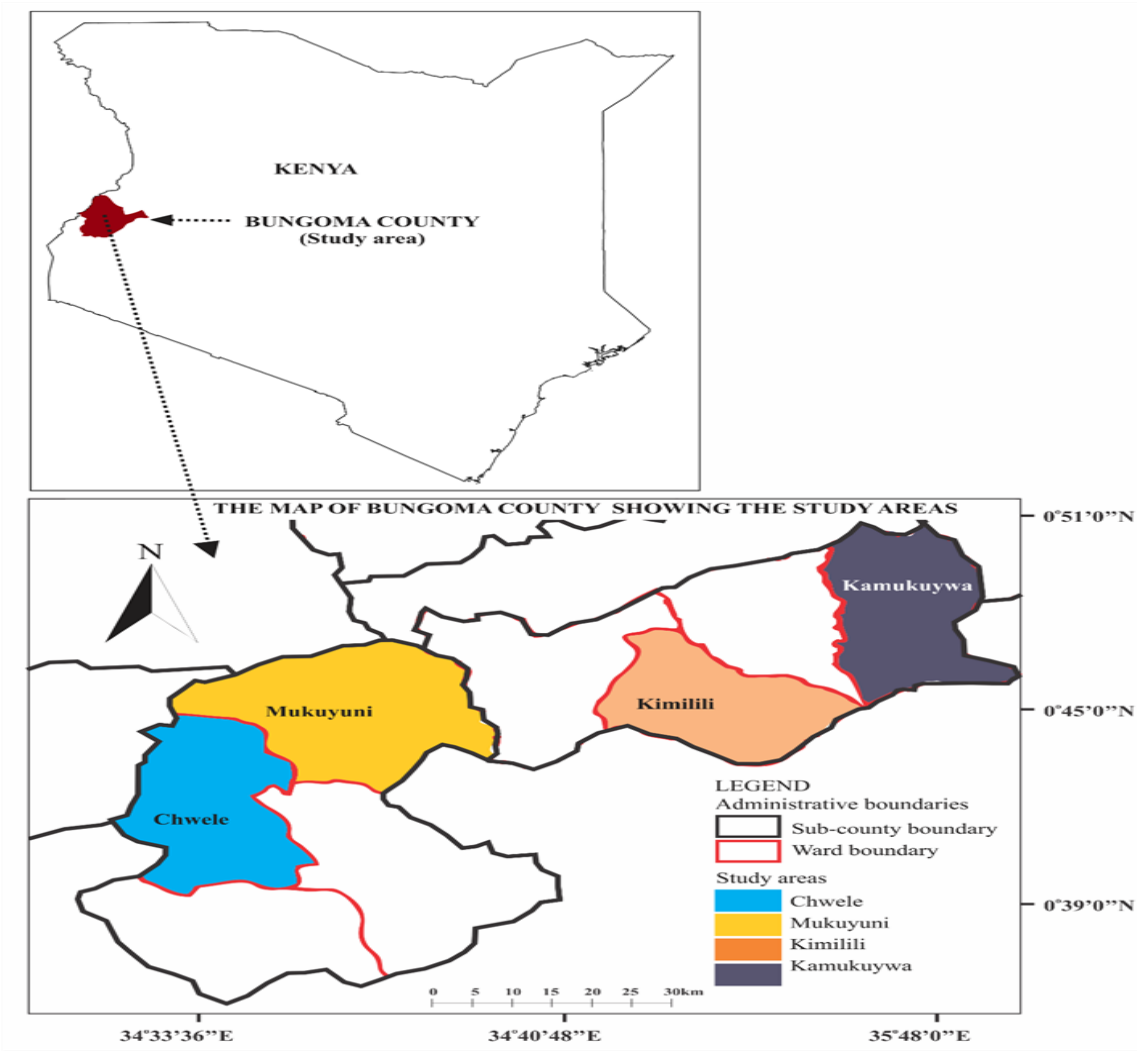

Figure 3.1: Map of the study area

Source: IEBC (2022)

3.2 Research Design

This research adopted a survey research design which is considered as an appropriate method for this study since the data was collected from a cross-section of respondents. According to Nyongesa (2021), descriptive research involves a one-time interaction with groups of people. Therefore, the researcher interacted with the participants through interviews during data collection to get the necessary information on how vertical market linkages affect and how they influence the commercialization of African Leafy vegetables. A list of ALV stallholder farmers obtained from the respective sub-county agricultural officers was used as a sampling frame where sample units of analysis involved smallholder ALV farmers who grew jute mallow, spider plant, amaranth, Africa night shade and cow peas.

3.3 Study Population and Sampling

3.3.1 Sample Size and Sampling Procedure

Sample Size

The determination of the sample size followed the proportionate sampling methodology specified by Cochran (1963) as follows:

$$n = \frac{z^2 pq}{e^2} \quad \text{.....(1)}$$

Where: n = sample size, p= implies maximum possible variance q = 1-p, z = the standard value at a given confidence level ($\alpha = 0.05$), e = the acceptable error (precision). The study desired a 95% confidence level and 5% precision level with a z score of 1.96. In addition, the study will assume that p=0.5, since over 50% of smallholder farmers in the study area grow ALVs.

The sample was determined as:

$$n = \frac{(1.96)^2 (0.5)(0.5)}{(0.05)^2} = 384 \quad \text{.....(2)}$$

The derived sample size for the study was 384 respondents.

Sampling Procedure

A multistage sampling technique was employed in the study. This is because the sampling frame was nonexistent and the construction of one may have been too costly to construct. The smallholder ALV farmers participating in the marketing of their produce, are widely spread and they do not have any sampling frame. Therefore, in the first stage, Kimilili and Kabuchai sub-counties were purposively selected because they have the largest population compared to all other sub-counties in Bungoma County. In the second stage, two wards were purposively selected per subcounty namely; Kimilili and Kamukuywa in Kimilili sub-county and Chwele and Mukuyuni in Kabuchai sub-county because they are among the major producers of ALVs in Bungoma County. All the projects intended to benefit ALV Smallholder farmers and markets in Bungoma County have been established in the Kimilili and Kabuchai sub-counties. The third stage involved a systematic sampling of smallholder ALV farmers within the chosen wards. A list obtained from the agricultural officers of the respective sub-counties was used to identify the respondents in the four wards that were considered. The respondents were selected using systematic sampling using the K^{th} interval.

$K^{th} = N/n$ where N is the total population and n is the desired sample size.

Table 3.1 Distribution of the sample proportion to the size of Kimilili sub-county population

Subcounty/Ward	HH population	Proportion to size (%)	Sample
Kimilili Subcounty	162,038	53	204
Kimilili ward	36,267	49	100
Kamukuywa ward	37,888	51	104
Total	74,155	100	204
Kabuchai Subcounty	141,113	47	180
Mukuyuni ward	37,988	51	92
Chwele ward	35,855	49	88
Total	73,843	100	180
Total	**303,151**	**100**	**384**

3.4 Data Collection

After getting the research permit from NACOSTI, the researcher first carried out the pilot study on 50 respondents equivalent to 13% of the total sample size of the study area to test the validity and the reliability of the research instrument. The study adopted chronbach instrument developed by Nasuna et al. (2021) to test for the effectiveness of the instrument in Maeni location in Kimilili Subcounty. The results of alpha 0,839 that was found indicated that the method used for data collection was valid and realiable and the study was easily replicable. Primary data was used to generate the information required for the study. Primary data collection was done through observations and interviews using a semi-structured questionnaire which was administered to ALV smallholder farmers. Questionnaires contained both open and closed questions that allowed the researcher to collect data on the vertical market linkages that exist between smallholder ALV farmers and other actors, the factors that influence the commercialization of African Leafy vegetables (ALVs) among the smallholder farmers, and the effect of vertical market linkages on the commercialization of African Leafy vegetables (ALVs) in Bungoma county

3.5 Data Analysis

The statistical package for social sciences (SPSS) program was used for data entry, and generating descriptive statistics while STATA was used to run the models in objectives 2 and 3. This program was used to determine the vertical market linkages that exist between smallholder ALV farmers and other actors in the study area. Thus, descriptive statistics including mean, frequencies, percentages, and standard deviation were used to analyze the first objective. For the second objective, to determine the factors influencing the commercialization of ALV among smallholder farmers, HCI, and fractional response model were applied where the respondents were asked about the commercialization of ALVs among Smallholder farmers. For the third objective, multinomial endogenous switching regression was used to determine the effect of vertical market linkages on the commercialization of ALVs. STATA was used to analyze the relationship between vertical market linkages and how they affect commercialization.

3.6 Analytical Framework

3.6.1 To Determine the Vertical Market Linkages that Exist Between Smallholder ALVs Farmers and Other Actors Kimilili sub-county in Bungoma County

Descriptive statistics was used to analyze this objective. Vertical Market linkages that exist between smallholder ALV farmers and other actors were identified. Frequencies, percentages, and standard deviations of various variables were also obtained. This helped to determine the most common linkages that exist, the nature of linkages that exist, and the actors with whom smallholder ALV farmers are linked. Inferential statistics including the t-test was used to determine the significance of the vertical market linkages that exist.

3.6.2 To Determine Factors Influencing Commercialization among Smallholder ALV Farmers in Bungoma County

Under this objective, commercialization was measured using the Household Commercialization Index (HCI). It takes into consideration the total value of agricultural produce that is marketed by a household (Strasberg *et al*., 1999). HCI was used as a dependent variable in determining the factors influencing commercialization among ALV smallholder farmers. The index reflects a proportion of the total value of ALVs sold in the market out of the total value of ALVs grown by a smallholder farmer. The total value of ALVs grown by smallholder farmers took into consideration the value of ALVs grown from the different portions of land in addition to the value of the volumes sold expressed as.

$$HCI = \frac{Total\ value\ of\ AIVs\ sold}{Total\ value\ of\ AIVs\ grown} \text{ X } 100$$

To determine the commercialization of value chains, censored and truncated models such as Tobit have been widely used. However, they are only applicable where the dependent variable is only bounded either from below or above a given value (Martey *et al.,* 2012). Logit and probit models are equally not appropriate because they estimate the probability of the occurrence of an event that takes a value of one if the event occurs and a value of zero, if otherwise. The Fractional Response Model (FRM) was used to analyze the factors influencing the ALVs commercialization. FRM is more applicable in cases where the dependent variable is measured as a proportion or percentage (Williams, 2015). According to Chegere (2017), the FRM predicts response values within the interval limits of the dependent variable, accounts for the continuous and bounded nature of the dependent variable from above and below, and captures the nonlinearity of the data thereby yielding efficient estimates compared to linear

estimation models. The bounded variables are referred to as those that cannot have values outside the interval of (0, 10) or (0, 100). The index ranges from 0 to 100 (Dube & Guveya, 2016). An index value of zero implies that a smallholder is fully pursuing subsistence-oriented farming while an index value of 100 signifies a higher commercialization.

Farmers who had high commercialization were assumed to be intensively engaged in the market. Non-commercialized farmers were those with zero index value because they were assumed not to be selling any of the ALVs that they grow. Commercialized farmers were those with index values greater than one because of the assumed participation in the marketing. The study did not anticipate an index value of 100 because most of the farmers are assumed to retain some stock for household consumption while some portion is kept for seed production. This implied that selling the entire produce may be impractical for smallholder ALV producers.

Woolbridge (1996) and Chegere (2017) considered the following model for the conditional expectation of the fractional response variable.

$$E(y_i \mid x_i) = G(x_i \phi),\ i = 1,2,\ldots..,N \qquad (3)$$

where: $0 \leq y_i \leq 1$ denoted the dependent variable, x_i represents the explanatory variables for the observation *i* and $G(\cdot)$ is a known function satisfying $0 \leq G(\cdot) \leq 1$.

A typical choice of $G(\cdot)$ is a cumulative distribution function, most popularly a logistic distribution $G(z) \equiv \exp(z)/(1+ \exp(z))$ directly estimated using nonlinear techniques. The estimation procedure proposed by the author is a particular quasi-maximum likelihood (QML) method based on a Bernouli log-likelihood function given by:

$$LL_i(\phi) = y_i \text{ Log}[G(x_i\phi)] + (1 - y_i)[1 - G(x_i\phi)] \qquad (4)$$

Since the Bernoulli distribution is a member of the linear exponential family (LEF), the QML estimator of ϕ defined by:

$$\phi = \arg\max \sum_{n=1}^{N} LLi(\phi)$$

Which was consistent and asymptotically normal regardless of the true distribution of y_i conditional on xi and y_i could be a continuous variable, a discrete variable or have both continuous and discrete characteristics. According to Wooldridge (1996), the method generates consistent and robust methods for the estimation and inference of the model parameters under general linear model conditions.

The FRM regression equation was therefore be specified as:

$y^* = b + f(x) + u$

where: u = unobserved latent variable

x= set of explanatory variables

f=defines the relationship between x and y*

y*=bounded depended variable of interest (HCI in our case)

b=vector of parameters to be estimated

Table 3.2: Description of variables and the expected signs

Variable	Description of variables	Expected sign
Dependent		
Comm	Commercialization	
Independent		
Age	Age of the farmer in years	+/-
Gender	Gender of the farmer (0-Male, 1- Female)	+/-
Education	Level of education of the farmer (Number of years in school)	+
Experience	Level of experience of the farmer (In years)	+
Marital status	Marital status of the farmers (1-Single, 2-Married, 3-Divorced, 4-Widowed)	+/-
Training	Access to training by the farmer (1-Yes, 0-No)	+
Irrigation	Access to irrigation (1- Yes, 0 – No)	+
Funds	Access to funding by the farmer (1-Yes, 0-No,)	+
Land Size	Size of the farm in acres	+/-
Tenure	Land tenure system (1-Owned, 2-Rented, 3-Both)	+/-
Demand	Consumer demand for ALVs (3-High, 2-Medium, 1-Low)	+/-
Crops grown	Crops grown on the farm (1-Spider plant, 2-Amaranth, 3-Africa nightshade, 4-Cowpea, and 5-Jute mallow, 6- Others)	+/-
Water available	Availability of water (1 – Yes, 0 – No)	+

3.6.3 To Determine the Effect of Vertical Market Linkages on Commercialization of African Leafy Vegetables (ALVs) in Bungoma County

In this objective, there was one outcome variable which is the commercialization (dependent variable) of ALVs measured in terms of increased volumes of sales and increased investments. Vertical market linkages include producer to retailer linkage, producer to wholesaler linkage, producer to processor linkage, and producer to final consumer linkage. The choice to participate in each vertical market linkage is affected by numerous factors like age, profitability, distance to the market, gender, among others. However, choices are also influenced by the perceived (unobserved) benefits associatedwith a given vertical market linkage. The unobserved characteristic gives rise to endogeneity which needs to be controlled or accounted for the real effect of vertical market linkage on commercialization to be determined.

To control for the possible bias resulting from the non-observable characteristic, the study used the Multinomial Endogenous Switching Regression model (MESRM). This model corrects for both the observed and non-observable biases that may result from participation in a vertical linkage based on perceived benefits. Commercialization was measured in terms of increased volumes of sales of ALVs. The MESR model used the average treatment on the treated (ATT) effect of vertical linkage and the outcome variable (commercialization).

The MESR model was conducted in two stages: the multinomial logit selection model and the Multinomial Endogenous Switching Regression. In the first stage, the decision to participate in each vertical market linkage is modeled using a multinomial logit selection model. In the second stage, the effect of vertical market linkage on the commercialization is modeled.

Multinomial Logit Selection Model

It was assumed that ALV smallholder producers participate in a vertical market linkage that can provide them with maximum utility. Smallholders aim to maximize their utility U_{im} by comparing the utility provided by vertical market linkage U_{ik} such that a smallholder will choose a combination of vertical market linkages m over any alternative k if $U_{im}>U_{ik}$, $k \neq m$. Based on Bourguignon *et al.* (2007); Kassie *et al*. (2015), let U^{*}_{im} represent the indirect utility associated with the mth vertical market linkage, $m = 1,\ldots,5$ for smallholder i such that

$$U^{*}_{im} = X_i B_m + \varepsilon_{im} \quad (5)$$

where X_i represents covariates such as demographic and socio-economic characteristics and ε_{im} is the idiosyncratic unobserved stochastic component. Although the utility of participating in

vertical market linkage is not observed, the decision to participate in a given vertical market linkage can be observed such that a smallholder will choose a combination of vertical market linkages *m* over other methods *k* if

$$U = \begin{cases} 1 \; if \; U^{*}_{im} > max_{k\neq 1} \; (U^{*}_{ik}) \; or \; \omega_{i1} < 0 & (6a) \\ \text{For all } k \neq m & \\ M \; if \; U^{*}_{im} > max_{k\neq 1} \; (U^{*}_{ik}) \; or \; \omega_{im} < 0 & (6b) \end{cases}$$

where $\omega_{i1} = \max_{k \neq m} (U^{*}_{ik} - U^{*}_{im}) < 0$. Equation 2 shows that smallholder *i* chooses a vertical market linkage m to maximize expected benefit if it provides greater expected utility than the alternative k, $k \neq m$ if $max_{k\neq j} (U^{*}_{ik} - U^{*}_{im}) < 0$. Under the assumption that ε_{im} are independent and identically Gumbel distributed, the probability that a smallholder *i* will choose *m* vertical market linkage can be expressed using a multinomial logit model (McFadden, 1973).

$$P_{im} = Pr \; (\omega_{im} < 0 \; |X_i) = \frac{\exp \; (\beta m X i)}{\sum j \; k \neq 1 \; \exp \; (\beta k X i)} \qquad (7b)$$

Multinomial Endogenous Switching Regression model

As earlier noted, the effect of vertical linkages on commercialization is computed in the second stage using multinomial endogenous switching regression. This was achieved using the Average Treatment on Treated (ATT). The model thus implied that a smallholder faces J regimes. Therefore, the reference category, in this case, will be *m*=0 represent, denoted by T_0A_0. The other category considered using at least one vertical linkage and their respective combinations by the smallholder represented by *m*=1……..5. Therefore, the likely outcome equation for each possible regime *m* was given as;

$$\begin{cases} \text{Regime1: } Y_{i1} = \beta_1 Q_{i1} + Z_{i1} \text{ if } U = 1 & (8a) \\ \text{Regime } M\text{: } Y_{im} = \beta_m Q_{im} + Z_{im} \text{ if } U = M & (8b) \end{cases}$$

where Y_i was the commercialization obtainable by a smallholder *i* in regime *m*, (*m*=1,2,3) and Q represents a set of exogenous explanatory variables while β represents the error term to

capture the smallholder's uncertainty. There could be unobserved correlated factors between the first and second-stage regressions, β and Z are not independent. Therefore, to avoid biases, a selection correction factor is required in the equation. Bourginoun *et al*. (2004) assert that the model can be used to correct the correlation between the error term from the multinomial logit model estimated in the first stage and the error terms from each of the regimes in the equation. The selectivity term (λ) was incorporated into Eq (9) to account for selection bias such that;

$$\begin{cases} \text{Regime1: } Y_{i1} = \beta_1 Q_{i1} + \sigma_1 \lambda_{i1+} v_{i1} \quad \text{if } U = 1 & (9a) \\ \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad m=1,2,3 & \\ \text{Regime } M\text{: } Y_{im} = \beta_m Q_{im} + \sigma_m \lambda_{im} + v_{im} \text{ if } U = M & (9b) \end{cases}$$

where λ is the inverse mills ratio predicted and computed from the probability estimates in equation (7), v is the error term with an expected value of Zero and σ is the covariance between β and Z.

The predictions and estimations from equation (9) above enable us to estimate counterfactual and treatment effects and compute individual exact effects of vertical market linkages on the commercialization of ALVs. This approach corrects the selection bias due to unobserved heterogeneity while at the same time controlling the selection bias due to observed heterogeneity (Kassie *et al*., 2015). ATT in the actual and counterfactual can be computed from equation (8) as follows:

smallholders who participate in each vertical market linkage (actual)

$$E(Y_{i2}/I=2) = \beta_2 Q_i + \sigma_2 \lambda_2 \quad (10a)$$

$$E(Y_{im}/I=M) = \beta_m Q_i + \sigma_m \lambda_m \quad (10b)$$

Deriving the expected commercialization by smallholders who participate in a given vertical market linkage m in the counterfactual hypothetical case that they participate in different vertical market linkages from the ones they used can be done using equation (8). Smallholders, if they decide to participate in other vertical market linkages other than the ones considered by the study (counterfactual)

$$E(Y_{i1}/I=2) = \beta_1 Q_i + \sigma_1 \lambda_2 \quad (11a)$$

$$E(Y_{im}/I=M) = \beta_1 Q_i + \sigma_1 \lambda_m \quad (11b)$$

Equation (10a, 10b) represents the actual expected commercialization that is observed for smallholders who use and those who may not while equation (11a, 11b) represents their respective counterfactual expected commercialization.

To derive an unbiased estimate of the ATT, the expected values can be used. This then allowed the calculation of ATT as the difference between equations 10a and 11a 0r 10b and 11b.

$ATT = \mathrm{E}\,(\mathrm{Yi2}/\mathrm{I} = 2) - \mathrm{E}\,(\mathrm{Yi1}/\mathrm{I} = 2) = \beta 2\mathrm{Q}i + \sigma 2\lambda 2 - \beta 1\mathrm{Q}i + \sigma 1\lambda 2\ \mathrm{Q}i\,(\beta 2 - \beta 1) + \lambda 2\,(\sigma 2\ - \sigma 1)$ …… 12

Equation (12) is divided into two separate terms on the right-hand side (first and second terms). The first represents expected change in the commercialization among smallholders while the second (λ) represents the fact that the effect of the unobserved terms are cancelled out.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussion information. It begins by giving brief information on the study socio-economic characteristics of the sampled unit, then the discussion about the vertical market linkages that exist between smallholder African Leafy Vegetables (ALVs) farmers and other actors in Bungoma County. It proceeds to discuss the factors influencing the commercialization among Smallholder ALV farmers and the effect of vertical market linkages on the commercialization of ALVs in Bungoma County**.**

4.2 Descriptive Statistics

This section provides an analysis of the descriptive characteristics of the 384 households sampled.

4.2.1 Socioeconomic Characteristics of Respondents

The socioeconomic characteristics of the respondents are presented in Table 4.1. With regards to relation to gender, the majority (51%) of the ALV producers in Bungoma County are females while 49% are males. This can be attributed to the fact that ALV production requires a small piece of land and since women have limited access to agricultural land, it becomes suitable for them. Men on the other hand largely prefer dealing with exotic vegetables and other high-paying cash crops. This is consistent with findings from Musotsi *et al.* (2018) who reported that women in Kenya are more responsible for producing, preparing, and cooking of ALVs. According to the International Journal of Rural Development (2021), over 70% of African Leafy Vegetables are produced by women.

Table 4.1. Socioeconomic Characteristics of the Respondents

Variable	Frequency	Percentage (%)
Gender		
Male	188	49
Female	196	51
Marital Status		
Married	337	87.8

Single	31	8.1
Widow/ Widower	14	3.7
Divorced	2	0.5
Education level		
University	11	2.9
College/Tertiary	56	14.6
Secondary	191	49.7
Primary	124	32.3
No formal education	2	0.2
Access to land		
Own	310	80.7
Rented	24	6.3
Both	50	13

The marital status of the respondents was categorized as married, single, widow/widower, and divorced. Results indicate that the majority (87.8%) of the respondents in Bungoma County are married. This implies that agriculture and food production in many African communities is often seen as a family affair, attributed to the involvement of all generations and family members in the process. This makes it possible for the household to collectively raise resources required to produce ALVs and engage other household members such as spouses, children, and other family members as a source of labor. Additionally, in African families set -up, the marital status of a household especially being married is highly ranked as the stability of households (Riziki, 2015). According to Ngenoh *et al.* (2019), over 80% of smallholder, ALV farmers in Western Kenya are married.

The level of education of the respondents was listed following this category: University, tertiary/college, Secondary school level, primary level, and no formal education. The results indicated that most of the respondents had attained secondary school level with 49.7%. Those with primary, college/tertiary and bachelor's degree levels of education were 32.3%, 14.6% and 2.9% respectively. Approximately 0.2% of the respondents had no formal education. The majority of ALV producers having secondary level education can be attributed to the increased demand for ALVs thus attracting high-profit margins compared to other vegetables and maize. The ability to comprehend market trends and profitable ventures compels secondary school levers to venture into ALV production. Contrary to this, Indeche *et al.* (2018) reported that

49.3% and 39.5% of the ALV producers in Kakamega County have primary and secondary level education respectively. The variation could be explained by the fact that the study in Kakamega only focused on only female ALV producers in Kakamega. The same study noted that only 11.2% of the respondents did not have formal education.

Land access by the respondents is represented into three categories, owned, rented, and both owned and rented. The results show that the majority (80.7%) of the respondents own the land on which they produce ALVs while 6.3% rent the land that is used for ALV production. The 13% of respondents both owned and rented land used for ALV production. Most of the respondents own land that is directly inherited from their parents while most of the women owned land due to their marriage to men who inherited land from their parents. This is consistent with findings from Govindasamy *et al.* (2020) who reported that over 59% of smallholder ALV farmers in Zambia own the land on which they produce ALVs. They noted that most of the farmers accessed land due to the communal nature of land ownership. Accessing land through renting was the least noted among ALV producers in Bungoma. This can be attributed to the economic constraints among smallholder farmers to rent land. According to Deininger *et al.* (2017), renting land in Sub-Saharan Africa is absent due to the land abundance and the popularity of subsistence farming.

Table 4.2 Means of Selected Socioeconomic Characteristics of Respondents

Variables	**Mean**	**Std. dev**	**t-test (based on subcounty)**
Age	45.9	14.391	-6.0852***
Experience	15.9	11.980	-3.8724***
Size of the land	2.1	1.612	-3.1782***
Land percentage	42.0	18.759	1.5795

The means of age, experience, size of the land, and percentage of land allocated to ALVs and the respective t-tests based on sub-county (Kimilili and Kabuchai) in Bungoma County are presented in Table 4.2. These variables were identified as the major continuous variables that differed greatly across males and females during the study. The results show that the mean age of the respondents in Bungoma County is 45.9 years. This can be attributed to the fact that the production and marketing of ALVs on a small piece of land is not so tedious

and does not require energetic and muscular individuals to manage. The fact that most of the producers are women who are mothers, at ages above 40 years, they may not secure physically demanding employment and thus focus on the production of ALVs to feed their families. This is close to findings from Chepkoech *et al.* (2020) who reported that the mean age of ALV producers in Kenya is 44.5 years.

In terms of experience in the production of ALVs in Bungoma County, the results indicate that the mean experience is 15.9 years. This can be attributed to the fact that the majority of ALV producers are older people (Above 40 years) who started engaging in ALV production at an earlier age. Contrary to this, Mulaudzi *et al.* (2019) reported that the mean age of ALV producers in South Africa was 30.9 years. This variation could be attributed to the high mean age of the respondents which was 59.9 years. However, 32.5% of the respondents had an experience of between 1-15 years. Similarly, Anyango (2016) noted 7 years as the mean experience in the production of ALVs in Siaya County.

The mean land size owned by the respondents is 2.1 acres. This is because most of the respondents depended on land that is inherited from their parents which must be distributed equally among the children in each household. Thus, for each child to access land from their parents, the land must be divided into small pieces for everyone to have a share of their parent's possession. This is consistent with FAO (2015) and One Acre Fund (2023) who found out that most smallholder farmers in Kenya own less than 2 hectares of land and over 3 million smallholder farmers in Sub-Saharan Africa own less than 1 hectare of land respectively.

The mean percentage of land allocated to ALV production is 42.0% which translates to approximately 0.9 acres. This could be attributed to the fact that ALVs are considered for both household consumption and source of income at the same time thus having the privilege of such a high land allocation. During the dry season, the land is not used for other agricultural activities and thus is purely used for ALV production. This is closely consistent with findings from Mwangi and Crewett (2019) who reported that 37% of land owned by smallholder farmers in Kenya is allocated to ALV production. Ngenoh *et al.* (2019) reported that the average land size allocated to ALV production in Kenya is 0.92 acres.

4.2.2 African Leafy Vegetables (ALVs) Grown in Bungoma County

The African Leafy Vegetables (ALVs) produced by smallholder farmers in Bungoma County are presented in Graph 4.1. African nightshade is the most produced ALV at 73.9%, followed by cowpeas at 68.8%, spider plant at 63.3%, Jute mallow at 34.4%, and vegetable amaranth at 21.9%. African nightshade is the most produced vegetable due to its popularity in

many Kenyan communities, and it is often used in traditional dishes resulting in its high demand for the market making it more profitable for farmers to produce. The popularity of African nightshade can equally be explained by the Kenyan government in conjunction with the county government of Bungoma's initiatives towards promoting the cultivation of traditional vegetables such as African nightshade, as part of efforts to improve food security and promote healthier diets. This is consistent with findings from Ogada *et al*. (2021), who reported that the most grown ALV in Kiambu, Nairobi, Kirinyaga, Kisumu, Migori and Vihiga counties in Kenya is African nightshade at 65%. Similarly, Ngonje *et al.* (2022) reported that over 90% of the respondents in Kenya and Tanzania reported having preferred consuming African nightshade.

Results further indicate that cowpeas are the second most produced ALV by 68.8% of smallholder farmers in Bungoma County. This production is attributed to the fact that cowpeas is well adapted to the dry conditions and it can tolerate drought better than many other crops since most of the ALVs are grown during the off-season period. This makes them a reliable source of food even during dry seasons and periods of low rainfall when farmers are not doing irrigation. Most smallholder farmers in Bungoma County prefer cowpeas because it is not costly in production and it is an important cash crop for smallholder farmers in Bungoma County, as it is sold for a good price in local markets, especially in dry seasons. Cowpeas are resistant to many pests and diseases that can affect other crops in the region. This makes them easier to grow and reduces the need for expensive pesticides. According to IITA (2023), cowpea's high protein content, its adaptability to different types of soil and intercropping systems, its resistance to drought, and its ability to improve soil fertility and prevent erosion makes it an important economic crop in many developing regions. According to Bokelman and Kebedde (2017), a study conducted in Kakamega and Kisii Counties, cowpeas was the second mostly produced ALV at 49% after African nightshade.

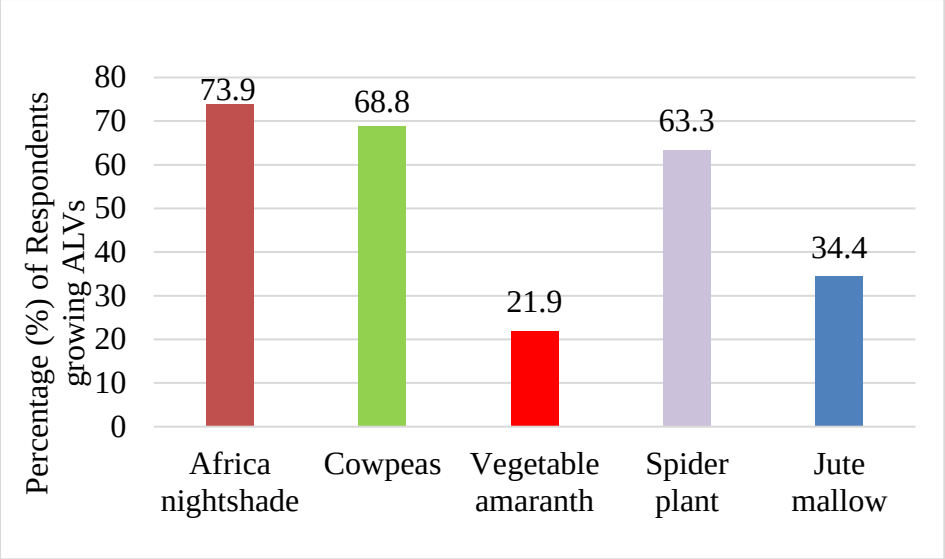

Figure 4.1 African Leafy Vegetables grown in Bungoma County (%)

Spider plant is produced by 63.3% of farmers, slightly lower than the percentage of farmers growing cowpeas. Spider plant is relatively easy to grow, and it can be cultivated in a variety of soil types and environmental conditions. This makes it a popular crop for smallholder farmers in the region and it is accepted in the market leading to its price being high in the markets. Spider plant is attributed to high yield potential, and this places the farmers at an advantage because they harvest the leaves multiple times during the growing season. Smallholder farmers reported that the spider plant has the second highest market price after the African nightshade. Riziki (2018) noted that the spider plant had the second-highest mean price in Kajiado and Narok counties after the African nightshade.

The results indicate that jute mallow is the second last in the production rate for it is produced by 34.4% of smallholder farmers in Bungoma County. This condition is attributed to the fact that it is consumed by a few people preferably by old people and this is because of its sliding nature when it is cooked hence young people fear consuming it, that it is disgusting to them. But despite this, jute mallow is well adapted to the dry conditions and it is drought drought-tolerant vegetable that is better than many other crops and, in many cases, it is intercropped. According to Mwema and Crewett (2019), jute mallow is demanded and consumed by only 6% of the Kenyan population.

Vegetable amaranth is the least produced ALV by 21.9% of smallholder farmers in Bungoma County. This is attributed to the fact that amaranth is common in every household and just a few smallholders produce them for commercialization. Amaranth vegetables are known as weed plants for they grow on themselves during the rainy season making them accessible to every household. Just a few stallholders have started expressing interest in its

production because there is the introduction of other agricultural varieties that are good for diet in terms of vegetables and seeds that are crushed and prepared as porridge for infants. According to Bokelman and Kebedde (2017), in a study conducted in Kakamega and Kisii Counties, vegetable amaranth was the second least produced ALV at 42.2% after Ethiopian kales. On the contrary, Bokelman *et al*. (2022), Chepkoech *et al.* (2020), Nyonje *et al.* (2022), and Ogada *et al.* (2021), indicate that vegetable amaranth is among the most grown ALV in Kenya. The variation could be attributed to the cultural setting of Bungoma County and the 'weed' perception that the community has about vegetable amaranth.

Table 4.3 Number of African Leafy Vegetables Grown by Smallholder Farmers in Bungoma

Variables	Frequency	Percentage
Single-type of Africa Leafy Vegetable	38	9.9
Two types of African leafy Vegetables	133	34.6
Three types of Africa Leafy Vegetables	128	33.3
Four types of Africa Leafy Vegetables	61	15.9
Five Types of Africa Leafy Vegetables	24	6.3

Smallholder ALV farmers in Bungoma County grow either single or multiple combinations of different types of ALVs as indicated in Table 4.3. The majority of the ALVs producers 34.6% produce two types of ALVs while 33.3% produce three types of ALVs. This could be explained by the fact the demand of certain ALVs vary according to the community and target market. Since ALV producers in Bungoma County target both restaurants and local community markets, they tend to diversify types of ALVs grown to cater for the locally available demand. According to Rapsomanikis (2015), majority of smallholder farmers in Africa tend to produce diverse crops as a risk management and to be able to stabilize their income and avoid risks of price shock in the markets. According to Kansiime *et al.* (2017),

some ALVs are culturally attached to the communities and producers tend to grow ALVs that are both attached to them as a source of food and that are accepted in their local markets.

Smallholder farmers who produce all the five types of ALVs are 6.3% while those who produce only a single ALV are 9.9%. Majority of the smallholders who produce ALVs are women who do not have decision making powers and control when it comes to land usage. Therefore, woman will only get a small size of land that is allocated for kitchen garden which will be used to produce a single species of ALVs. Hackfort (2023) explained that smallholder ALVs farmers produce one species of ALV because for decades ALVs production was never given attention like other exotic crops. This is because they were treated as a key component of local diet and only a little commercialized locally. According to One Acre Fund (2023), smallholder farmers operate on small scale to produce substantial varieties of food to ensure balanced nutrition and diversification of the markets. This make it difficult for them to have all the species of ALVs, therefore they tend to select what is highly demanded and which one is tolerable to harsh climatic conditions.

Table 4.4 Land allocated to Africa LeafyVegetables production

ALVs	Land allocated (acres)	Percentage of total land allocated to ALVs (%)
Africa Nightshade	0.2	22.2
Cowpeas	0.3	33.4
Vegetable amaranth	0.1	11.1
Spider plant	0.2	22.2
Jute Mallow	0.1	11.1
Total	0.9	100

Note: ALVs means, Africa Leafy Vegetable

The results shown in Table 4.3 represents results of land allocation for both Kimilili and Kabuchai subcounties, indicating that most of the respondents allocate 33.4% (0.3 acres) of the total land allocated to ALV production to cowpea production. Cowpeas compared to other ALVs is more tolerant to dry conditions and thus take the largest share of the land during the off-season period when other major food and cash crops have been harvested. This is consistent with findings from Kansiime *et al.* (2017) who reported that farmers in various parts of Uganda allocated an average of 0.3 acres of land to the production of cowpeas.

African nightshade and spider plants had the same percentage (22.2%) of allocation of land which is equivalent to 0.2 acres. This can be attributed to the cultural attachment to these two ALVs as cultural foods and the high market demand for them. From the community, farmers reported that African nightshade is the most demanded ALV followed by cowpeas. Kebedde and Bokelman (2017) noted that ALV smallholder farmers in Kisii and Kakamega allocated 0.19 and 0.21 acres of land to African nightshade and spider plant respectively. The slight difference in the land allocation could be attributed to the cultural significance attached to the crops.

Vegetable amaranth and Jute mallow had a least land allocation of 0.1 acres each which is equivalent to 11.1% of the total land area allocated to ALV production. Vegetable amaranth is not well consumed in the communities, and most of the people refer to them as weeds because, during rainy seasons, they grow everywhere hence the adoption of this vegetable is low and just a small number of respondents had allocated land for its production. Jute mallow is produced mainly for household consumption, and in the market, the demand is very low. Most people claim that when cooked, jute mallow slides like mucus leading to people having a bad notion about them. But they are very much liked by old people. Makauke (2021) noted that smallholders in Tanzania allocated between 5-30% of the land allocated to ALV production to either jute mallow or vegetable amaranth.

4.3. Vertical Market Linkages that exist between Smallholder ALVs Farmers and other Market Actors.

According to the study, vertical market linkage was used to refer to market relationships between smallholder ALV farmers and other market actors operating at different levels of the value chain. These linkages are important for the flow of goods, services, and information, as well as for the distribution of profits and risks along the value chain. Smallholder Leafy vegetable farmers are often vertically linked with other market actors in the markets. This is attributed to the fact that, through linkages smallholder ALV farmers can access the market that they would have not been able to access before, and they can bargain for their products. Smallholder ALVs farmers get the market information that helps them to maneuver in the market via market linkages; through this, they can reduce the risks that would arise if they had not been vertically linked. The vertical market linkages that exist between smallholder ALVs and other market actors are presented in Figure 4.2.

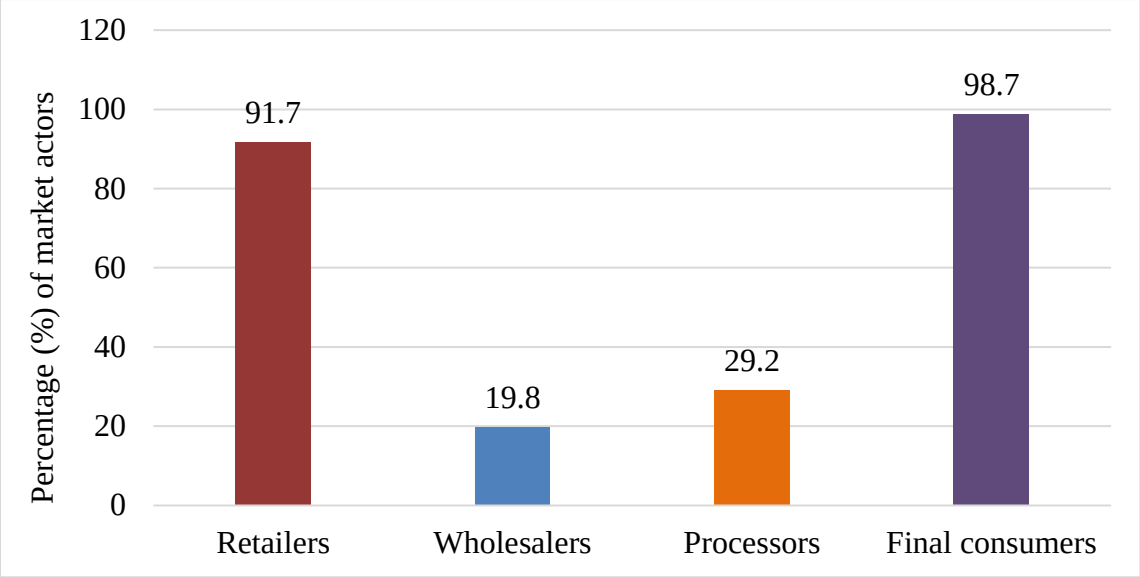

Figure 4.2 Actors who are Vertically Linked to Smallholder ALV Farmers

The results in Table 4.4 indicate that smallholder ALV farmers are linked to market actors such as retailers, wholesalers, processors, and final consumers. The relationship between smallholder ALV farmers and the mentioned market actors was considered vertical market linkages. Therefore, the vertical market linkages that exist include producer-retailer linkage, producer-wholesaler linkage, producer-retailer linkage, and producer-final consumer linkage. The majority (98.7%) of ALV smallholder farmers are linked to final consumers thus the largest linkage that exists is producer-final consumer linkage. The final consumers linked to the ALV smallholder producers were friends, neighbours, relatives, fellow village members, schools, and hospitals. The prominence of this vertical market linkage could be attributed to reduced distance to the market thus limiting the transaction costs involved in marketing. Final consumers equally prefer fresh ALVs which they can easily guarantee in case they buy directly from the farm gate. Additionally, the farmgate prices tend to be lower compared to the market price of ALVs thus the preference by final consumers to deal directly with smallholder farmers. This is consistent with findings from Gido *et al.* (2016) and Jalango (2016) who reported that the largest volumes of ALV sold by smallholder ALV farmers are sold through open-air markets and farmgate to final consumers respectively. Additionally, Mwema and Crewett (2019) reported that smallholder ALV farmers in Kenya sell 75% of their produce to final consumers.

Smallholder ALV farmers who have vertical market linkages with retailers are 352 translating to 91.7%. This implies that 91.7% of smallholder farmers are engaged in producer-retailer linkages which is the second most important vertical market linkage. The retailers that

smallholder ALV farmers are linked to are mainly female market vendors (*mama mbogas*). Bungoma County has Chwele and Kimilili old markets which have numerous ALV market vendors who create demand for the ALVs produced by smallholder farmers. Besides, the streets of Kimilili town, Kamukuywa town, Mukuyuni and Kabuchai attract a variety of roadside retailers in the evening who handle numerous foodstuffs including leafy vegetables. These vendors equally source ALVs from smallholder farmers within the study area. Since most of the retailers are residents within the same communities, there is a long-term relationship that exists between smallholder farmers and retailers which makes it convenient for both parties to engage in a vertical market relationship. According to Minyattah *et al*. (2022), the second most important customers for ALVs produced by smallholder farmers are retailers.

The third most important actors linked to smallholder ALV farmers are processors at 29.2%. These actors buy ALVs for value-addition purposes. The only actors under this category who are linked to smallholder farmers are restaurants and hotels. Restaurants and hotels serve ALVs to their customers who treasure them as traditional staples. Besides, the Kenyan feeding culture involves eating leafy vegetables as a side dish which creates demand by hotels and restaurants to meet the expectations of their customers. Thus, restaurants and hotels are compelled to engage in relationships with smallholder ALV farmers to provide a constant supply for their needs. However, only a few smallholder farmers sell to hotels and restaurants due to the constant quantities demanded that smallholders cannot constantly supply due to the seasonality of production. Additionally, since smallholders only deal with restaurants and hotels within their sub-counties, hotels and restaurants are fewer to accommodate all the smallholder farmers who are engaged in ALV production. According to Vivas *et al.* (2023), hotels and restaurants demand ALVs from smallholder farmers to meet the demand of customers who value traditional vegetables. Jalango (2016) asserts that hotels and restaurants are just taking shape in rural areas of Kenya thus explaining why the proportion of smallholder ALV farmers linked with them is lower compared to retailers and final consumers.

Results in Figure 4.3 indicate that the least (19.8%) actors that smallholder ALV farmers are linked to are wholesalers. Therefore, the least linkage that exists between smallholder farmers and other actors is the producer-wholesaler linkage. Selling to wholesalers requires huge volumes of ALVs produced and prepared at regular intervals (daily or weekly) which most of the smallholder farmers cannot guarantee. Thus, wholesalers tend to rely on a few smallholder ALV farmers and other market actors to acquire the volumes that they require. According to Abebe *et al.* (2016), wholesalers in Ethiopia prefer to work with middlemen to guarantee maximum quantity and quality, and to reduce the cost of measuring quality since

they tend to deal with high-end markets. In addition, Senyolo *et al.* (2018) noted that there is no linkage and market relationship between smallholder farmers and wholesalers in Limpopo province in South Africa which limit the important access points for smallholder farmers.

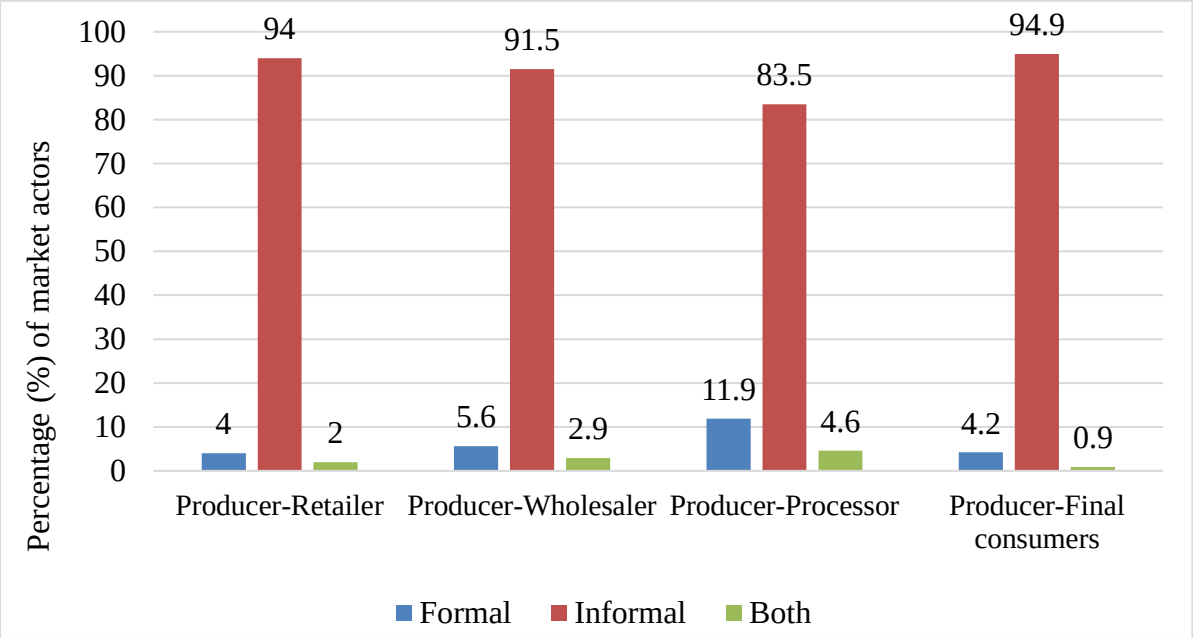

Figure 4.3: **The nature of vertical market linkages between smallholder ALV farmers and other market actors**

The nature of vertical market linkages that exist between smallholder ALV farmers and other market actors is presented in Table 4.6. The nature of vertical market linkages was categorized into formal, informal and both. The relationship between smallholder ALV farmers and retailers (producer-retailer linkage) was largely informal (94%). The same was observed across other vertical market linkages such as producer-final consumer (94.9%), producer-processor linkage (83.5%), and producer-wholesaler linkage (91.5%). Smallholder ALV farmers in Bungoma County assert that informality is time-saving, less tedious and never binding to conditions that may have negative consequences on their livelihood. This is in line with findings from Mersha and Ayenew (2018) who noted that smallholder farmers in Ethiopia preferred informal transactions due to the limited understanding of procedures involved in formal transactions. The informality was largely observed in producer-final consumer linkage (94.9%) and least observed in producer-processor linkage (83.5%). Final consumers include friends, relatives and neighbours who are in constant communication and closer vicinity to the smallholder ALV farmers. Besides, these are people that they interact with daily thus having a higher degree of trust amongst themselves which does not necessitate formalizing the relationship. According to Anderson and Cuevas (2015), rural farming communities tend to have stronger concerns amongst themselves allowing them to adjust their terms and conditions

incase unforeseen circumstances befall a colleague with whom they transact thus the prevalence of informal relationships.

Formal vertical market linkages exist largely in producer-processor linkage (11.9%). The most important processors of ALVs in Bungoma County are hotels and restaurants which require constant supply at regular intervals and an assured quality of the produce supplied. According to Mbatha (2019), hotels and restaurants in Namibia transact with smallholder farmers formally to raise volumes constantly demanded by tourists while maintaining the quality of their services to their clients. This is followed by producer-wholesaler linkage (5.6%), producer-final consumer linkage (4.2%), and least observed producer-retailer linkage (4%). Final consumers formally linked to smallholder ALV farmers are schools and hospitals which require formal signing of contracts with smallholder farmers before supply of ALVs. This is because of the sensitivity of these institutions and their clients thus the need to guarantee quality. The main retailers that smallholders engage with are *mama mbogas* who always come and pick up the ALVs directly from the garden after either a phone call or an informal talk during the market day or within their communities of residence. According to Research Solutions Africa (2015), the majority of smallholder farmers and retailers (*mama mbogas*) in Kenya are less educated and thus cannot organize contracts that formally bind their transactions.

4.4 Factors influencing the commercialization of African Leafy Vegetables (ALVs) among the smallholder farmers in Bungoma County

To get the level of AIVs commercialization, the Household Commercialization Index (HCI) was used. The index refects a proportion of the total value of AIVs sold in the market out of the total value of AIVs grown by a smallholder farmer. This is presented as follows

$$HCI = \frac{Total\ value\ of\ AIVs\ sold}{Total\ value\ of\ AIVs\ grown} \text{ X } 100$$

$$HCI = \frac{41184}{49985} \text{ X } 100$$

HCI= 82%

The level of commercialization of AIVs among smallholders in Bungoma County was calculated and reported as 82% based on the results from the HCI. This implies that the majority of AIVs smallholder farmers produce for commercial purposes (Chirwa, 2012). According to

the study, African Indigenous Vegetables (AIVs) are the vegetables that are highly produced in many regions in Kenya and this is a result of the available market for AIVs. Increased sales of AIVs are attributed to the fact that their nutritional benefits are highly recognized making them more popular in many family dishes (Sharma & Harish, Adenike &, Adewoye, 2018). The increased level of commercialization in AIVs is a result of a change in production pattern as most of the people are now producing at a large scale throughout the year and those that were producing for subsistence purposes are now producing for commercialization, and this is attributed to access to AIVs markets through vertical market linkages, another reason is that many families are now consuming AIVs because of its nutrition benefits and solution for health issues that are emerging making people cautious of what they consume. Chepkoech *et al.* (2020), reported that over 90% of the respondents in Kenya and Tanzania reported having preferred consuming African nightshade

To determine the factors that influence the commercialization of African Leafy Vegetables (ALVs) among the smallholder farmers in Bungoma County, fractional regression model was used. The results of FRM results presented in Table 4.5 shows a good model fit with a log pseudo likelihood of -179.203, Wild Chi2 (17) of 62.02, a significant probability (Prob > chi2 0.0000) and Pseudo R2 of 0.1951. The Wild Chi-square test was significant at 1% indicating that the explanatory variables jointly determined the response variable. The Pseudo R square of 0.1951 implies that the model was good in that the explanatory variables were able to explain about 20% of the variation in the dependent variable. The results in Table 4.5 indicate that seven of the explanatory variables included significantly influenced the commercialization of ALVs among smallholder farmers. These variables include the education level of the farmer, land size, distance to the markets, ALV yields, ALV cost of production, average price and value-added.

The education level of smallholder ALV producers positively influences the commercialization of ALVs at 10% significant level. A unit increase in the number of years spent in school increases level of commercialization of ALVs by 12.8%. This is attributed to the fact that educated smallholder ALVs farmers are more likely to adopt new technology. This is because the knowledge they have acquired throughout their schooling positively influences their priorities and decisions regarding ALV commercialization. This is based on prior research and information disseminated across various media platforms in the current generation. Education gives them the bargaining power when it comes to marketing and meeting the quality and safety concerns that other ALV producers continuously grapple with. Oloo (2013) reports that the level of education is believed to have extreme impact on the

commercialization of ALVs due to improved access and usage of information on market trends and changing consumer behaviours.

The proportion of land allocated for African Leafy vegetables production significantly and positively influenced the commercialization ALVs among smallholder farmers at 10%. This means that 1% of the increased proportion of land allocated to produce ALVs is associated with 3.3% increase in the commercialization of ALVs by smallholder farmers. This is attributed to the fact that land size facilitates eceonimies of scales, influenceing the the production of ALVs on a commercial scales the vice verse is also true. Land is a resource that is crucial when it comes to the production of ALVs, more land cultivated will increase farm output which invariable will be sold for income generation. This will lead to income increases for smallholder farmers, and the tendency to expand farmland increases hence increasing the commercialization level of the smallholder farmers and ALVs commercialization. This is consistent with findings from Wachuka and Majiwa (2019) who reported that land size positively and significantly influenced the commercialization of traditional vegetables in Kiambu County in Kenya.

The distance (kilometers) to the markets covered by a smallholder ALV farmer negatively influenced the commercialization of African Leafy vegetables at a 1% significance level. An increase in the distance covered to the market reduces a smallholder ALV farmer's likelihood to commercialize by 16.5%. With the unpredictability of ALV prices and high transaction costs incurred in selling ALVs, smallholder farmers prefer to either sell at Farmgate or use the ALV for household consumption rather than trekking distances to an unpredictable market. According to Kangile *et al.* (2020), the increase in the distance to the markets increases the average probability that smallholder farmers in Tanzania will consider selling their product at the nearest market or either to use the produce for household consumption. This clearly shows that the distance to the market is a critical determinant in accessing various market choices.

Table 4.5 Fractional Regression Results on Factors that Influence Commercialization of ALVs

Fractional logistic regression	Number of obs = 383
	Wald chi2(19) = 93
	Prob > chi2 = 0000
Log pseudolikelihood = -179.06536	Pseudo R2 = 0.0097

Proportion sold	Coef.	Std.Err.	z	P>z
Expe	-0.074	0.082	-0.91	0.356
Age_HHhead	0.016	0.037	0.44	0.66
Gender	-0.185	0.083	-2.21	0.027**
Educ	-0.074	0.065	-1.14	0.253
Land	0.037	0.021	1.73	0.083*
Marital	0.095	0.075	1.27	0.205
Access_credit	0.193	0.373	0.52	0.605
Training	-0.054	0.105	-0.52	0.604
Consumer	-0.139	0.089	-1.55	0.121
Payment	-0.257	0.096	-2.67	0.008***
Distance	-0.173	0.053	-3.25	0 .001***
Duration	0.003	0.002	1.66	0.098
Info	0.028	0.023	1.26	0.208
AIV_yield	0.001	0.000	2.56	0.011**
AIV_cost	-0.001	0. 383	-3.14	0. 002***
AIV_price	-0.001	0.000	-1.57	0.116
Valadd	0.048	0.024	2.00	0.045**
AGE2	-0.000	0.000	-0.59	0.554

Note: ***, ** and * means significant at 1%, 5% and 10% level respectively.

The Gender of the respondents negatively and significantly influenced the commercialization of the AIVs among smallholder farmers at 5% significance level. The results indicated that 18.5 % of male gendered smallholder AIV famers are less likely to commercialize AIVs compared to their female counterparts. In Bungoma County, men tend to associates themselves with commercial crops that can fetch high and instant cash compared to women who controls indigenous crops and subsistence food crops. Therefore, the engagement of men in AIV production tends not to be focused on income generation but rather household food supply. Adenike (2018) explained that an increase in the number of female-headed households increased the level of commercialization of agricultural produce in Nigeria. Additionally, Zondi *et al.* (2022) reports that gender negatively influence commercialization of traditional vegetables in Limpompo and Mpumulanga provinces in South Africa. They asserted this to the fact that female-headed households are more likely to be involved in the

market of indigenous crops as compared to the male counterparts who mostly involved in the harvesting and marketing of cash crops.

The proportion of land allocated for African indigenous vegetables production significantly and positively influenced the commercialization AIVs among smallholder farmers at 10%. This means that 1% of the increase proportion of land allocated to produce AIVs is associated with 3.6% increase in the commercialization of AIVs by smallholder farmers. Land is a resource that is crucial when it comes to the production of AIVs, more land cultivated will increase farm output which invariable will be sold for income generation. This will lead to an income increases for smallholder famers, the tendency to expand farmland increases hence increased commercialization level of the smallholder farmers and AIVs commercialization. This is consistent with findings from Wachuka and Majiwa (2019) who reported that land size positively and significantly influenced commercialization of traditional vegetables in Kiambu County in Kenya.

The contractual mode of payment negatively influenced the commercialization of Africa indigenous vegetables among smallholder famers at 1% significance level. This implies that the using contractual mode of payment compared to when smallholder use instant cash mode of payment reduces the likelihood of commercialization by 25.7%. Famers face numerous challenges and have daily cash needs to alleviate the problems they currently have and those that come along. Therefore, choice of AIV smallholder famers of the payment mode depend on the market target and the goal of their production. Additionally, smallholder AIV farmers in Bungoma County largely transact with final consumers (friends, relatives, neighbours, village members) who do not require a formal means of payment and transaction. Ochieng *et al*. (2017) reported that vegetable farmers drop out from contractual agreements is very high. They attributed this to the fact that farmers dislike delayed payments that are common place in contract schemes.

The distance to the markets covered by a smallholder AIV farmer negatively influenced the commercialization of African indigenous vegetables at 1% significance level. An increase in the distance covered to the market reduces a smallholder AIV farmers likelihood to commercialize by 17.3%. With the unpredictability in AIV prices and high transaction costs incurred in selling AIVs, smallholder farmers prefer to either sell at farmgate or use the AIV for household consumption rather than trekking distances to an unpredictable market. According to Kangile *et al.* (2020), the increase in the distance to the markets increases the average probability that smallholder farmers in Tanzania will consider selling their product at

the nearest market or either to use the produce for household consumption. This clearly show that the distance to the market is a critical determinant in accessing various market choices.

Value addition was measured as a dummy variable where smallholder ALV farmers were asked whether they add value to their produce or not. The value addition considered were primary (sorting, cleaning, drying), secondary (grinding into powder, cooking) and tertiary (transportation, distribution, and delivery). Value addition positively and significantly influences the commercialization of ALVs at a 5% significance level. This implies that an additional value added to ALVs increases the likelihood of commercialization by 4.8%. Adding values to ALVs be it, grading, sorting, and packing significantly impacts the commercialization of ALVs, this is attributed to the fact that it creates new market opportunities for ALVs and it results in increased profitability for smallholder ALVs farmers. According to Arumugam *et al.* (2022), adding value to ALVs is the most important activity that smallholder farmers in Zambia can venture into to get a good price for ALVs. However, value addition in Africa is less produced due to the poorly developed marketing of ALVs.

The yields of ALV had a significant positive influence on the commercialization of ALVs at a 1% significant level. An increase in the yields of ALVs increased the likelihood for commercialization of ALVs by 0.1%. This is attributed to the fact that high yields reduce the cost of production per unit, making the products more competitive in the market and potentially increasing the profitability of the business. On the other hand, low yields in LVs limit the availability of the products and increase the cost of production per unit, increasing the competitiveness of ALVs in the market. This results in reduced profit for smallholder farmers. Low yields can also make it difficult for farmers to meet the demand for the products, which can result in lost sales and reduced market share. Ayenew *et al.* (2018) note that an increase in the yield of traditional crops in Nigeria is associated with increased commercialization, increased incomes, and increased ability to diversify household diets.

ALV production costs negatively influenced the commercialization of ALVs at 5% significance level. The results indicated that when keeping other factors constant, the increase in the ALVs costs reduces the likelihood of commercializing at 0.1%. The higher the cost of production, the higher the final price of sale. At a higher price, buyers are reluctant to buy and those willing to buy always offer lower prices thus lowering the general profitability of the producers. The higher cost of production equally discourages producers from widening production, instead, they focus on production for household consumption. According to Katovich and Sharma (2014), the low level of commercialization of vegetables among

smallholder farmers in the mid-western region of Nepal is attributed to the high cost of motor pumps and drip irrigation required in the production of vegetables.

4.4 Effect of Vertical Market Linkages on the Commercialization of African Leafy Vegetables

4.4.1 Combinations of Vertical Market Linkages

The vertical market linkages that smallholder ALV farmers participate in include producer-retailer linkage (R), producer-wholesaler linkage (W), producer-processor linkage (P), and producer-final consumer linkage (F). The results in Table 4.5 indicate that none of the smallholder ALVs participates in a single vertical market linkage. Instead, they participate in a combination of vertical market linkages at the same time. The combinations of vertical market linkages included producer-wholesaler and producer-final consumer linkages ($R_0W_1P_0F_1$), producer-wholesaler and producer-processor linkages ($R_0W_1P_1F_0$), producer-retailer, producer-processor and producer-final consumer linkages ($R_1W_1P_0F_1$), producer-processor and producer-final consumer linkages ($R_0W_0P_1F_1$), producer-retailer and producer-final consumer linkages ($R_1W_0P_0F_1$), a combination involving all the identified vertical market linkages ($R_1W_1P_1F_1$) and producer-retailer, producer-processor and producer-final consumer linkages ($R_1W_0P_1F_1$).

Table 4.6 Combinations of Vertical Market Linkages Used by Smallholder Farmers

Combinations of vertical market linkages	Freq.	Percent (%)	Cum.
$R_0 W_1 P_0 F_1$	5	1.30	1.30
$R_0 W_1 P_1 F_0$	2	0.52	1.82
$R_1 W_1 P_0 F_1$	32	8.33	10.16
$R_0 W_0 P_1 F_1$	15	3.91	14.06
$R_1 W_0 P_0 F_1$	236	61.46	75.52
$R_1 W_1 P_1 F_1$	38	9.90	85.42
$R_1 W_0 P_1 F_1$	56	14.58	100.00
Total	384	100.00	

Note: Producer-retailer linkage (R), Producer-wholesaler linkage (W), Producer-processor linkage (P), Producer-final consumer linkage (F)

Most (61.5%) of the smallholder ALV farmers participated in the $R_1W_0P_0F_1$ combination. Thus, most of the smallholder ALV farmers are linked more to retailers and final

consumers. Selling directly to retailers and final consumers offers ALV farmers greater control over pricing, higher profit margins, and more reliable demand. It also allows farmers to build relationships with their customers and receive valuable feedback on their produce. Since most of the retailers and final consumers pick the ALVs directly from the farm, transaction costs are greatly lowered. Smallholder farmers have full control of the prices and the market by selling ALVs directly to consumers, they are also able to secure their market by differentiating themselves from competitors by creating a loyal customer base due to the feedback received from consumers. According to Liverpool-Tassie *et al.* (2020), smallholder farmers in developing countries largely interact with retailers and final consumers who in turn purchase the largest volumes of their produce.

$R_0W_1P_1F_0$ combination had the least (0.5%) participants across the study area. This implies that very few smallholder ALV farmers participated in a linkage that combined both wholesalers and processors. This can be attributed to limited production volumes since wholesalers and processors require large volumes consistently. The fact that most of processors and some wholesalers prefer formal business transactions could explain the limited usage of such a combination. This is consistent with findings from Ferris *et al.* (2014) who reported that smallholder farmers in developing countries fail to access profitable markets offered by processors and wholesalers because they rarely have reasonable volumes to establish a reliable business relationship. Similarly, FAO (2001) notes that wholesalers and processors cannot invest in a relationship with smallholder farmers unless they are assured that the required commodities can be consistently produced.

4.4.2 Factors Influencing Utilization of Combinations of Vertical Market Linkages

The results of the multinomial regression estimate with the corresponding marginal effects are presented in Table 4.6 and Appendix 3. The estimated coefficients differ significantly across alternative combinations of vertical market linkages. The gender of the smallholder ALV farmer had a significant and negative influence on the choices of producer-processor and producer-final consumer linkages ($R_0W_0P_1F_1$) and producer-retailer, producer-processor, and producer-final consumer ($R_1W_0P_1F_1$) combinations. This implies that male smallholder ALV farmers are less likely to use $R_0W_0P_1F_1$ and $R_1W_0P_1F_1$ combinations at a 10% significance level respectively. Men, unlike women, prefer selling larger volumes of produce at once which would most likely be possible while dealing with wholesalers. Since wholesalers are not part of the two combinations under consideration, the participation of men becomes very unreliable. The lack of transport means by female farmers leaves them with limited

choices of selling largely to final consumers and retailers who pick the produce from the farm gate. Abebe *et al.* (2016) report that male smallholder farmers in Ethiopia sell their produce to wholesalers and not to final consumers and retailers because they own means of transport allowing them to ferry their produce to the nearest wholesalers.

The age of the respondents negatively and significantly influenced smallholder participation in $R_1W_1P_0F_1$ and $R_1W_1P_1F_1$ at a 10% and 1% significance level respectively. Age positively influences participation in $R_1W_0P_0F_1$ combinations at a 1% significance level. This implies that a unit increase in the age of a smallholder ALV farmer leads to a reduction in participation in $R_1W_1P_0F_1$ and $R_1W_1P_1F_1$ combinations by 0.2% and 0.7% respectively. However, a unit increase in age leads to an increase in participation in $R_1W_0P_0F_1$ combination by 1.4%. As a farmer age, he/she gets insight and experience about the best combination that offers better prices and higher profits and thus tends to make future decisions based on the experience gained over the years. According to Wambua *et al.* (2021), as smallholder farmers age, their cassava yield reduces significantly thus their market participation largely relies on actors who can buy on-farm in Kenya and Brazil.

Smallholder ALV farmers' farming experience had a positive significant influence on the choice of participating in $R_1W_1P_0F_1$, $R_1W_1P_1F_1$, and $R_1W_0P_1F_1$ combinations of vertical market linkages. This implies that a unit increase in farming experience (years) increases the possibility of participating in $R_1W_1P_0F_1$, $R_1W_1P_1F_1$, and $R_1W_0P_1F_1$ combinations by 0.3%, 0.6%, and 0.9% respectively. The longer a smallholder ALV farmer participates in production and marketing, the more knowledge they gain in terms of the advantages and the disadvantages associated with the different combinations of vertical market linkages. Thus, they become conversant about the most attractive and profitable combinations to use. Ozkhan *et al.* (2022) noted that smallholder fruit and vegetable farmers in Ethiopia expanded their sales outlets and market base over time after building consistent and reliable market relationships.

The size of agricultural land owned by the smallholder ALV farmer had a significant and negative influence on the choice of participating in the $R_0W_0P_1F_1$ combination at a 10% significance level. Thus, a unit increase in the size of land owned by smallholder ALV farmers results in a reduction in the likelihood of using the $R_0W_0P_1F_1$ combination by 0.5%. This could be associated with the fact that smallholders prefer supplying produce largely to final consumers and retailers. Therefore, in case land size under ALV production increases, more of the product will have to be sold to either final consumers or retailers. Additionally, an increase in land area under ALVs implies increased production volumes which attract wholesalers to track distances and buy large volumes directly from an individual farmer. Nyamamba *et al.*

(2022) reported a positive significant influence between increased land size and increased cases of side selling among smallholder farmers in Kisumu. They equally noted the increased frequencies of smallholder farmers dealing with other market actors as the land size and production volumes increased.

Regarding land tenure or the mechanism through which land is accessed, smallholder ALV farmers were more likely to participate in the $R_1W_1P_1F_1$ combination at a 10% significance level. Therefore, ownership of land on which ALV is produced increased the likelihood of using a combination of all the vertical market linkages by 2.6%. Ownership of land motivates long-term investments in land such as the installation of irrigation infrastructure which supports the production of ALVs throughout the year. The increased production may turn out to be excess for only one type of market actor to handle thus the need to deal with all market actors. According to Weatherspoon *et al.* (2021), commercialization and diversification of the relationships with market actors among smallholder farmers in Rwanda increased with the increase in ownership of agricultural land.

Smallholder ALV farmers' access to irrigation positively and significantly influenced the choice of smallholder ALV farmers participating in $R_1W_1P_0F_1$, and $R_1W_0P_0F_1$ at a 5% significance level respectively. Access to irrigation significantly and negatively influenced participation in $R_1W_1P_1F_1$ and $R_1W_0P_1F_1$ combination of vertical market linkages at a 10% significance level. This implies that increased access to irrigation increases smallholders' participation in $R_1W_1P_0F_1$ and $R_1W_0P_0F_1$ combination by 4.5% and 8.8% level respectively. This is equally associated with a decrease in the likelihood of using the $R_1W_1P_1F_1$ and $R_1W_0P_1F_1$ combination by 4.3% and 8.5% respectively. The use of irrigation is likely to increase production and production costs. Thus, smallholder farmers would prefer to sell to a combination that comprises retailers and final consumers compared to any combination that comprises processors. This is because, on top of the increased production cost, processors prefer receiving the produce transported by the smallholder farmers to their premises unlike retailers and final consumers who transact with the producers at the farm gate. According to Nekuphiwa *et al.* (2014), irrigation plays an imminent role in improving crop production, most especially during the dry season. However, it is associated with an increased unit cost of production.

The status of consumer demand for ALVs had a significant and negative influence on the choice to participate in the $R_1 W_1 P_0 F_1$ and $R_1 W_1 P_1 F_1$ and positively influenced the choice to use the $R_1W_0P_0F_1$ combination. This implies that a unit increase in consumer demand for ALVs leads to a decline in the likelihood of a smallholder participating in the $R_1W_1P_0F_1$ and

$R_1W_1P_1F_1$ combinations by 6.8% and 7.0% respectively while increasing the likelihood of participating in $R_1W_0P_0F_1$ combination by 13.1%. This can be explained by the fact that the largest consumers of ALVs are retailers and final consumers who visit producers and buy directly from the farm gate thereby limiting the volumes that can be sold to other actors. This is closely consistent with findings from Adanacioglu (2021) who noted that most of the consumers in Turkey prefer to visit fruit and vegetable farms to purchase food items rather than using the designed market facilities by the government and other traders involved in the mentioned value chain.

The mode of payment for ALVs had a negative and significant influence on the choice of participating in $R_0W_0P_1F_1$ combination of vertical market linkages at a 10% significance level. This implies that the contractual mode of payment reduces smallholder ALV farmers' participation in the $R_0W_0P_1F_1$ combination by 0.8%. Dealing with contracts that bind smallholder ALV farmers to constantly supply an agreed volume before receiving pay is one of the reasons that was cited for their reluctance towards formal transactions. Since the daily cash demand among smallholder farmers is high, any arrangement that binds them in terms of receiving cash after fulfilling a given obligation will be rejected. According to Riziki (2017), final consumers in Kenya are required to pay upon receiving vegetables from the farmer or at the farm gate.

In relation to time, the duration that is taken by smallholder ALV farmers to reach the market positively and significantly influences smallholder farmers' participation in $R_1W_1P_0F_1$ and negatively influences the choice of usage of $R_1W_1P_1F_1$ combination at a 10% significance level respectively. Therefore, a unit increase in the time it takes to reach the market by a smallholder ALV farmer increases the likelihood of participating in the $R_1W_1P_0F_1$ combination and decreases the likelihood of participating in the $R_1W_1P_1F_1$ combination by 0.1% respectively. The longer it takes to reach the market, the higher the cost of transporting produce to the market. Therefore, smallholder farmers would prefer participating in a combination that involves actors purchasing directly on farms rather than combinations where they must incur the cost of transporting produce to the market. Another reason could be related to the fact that ALVs are very perishable, therefore, longer duration can affect the quality and freshness of produce delivered to the market which can affect the demand and the final price of the ALVs. This is consistent with findings from Haile *et al.* (2022) who revealed that the longer the distance to the nearest market, the lower the participation of smallholder farmers in the marketing of their produce in Southern Ethiopia.

Table 4.7 Parameter Estimates of the Alternative Combinations of Vertical Market Linkages – Multinomial Logit Model

Variables (Base category - $R_0 W_1 P_1 F_0$)	$R_0 W_1 P_0 F_1$	$R_1 W_1 P_0 F_1$	$R_0 W_0 P_1 F_1$	$R_1 W_0 P_0 F_1$	$R_1 W_1 P_1 F_1$	$R_1 W_0 P_1 F_1$
Sample size (n)	5	32	15	236	38	56
Gender	-5.379	-2.132	-4.002*	-3.016	-3.290	-3.715*
Age	-0.116	-0.134	0.01**	-0.07	-0.241**	-0.119
Marital	5.424	16.974	18.743	17.907	17.538	17.742
Education	-1.737	0.89	0.154	0.373	0.640	0.507
Experience	0.079	0.153	0.052**	0.063	0.213*	0.141
Land size	-0.243	-0.159	-1.101	-0.282	-0.204	-0.321
Access	-14.259	-1.949*	-2.103*	-2.138**	-1.531	-1.955*
Training	1.145	-0.243	0.332	0.501	0.664	0.117
Irrigation	-18.254	-0.603	-2.536	-1.584	-2.576	-2.233
Consumer	19.359	0.907	4.868**	2.745	1.135	2.529
Payment	12.895	1.484	-0.433	0.948	0.727	1.372
Distance	-0.437	-2.376**	-0.954	-2.021*	-1.614	-1.743
Transport means	-1.202	-0.327	-0.728	-0.617	-0.565	-0.545
Duration	0.161	0.223***	0.144*	0.198**	0.167**	0.192**
ALV_cost	-0.076	0.011	0.038	0.034*	0.070	0.111
Sub-county	-6.419	8.621*	7.755	8.909*	7.221	1.095*
Constant	-16.185	-9.08	-8.998	-5.484	-0.071	-5.138

Note: Standard deviations are given in parentheses. ***, ** and * means significant at 1%, 5% and 10% level respectively.

The sub counties (Kimilili (0) and Kabuchai (1) where the data was extracted positively and negatively influenced the participation of ALVs smallholder farmers in combinations of vertical market linkages. A smallholder ALV farmers sub-county significantly and positively influenced participation in the $R_1W_0P_1F_1$ combination and negatively influenced participation in the $R_1W_1P_1F_1$ combination at 1% respectively. This implies that belonging to the Kimilili sub-county increases the probability of participation in the $R_1W_0P_1F_1$ combination and reduces the probability of participating in the $R_1W_1P_1F_1$ combination by 7.4% and 15.1% respectively. This could be attributed to the fact that Kimilili is a very busy and developed town with a large number of residents and restaurants that constantly demand the ALVs compared to the Kabuchai sub-county. This is consistent with findings from Vandercastelen *et al.* (2018) who reported that big towns with larger populations in Ethiopia demanded more food produced by smallholder farmers compared to smaller and less developed towns.

The cost of producing ALVs positively and significantly influenced participation in the $R_1W_0P_1F1$ combination while it negatively influenced participation in the $R_1W_0P_0F_1$ and $R_0W_0P_1F_1$ combinations at a 10% significance level. This implies that a unit increase in the cost of production increases the likelihood of participation in the $R_1W_0P_1F1$ combination by 7.6% while decreasing the likelihood of participating in the $R_1W_0P_0F_1$ and $R_0W_0P_1F_1$ combinations by 6.7% and 6.6% respectively. The increase in production cost requires a market that is willing to pay higher prices for the produce for the smallholders to break even. The study participants revealed that the highest price paid for ALVs was realized when dealing with processors. Therefore, a combination involving processors would receive a potential number of smallholders since retailers and final consumers tend to prefer buying at lower prices. According to Karuho and Collins (2020), processors offer smallholder farmers a premium price for their produce in Africa which offsets the cost-related challenges that they meet during production.

4.4.3 Effects of Vertical Market Linkages on the Commercialization of ALVs

Results from the last stage of the MESR model were subjected to t-tests to find the resulting effect of smallholder ALV farmers' participation in a single or combination of ALVs presented in Table 4.8. Associated and associated effects provide the actual percentage of ALVs sold when a smallholder farmer engages or chooses not to engage in a given vertical market linkage respectively. The difference between the associated and not associated effects was determined to get the treatment effect (ATT/ATU). This was subjected to t-tests to ascertain their level of significance in determining the percentage of ALVs sold. On the other

hand, the heterogeneity effect is the difference between the percentage sold when a smallholder farmer engages in each vertical market linkage and when a smallholder farmer who does not use the same linkage decides to engage in it.

The resulting effect of smallholder ALV farmers' participation in a combination of vertical market linkages on the commercialization of ALVs is presented in Table 4.8. Commercialization of ALVs was measured in terms of the percentage sold by the smallholder ALV producer. Results indicate that the highest of commercialization is achieved when smallholder ALV producers participate in producer-processor and producer-final consumer linkages (R0W0P1F1) by 5.2 units. This implies that smallholders' participation in producer-processor and producer-final consumer linkages (R0W0P1F1) increases commercialization among smallholder ALV producers by 6.4 percentage points. This can be expounded by the reality that processors and final consumers typically require a steady supply of products, which can provide smallholder farmers with a more predictable source of income. When selling to final consumers, smallholder farmers can avoid the cost and time required to market and transport their products to multiple buyers. This can result in cost savings and more efficient use of their time. Processors and final consumers are often more knowledgeable about market trends and demand than other actors. This can help smallholder farmers make better-informed decisions about what ALVs to produce and when to sell them.

Other combinations that led to an increased percentage of ALVs commercialized among smallholder farmers were producer-retailer, producer-wholesaler, and producer-final consumer linkages (R1W1P0F1) and the participation in a combination of all the four vertical market linkages (R1W1P1F1) by 2.8 units and 2.2 units respectively. This implies that smallholder ALV farmers' participation in R1W1P0F1 and R1W1P1F1 combinations increase the commercialization of ALVs by 3.4% and 2.6% respectively. The steady demand created for ALVs by the multiple linkages can act as a motivation for smallholders to slightly increase the volumes of ALVs sold.

Unlike the earlier presented combinations, a smallholder farmer's participation in producer-retailer and producer-final consumer ($R_1W_0P_0F_1$) and producer-retailer, producer-processor, and producer-final consumer linkages ($R_1W_0P_1F_1$) is associated with a decline in commercialization by 2.3 units and 3.6 units respectively. Therefore, participation in ($R_1W_0P_0F_1$) and producer-retailer, producer-processor, and producer-final consumer linkages ($R_1W_0P_1F_1$) would lead to a decrease in commercialization of ALVs by 2.8% and 4.3% respectively. This can be attributed to the fact that selling to a combination of retailers and final consumers can lead to a fragmented market, where the farmer's products are sold in small

quantities to different buyers. This may lead to inefficiencies in the marketing process and lower prices due to the increased transaction costs. Additionally, smallholder farmers may lack the necessary bargaining power to negotiate better prices with retailers and final consumers. This is because retailers and final consumers may have alternative sources of supply and may not be willing to pay higher prices for the farmer's products.

Participation of smallholder ALV producers in producer-retailer, producer-wholesaler, and producer-final consumer ($R_1W_1P_0F_1$) linkages, producer-processor, and producer-final consumer ($R_0W_0P_1F_1$) linkages and producer-retailer, producer-processor, and producer-final consumer ($R_1W_0P_1F_1$) linkages had a positive and significant effect on commercialization at a 1% significance level. This implies that, when a smallholder ALV farmer who does not participate in these three different combinations finally decides to participate in them, their of commercialization would increase by 16%, 40.2%, and 1.8% respectively. In contrast, participation in producer-wholesaler and producer-final consumer ($R_0W_1P_0F_1$) linkages, a combination of all the four vertical market linkages ($R_1W_1P_1F_1$), and producer-retailer, producer-processor, and producer-final consumer ($R_1W_0P_1F_1$) linkages had a significant and negative effect on the commercialization of ALVs. This implies that, if a smallholder ALV producer who was not using these combinations decides to use them, the commercialization of ALVs among those farmers would decrease by 31.2%, 1.7%, and 1.2% respectively. This can be due to smallholder farmers facing challenges in meeting the quality and quantity requirements of retailers, processors, wholesalers, and final consumers. This may lead to rejected deliveries, lower prices, and reduced incentives to invest in quality improvement. Therefore, due to their smallholder nature, these ALV producers would be better off not utilizing these combinations.

Smallholder ALV farmers' participation in producer-retailer vertical linkage was significant and negative at 1% while participation in producer-wholesaler was positive and significant at 1%. This implies that participation in producer-retailer and producer-wholesaler vertical market linkages leads to a decrease in commercialization by 15.9% and an increase in commercialization by 4.2% respectively. However, if smallholder ALV farmers who were not participating in producer-wholesaler vertical market linkages decide to participate, their commercialization increases by 4.9%. This could be attributed to the fact that wholesalers demand larger quantities at regular intervals, which motivates a smallholder farmer to produce more and sell more. Therefore, a smallholder would be better off participating in this linkage.

Unlike retail and wholesale linkages, when a smallholder ALV farmers who were not participating in producer-processor vertical market linkages decide to participate, their of

commercialization increases by 0.9%. However, when a smallholder ALV farmer who was not participating in producer-final consumer vertical market linkages decide to participate, their level of commercialization decreases by 1.9%. Therefore, a smallholder would be better off not participating in this linkage.

Combinations of vertical market linkages (Base category - $R_0W_1P_1F_0$)		Associated with Vertical Market Linkage Combination	Not Associated with the Combination	Treatment Effect: ATT/ATU
$R_0W_1P_0F_1$	Associated	85.0	78.9	6.1
	Not Associated	56.0	81.4	-25.4*
	Heterogeneity Effect	29.0	-2.5	31.5
$R_1W_1P_0F_1$	Associated	84.1	81.8	2.8***
	Not Associated	94.8	81.7	13.1***
	Heterogeneity Effect	-10.7	0.1	-10.3
$R_0W_0P_1F_1$	Associated	86.9	81.7	5.2*
	Not Associated	114.6	81.8	32.9***
	Heterogeneity Effect	-27.7	-0.1	-27.7
$R_1W_0P_0F_1$	Associated	81.2	83.4	-2.3***
	Not Associated	81.9	83.2	-1.4**
	Heterogeneity Effect	-0.7	0.2	-0.9
$R_1W_1P_1F_1$	Associated	85.3	83.2	2.2**
	Not Associated	83.1	81.6	1.5***
	Heterogeneity Effect	2.2	1.6	0.7
$R_1W_0P_1F_1$	Associated	79.7	83.2	-3.6**
	Not Associated	81.4	82.3	-1.0*
	Heterogeneity Effect	-1.7	0.9	-2.6
$R_1W_0P_0F_0$	Associated	81.8	97.7	-15.9***
	Not Associated	82.0	83.8	-1.8
	Heterogeneity Effect	-0.2	13.9	-14.1
$R_0W_1P_0F_0$	Associated	85.3	81.1	4.2***

	Not Associated	86.0	81.1	4.9***
	Heterogeneity Effect	-0.7	0	-0.7
$R_0W_0P_1F_0$	Associated	82.5	82.7	-0.2
	Not Associated	82.6	81.7	0.9*
	Heterogeneity Effect	-0.1	1.0	-1.1
$R_0W_0P_0F_1$	Associated	81.6	81.4	0.2
	Not Associated	80.3	82.2	-1.9*
	Heterogeneity Effect	1.3	-0.8	0.5

Table 4.8 Average Treatment Effects of the Utilization of a Combination of Vertical Market Linkages on the Commercialization of ALVs – Multinomial Endogenous Switching Regression

Note: Standard deviations are given in parentheses. ***, ** and * means significant at 1%, 5% and 10% level respectively.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter comprises of conclusion, recommendations, and suggestions for further research. The study's general objective was to contribute to improved livelihoods among African Leafy vegetable smallholder farmers in Kenya by evaluating the effect of vertical linkages on the commercialization of ALVs. The specific objectives of the study were determining the vertical market linkages that exist between smallholder ALV farmers and other actors in Bungoma County, determining the factors that influence the commercialization of African Leafy vegetables (ALVs) among the smallholder farmers in Bungoma County, and determining the effect of vertical market linkages on the commercialization of African Leafy vegetables (ALVs) in Bungoma county. Data was collected by using a personal administered questionnaire and analyzed by using STATA. The fractional regression model was used to determine factors influencing the commercialization of African Leafy Vegetables (ALVs) among smallholder farmers and Multinomial Endogenous Switching Regression Model was used to determine the effect of vertical market linkages on the commercialization of ALVs. Below are the research conclusions in relation to the specific objectives of the study.

5.2 Conclusions

One of the three specific objectives was to determine the vertical market linkages that exist between smallholder ALVs farmer's and other actors in Bungoma County. The results showed that that smallholder ALV farmers are linked to market actors including retailers, wholesalers, processors, and final consumers. The relationship between smallholder ALV farmers and the mentioned market actors were considered as vertical market linkage. Four market linkages including producer-retailer linkage, producer-wholesaler linkage, producer-Processor linkage, producer-final consumer linkage and producers to other were determined. The results showed that the majority of ALV smallholder farmers are linked to final consumers and least ALV smallholder farmers are linked to the wholesalers.

On the second objective which was to determine the factors that influence the commercialization of African leafy vegetables (ALVs) among the smallholder farmers in

Bungoma County and the results showed that seven explanatory variables including level of education, land size, distance to the markets, ALV yields, ALV cost of production, average price of ALVs and value added significantly influenced the commercialization of ALVs among smallholder farmers.

Lastly, on the third objective which was to determine the effect of vertical market linkages on the commercialization of African Leafy vegetables (ALVs) in Bungoma county, the result showed that the highest commercialization is achieved when smallholder ALV producers participate in producer-wholesaler and producer-final consumer linkages. However, smallholders' participation in producer-processor and producer-final consumer linkages increases commercialization among smallholder ALV producers. This is because processors and final consumers typically require a steady supply of products, which can provide smallholder farmers with a more predictable source of income. When selling to final consumers, smallholder farmers reduce the cost and time associated with other market linkages, resulting in cost savings and more efficient use of their time and making farmers better-informed about the ALVs market.

5.3 Recommendations

i. Both Smallholder ALV farmers, market actors and processors need to put much efforts in increasing their linkages by considering payment methods that favour farmers to formalize their relationships so that smallholder ALV farmers will have a steady supply as well as processors and other market actors to maintain a steady demand and ensure the realization of better prices for the ALVs produced. This will improve the strength of ALVs value chain and improving the livelihoods of the chain actors.

ii. There is need for Local government to develop awareness programs to promote the utilization of a combination of vertical market linkages while giving priority to combinations that largely increases commercialization among smallholder ALV producers. This should equally be augmented by building the capacity of smallholder farmers in understanding the business-related benefits associated with the different combinations of vertical market linkages.

iii. The policymakers should focus on significant factors of the study when developing policies related to the commercialization of ALVs. Since most smallholder farmers have a combination of cross-cutting socioeconomic and institutional characteristics,

any policy targeting their commercialization should emphasize factors that can propel a larger section of smallholder farmers.

5.4 Further Research

The study only focused on five types of ALVs, that were grown in the study area, this could have been influenced the cultural setting of the study area. Thus, a similar study conducted in a community that have a combination of different ALVs as compared to those in Bungoma County would yield interesting results. Since this study focused more on the social-economic factors that influence the commercialization of ALVs among smallholder ALVs farmers in Bungoma County, further research can focus on the contribution of ALVs commercialization on the development vegetable value chain.

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APPENDICES

Appendix A: Survey Questionnaire

EFFECTS OF VERTICAL LINKAGES ON THE COMMERCIALIZATION OF AFRICAN LEAFY VEGETABLES (ALVs) IN BUNGOMA COUNTY

Dear respondent.

You are one among several smallholder farmers in this area who have been selected for this study. The study aims to evaluate the effects of vertical market linkages on the commercialization of African Leafy Vegetables (ALVs). The study seeks to find information that may be used to promote ALV production and commercialization among smallholder ALVs, resulting in improved food security and livelihoods. The information you give will be very useful towards this end. Your identity however will be strictly confidential.

Questionnaire number……..…… Date……. Starting Time…….

Enumerators Name……Tel. contact……

Sub County……. Ward …… Village……..

FARMER PROFILING

Respondent	Gender (HH	Age (Years) (HH)	Marital Status (HH)	Educ. Level (HH)	Farming experience(years)

SECTION A: PRODUCTION CHARACTERISTICS

A1. What is the size of your Agricultura land……(acres)?

A2. How do you access land for Agriculture (tick where appropriate)?

a. You own b. Rented c. Both owned and rented

A3. What is the percentage of land that is allocated to ALVs…….?

A4. Why is that percentage allocated……?

A5. When do you plant ALVs…….?

A6. When do you harvest ALVs……?

A7. What is the system for producing ALVs?

a. Mixed with other crops b. Mono cropped c. Or both

A8. Why do you use the system above…….?

A9. What are the main ALVs grown (Mention them in their order of priority)?

i …… ii ……..……

iii…… iv …….

v …… vi ……..……..

A10. What is the purpose of growing the ALVs mentioned above?

a. Making profit b. Household consumption c. Reduce risks of hunger

d. Both for marketing and household consumption. d. Others (specify)

Fill in the table below

ALVs Name	Area Cultivated in Acres	Quantity Produced	Cost of Producing (Ksh). per acre	Quantity Consumed	Quantity sold	Average Price/Kg

SECTION B: AFRICAN LEAFY MARKETING BY SMALLHOLDERS

B1. Where do you sell your ALVs?

a. Farm gate b. Open- air market c. Cooperatives d. Wholesalers

e. Brokers f. Distributors g. Retailers h. contractors i. Customers picking on their own j. Roadside stands k. Final consumers

B2. Which markets do you usually use for selling your ALVs?

i. Formal……. ii. Informal……. iii. Both……

B3. Which one is preferred and why……?

B4. Do you have a contractual form of payment with your buyer? Yes [ ] No [ ]

B5. If yes what is the mode of payment?

a. Daily [ ] b. Weekly [ ] c. Monthly [ ] Yearly [ ]

B6. Who sets the price of ALVs?

B7. How far is the nearest market from your house/village?

1. Less than 1 km 2. More than 1 km but less than 5 km 3. More than 5 but less than 15 km 4. More than 15 km

B8. What is the type of road from the village to the nearest local market?

1. Earth Road 2. Laterite/murram 3. Tarmac road 4. Other (specify)

B9. Which means of transport do you usually use in ALVs delivery?

a. Head carrying b. Bicycles/Motorcycles c. Wheelbarrow

d. Hired vehicles

B10. What is the time taken to get to the market…… (Mins)?

B12. What has been the trend of ALV yield in the last years?

1=Decreasing 2=Increasing 3=Stagnated

B14. If decreasing, what are the reasons?

a. …….....

b. …….

c. …….

B15. When do you prefer to sell harvest?

a. Immediately after harvest b. Prefer to wait longer

B16.What is the yields (kg) of ALVs produced per season……(kgs)?

B17. What percentage of the produce do you sell.....%?

B18. Why do you sell that percentage?

……
……
……
……

B19. In what form did you mostly sell the product?

a. Fresh b. Dry c. Processed, specify _____ d. Other, specify

B20. What value addition activities did you undertake before selling? Indicate all that apply.

1. Sorting 2. Grading 3. Packaging 4. Processing 5. None 6. Other, specify

B21. Which was the most important source of market information for you in the last 12 months?

a. Newspaper b. Farmer cooperatives c. Radio d. TV
e. Mobile phone f. Community meetings g. From the marketplace (traders, market

authorities) h. Other specify from a list or other (neighbors, friends, family members, church, government extension agents, NGO workers)

B22. Were you satisfied with this source of market information?

1. Very much satisfied 2. Moderately satisfied 3. Indifferent, neither 4. Not satisfied at all

B23. What is the source of your funding for ALV production?

.....

.....

B24. Do you use yield-enhancing input?

a. Yes b. No

B25. If yes, name the input……

SECTION C: VERTICAL LINKAGES

C1. Tick from the following list of the category of market actors you collaborate with

i.	Retailers	()
ii.	Wholesalers	()
iii.	Processors (hotels/restaurants/companies)	()
iv.	Final consumer (Neighbors and friends)	()
v.	Others (specify)	()

C2. The linkages with other market actors positively affect the commercialization of ALVs

Actors collaborated with	1-Strongly agree, 2-Agree, 3-Disagree, 4-Strongly disagree	Formal	Informal	Both
Retailers				
Wholesalers				
Processors				
Final consumers (friends/neighbours)				

Others (specify)				

C3. What factors do you consider when choosing a collaborating partner?

a. Price offered b. Experience c. Volume ordered d. Low cost of supply

e. Credit f. Stable demand g. Distance h. Others (specify)

TRANSACTION COST, TRANSACTION UNCERTAINTY AND INFORMATION SHARING

Please tick the number for each Transaction costs statement that applies to your enterprise using a 5-point scale.

TRANSACTION COST					
Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
It is very difficult find proper business partner					
It is very difficult to know the information about a cooperative partner					
It is very difficult to get on an agreement with a cooperative partner					
It is very difficult to agree on the conditions of the agreement with the collaborating partner					
It is very difficult to decide to sign an agreement with the collaborating partner					
It takes a lot effort (time, fund, Labor) to ensure compliance to an agreement					
It is very difficult for you to monitor your partner					

Please tick the number for each Transaction uncertainty statement that applies to your enterprise using a 5-point scale.

TRANSACTION UNCERTAINTY					
Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
The volume of customer demand is difficult to predict					
ALV delivery time is not certain					
It is difficult to meet the quantity demands of the customer					
It is difficult to meet the quality demands of the customer					

Please tick the number for each information-sharing statement that applies to your enterprise using a 5-point scale.

TRANSACTION UNCERTAINTY					
Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
Information to your partners is timely					
Information from your partners is timely					
Feedback from customers is frequent					
All partners trust each other with information					
There are special meetings with different partners to share information					

VERTICAL MARKET LINKAGES AND THE COMMERCIALIZATION

Volumes (Kg) sold through different vertical linkages per season

Vertical linkage	Volume sold (Kg)/season	Percentage of total harvest
Formal Vertical Market Linkage		
Producer-retailer		
Producer-wholesaler		
Producer-processor		
Producer final consumer (friends/neighbours)		
Producer-others		
Informal Vertical Market Linkage		
Producer-retailer		
Producer-wholesaler		
Producer-processor		
Producer final consumer (friends/neighbours)		
Producer-others		

Collaboration between you and other actors has led to increased /decreased/constant volumes of ALVs sold (indicate the rate in the spaces provided)

Vertical linkage	Rate of ALV sales (1-Increased, 2 – decreased, 3 – constant)
Producer-retailer	
Producer-wholesaler	
Producer-processor	
Producer-final consumer (friends/neighbours)	
Producer-others	

Reasons for the rate of ALV sales provided above

Increased

……

……

Decreased……

……

Constant……

……

……

Appendix B: Fractional Regression Model Results

Iteration 0: log pseudolikelihood = -196.02987
Iteration 1: log pseudolikelihood = -179.22606
Iteration 2: log pseudolikelihood = -179.1019
Iteration 3: log pseudolikelihood = -179.10172
Iteration 4: log pseudolikelihood = -179.10172

Fractional logistic regression — Number of obs = 384
Wald chi2(17) = 62.0226
Prob > chi2 = 0.0000
Log pseudolikelihood = -179.203 — Pseudo R2 = 0.1951

perc_sold	Coef.	Robust Std.Err.	Z	P>z	[95%Conf.	Interval]
Gender	0.015	0.071	0.210	0.831	-0.124	0.155
Age	-0.007	0.005	-1.310	0.189	-0.017	0.003
Marital	0.087	0.072	1.210	0.227	-0.054	0.227
Educ	0.128	0.068	-1.900	0.058	-0.260	0.004
Expe	0.004	0.008	0.550	0.582	-0.011	0.019
Land	0.033	0.020	1.650	0.099	-0.006	0.073
Finance	-0.229	0.361	-0.630	0.526	-0.936	0.479
Training	0.007	0.112	0.060	0.950	-0.213	0.227
Consumer	0.133	0.082	1.630	0.103	-0.027	0.293
Payment	0.158	0.125	1.260	0.208	-0.088	0.403
Distance	-0.166	0.057	-2.930	0.003	-0.277	-0.055
Duration	0.003	0.002	1.560	0.118	-0.001	0.007
Valadd	0.048	0.025	1.910	0.056	-0.001	0.097
Info	0.029	0.026	1.110	0.265	-0.022	0.080
ALV_yield	0.001	0.000	2.930	0.003	0.000	0.001
ALV_cost	-0.000	0.000	-2.540	0.011	-0.000	-0.000
ALV_price	0.004	0.002	-1.770	0.077	-0.007	0.000
_cons	1.766	0.513	3.450	0.001	0.762	2.771

Appendix C: Multinomial Logit Regression Results

	comb_vertl	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]
$R_0W_1P_0F_1$	Gender	-5.379	3.428	-1.57	.117	-12.099	1.34
	Age	-.116	.184	-0.63	.527	-.476	.244
	Marital	5.424	6517.474	0.00	.999	-12768.591	12779.438

	Educ	-1.737	2.351	-0.74	.46	-6.345	2.87
	Expe	.079	.218	0.36	.716	-.348	.507
	Land	-.243	.378	-0.64	.519	-.984	.497
	Access	-14.259	1633.162	-0.01	.993	-3215.197	3186.68
	Training	1.145	2.73	0.42	.675	-4.206	6.497
	Irrigation	-18.254	1453.703	-0.01	.99	-2867.46	2830.952
	Consumer	19.359	1272.489	0.02	.988	-2474.674	2513.392
	Payment	12.895	819.956	0.02	.987	-1594.19	1619.98
	Distance	-.437	1.64	-0.27	.79	-3.651	2.777
	Tranmean	-1.202	2.312	-0.52	.603	-5.733	3.328
	Duration	.161	.111	1.46	.145	-.056	.378
	ALV_cost	0	0	-0.15	.879	-.001	.001
	Constant	-16.185	7775.147	-0.00	.998	-15255.192	15222.822
$R_1W_1P_0F_1$	Gender	-2.132	2.171	-0.98	.326	-6.388	2.123
	Age	-.134	.104	-1.28	.199	-.338	.07
	Marital	16.974	6351.656	0.00	.998	-12432.043	12465.99
	Educ	.89	1.099	0.81	.418	-1.264	3.044
	Expe	.153	.108	1.42	.156	-.058	.364
	Land	-.159	.354	-0.45	.654	-.853	.536
	Access	-1.949	1.132	-1.72	.085	-4.167	.269
	Training	-.243	1.908	-0.13	.898	-3.983	3.496
	Irrigation	-.603	2.052	-0.29	.769	-4.625	3.418
	Consumer	.907	2.37	0.38	.702	-3.738	5.551
	Payment	1.484	2.221	0.67	.504	-2.868	5.837
	Distance	-2.376	1.202	-1.98	.048	-4.732	-.02
	Tranmean	-.327	.637	-0.51	.607	-1.575	.92
	Duration	.223	.082	2.71	.007	.062	.385
	ALV_cost	0	0	-1.42	.154	0	0
	Constant	-9.08	6351.664	-0.00	.999	-12458.113	12439.953
$R_0W_0P_1F_1$	Gender	-4.002	2.222	-1.80	.072	-8.358	.353
	Age	.01	.11	0.09	.931	-.207	.226
	Marital	18.743	6351.656	0.00	.998	-12430.273	12467.76
	Educ	.154	1.136	0.14	.892	-2.073	2.382
	Expe	.052	.116	0.45	.656	-.175	.278
	Land	-1.101	.518	-2.13	.033	-2.116	-.086
	Access	-2.103	1.155	-1.82	.069	-4.368	.161
	Training	.332	2.01	0.17	.869	-3.607	4.272
	Irgation	-2.536	2.169	-1.17	.242	-6.787	1.715
	Consumer	4.868	2.45	1.99	.047	.067	9.669
	Payment	-.433	2.284	-0.19	.85	-4.909	4.043
	Distance	-.954	1.245	-0.77	.443	-3.394	1.485
	Tranmean	-.728	.698	-1.04	.297	-2.095	.639
	Duration	.144	.086	1.69	.091	-.023	.312
	ALV_cost	0	0	-1.18	.236	0	0
	Constant	-8.998	6351.664	-0.00	.999	-12458.032	12440.035
$R_1W_0P_0F_1$	Gender	-3.016	2.126	-1.42	.156	-7.183	1.151
	Age	-.07	.1	-0.70	.483	-.267	.126
	Marital	17.907	6351.656	0.00	.998	-12431.109	12466.924
	Educ	.373	1.057	0.35	.724	-1.699	2.445
	Expe	.063	.105	0.60	.548	-.142	.268
	Land	-.282	.329	-0.86	.392	-.928	.364
	Access	-2.138	1.087	-1.97	.049	-4.268	-.008
	Training	.501	1.826	0.27	.784	-3.078	4.08
	Irgation	-1.584	1.996	-0.79	.427	-5.496	2.327
	Consumer	2.745	2.29	1.20	.231	-1.745	7.234
	Payment	.948	2.081	0.46	.649	-3.131	5.026

	Distance	-2.021	1.162	-1.74	.082	-4.299	.257
	Tranmean	-.617	.625	-0.99	.324	-1.841	.608
	Duration	.198	.081	2.44	.015	.039	.357
	ALV_cost	0	0	-1.66	.097	0	0
	Constant	-5.484	6351.664	-0.00	.999	-12454.516	12443.548
$R_1W_1P_1F_1$	Gender	-3.29	2.152	-1.53	.126	-7.508	.929
	Age	-.241	.107	-2.25	.024	-.45	-.031
	Marital	17.538	6351.656	0.00	.998	-12431.478	12466.555
	Educ	.64	1.092	0.59	.558	-1.5	2.779
	Expe	.213	.111	1.92	.055	-.005	.431
	Land	-.204	.357	-0.57	.568	-.904	.496
	Access	-1.531	1.115	-1.37	.17	-3.716	.655
	Training	.664	1.876	0.35	.724	-3.014	4.341
	Irgation	-2.576	2.029	-1.27	.204	-6.553	1.4
	Consumer	1.135	2.334	0.49	.627	-3.44	5.709
	Payment	.727	2.162	0.34	.737	-3.512	4.965
	Distance	-1.614	1.202	-1.34	.179	-3.969	.742
	Tranmean	-.565	.641	-0.88	.378	-1.82	.691
	Duration	.167	.082	2.04	.041	.007	.328
	ALV_cost	0	0	-0.96	.337	0	0
	Constant	-.071	6351.664	-0.00	1	-12449.104	12448.961
$R_1W_0P_1F_1$	Gender	-3.715	2.141	-1.73	.083	-7.912	.482
	Age	-.119	.102	-1.16	.246	-.319	.082
	Marital	17.742	6351.656	0.00	.998	-12431.274	12466.759
	Educ	.507	1.07	0.47	.636	-1.591	2.604
	Expe	.141	.106	1.32	.186	-.068	.349
	Land	-.321	.337	-0.95	.341	-.983	.34
	Access	-1.955	1.099	-1.78	.075	-4.109	.199
	Training	.117	1.854	0.06	.95	-3.516	3.75
	Irgation	-2.233	2.015	-1.11	.268	-6.183	1.716
	Consumer	2.529	2.304	1.10	.272	-1.988	7.045
	Payment	1.372	2.129	0.64	.519	-2.8	5.544
	Distance	-1.743	1.173	-1.49	.137	-4.043	.557
	Tranmean	-.545	.632	-0.86	.388	-1.784	.693
	Duration	.192	.082	2.36	.018	.032	.352
	ALV_cost	0	0	-1.09	.275	0	0
	Constant	-5.138	6351.664	-0.00	.999	-12454.17	12443.894
	Mean dependent var			4.128	SD dependent var		1.115
	Pseudo r-squared			0.256	Number of obs		383
	Chi-square			239.304	Prob > chi2		0.000
	Akaike crit. (AIC)			888.098	Bayesian crit. (BIC)		1267.110

Appendix D: Marginal effects, Estimates from Multinomial Logit Model (dy/dx)

Variables (Base category - $R_0 W_1 P_1 F_0$)	$R_0 W_1 P_0 F_1$	$R_1 W_1 P_0 F_1$	$R_0 W_0 P_1 F_1$	$R_1 W_0 P_0 F_1$	$R_1 W_1 P_1 F_1$	$R_1 W_0 P_1 F_1$
Sample size (n)	5	32	15	236	38	56
Gender	-0.000	0.040**	-0.005	0.071	-0.009	-0.097**
Age	-0.000	-0.002*	0.001	0.014***	-0.007***	-0.005

Marital	-0.000	-0.035	0.005	0.058	-0.014	-0.014
Education	-0.000	0.019	-0.002	-0.040	0.010	0.013
Experience	-0.000	0.003*	-0.000	-0.017***	0.006***	0.009***
Land size	0.000	0.005	-0.005*	0.002	0.004	-0.006
Access	-0.000	0.005	-0.000	-0.050	0.026*	0.019
Training	0.000	-0.027	-0.000	0.063	0.012	-0.048
Irrigation	-0.000	0.045**	-0.005	0.088*	-0.043*	-0.085*
Consumer	0.000	-0.068***	0.013	0.131**	-0.070**	-0.006
Payment	0.000	0.019	-0.008*	-0.053	-0.014	0.057
Distance	0.000	-0.017	0.006	-0.042	0.017	0.036
Transport mean	-0.000	0.011	-0.001	-0.019	0.001	0.007
Duration	-0.000	0.001**	-0.000	0.001	-0.001**	-0.001
Subcounty	0.000	-0.016	-0.007	-.0535	-0.074***	0.151***
ALV_cost	0.000	0.042	-0.067*	-0.066*	0.015**	0.076*
Constant	-0.000	0.040	-0.005	0.071	-0.009	-0.097

Note: Standard deviations are given in parentheses. ***, ** and * means significant at 1%, 5% and 10% level respectively.

Appendix E: Research Permit.

REPUBLIC OF KENYA

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Appendix F: AIVs Pictures

Appendix G: Published paper under objective one.

Discover Agriculture

Research

Determinants of commercialization of African Indigenous Vegetables among smallholder farmers in Bungoma County, Kenya

Scolastica Nanjala Nambafu[1] · Hillary Bett[1] · Kenneth Waluse Sibiko[2]

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Abstract
Rising awareness of various lifestyle diseases and illnesses has led to an increased understanding of healthy eating habits, the increased demand for African Indigenous Vegetables (AIVs), and a strict healthier diet in Kenya. Apart from the awareness about the benefits of consuming the AIVs, their commercialization is still low due to how producers are less informed and not connected to market actors beyond their community. On the other hand, the literature on factors that influence commercialization is still limited. The purpose of this study is to sought to reduce that gap by determining the factors that influenced the commercialization of African Indigenous Vegetables (AIVs) among smallholder farmers in Bungoma County. In order to identify 384 respondents from whom data was collected, multistage sampling was used through personally administered questionnaires. The fractional regression model (FRM) was used to determine factors influencing the commercialization of AIVs in Bungoma County. The FRM results indicate that the eight explanatory variables included in the model significantly influenced the commercialization of AIVs among smallholder farmers. These variables are the gender of the farmer, land size, mode of payment, distance to the markets, AIV yields, AIV cost of production, duration to reach the market, and value addition. The researcher recommended that all gender should be engaged in the commercialization of AIVs and that the government to put in place policies and regulations that support the commercialization of AIVs, as they support other cash crops, which would equally enhance the quality and quantity improvement of AIVs that are distributed to various markets.

Keywords Market outlets · Market actors · Market facilities · Market information · Market channels

1 Introduction

Diseases and ailments related to people's lifestyles have increased the population's understanding of the benefits associated with African Indigenous Vegetables (AIVs) in Kenya. Unlike major vegetables such as cabbages, AIVs are yet to receive

Appendix H: Published paper under objective two

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Journal of Development and Agricultural Economics

Full Length Research Paper

Vertical market linkages between smallholder African indigenous vegetables farmers and other market actors in Bungoma County

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The study aimed at determining the vertical market linkages that exist between smallholder African indigenous vegetable (AIV) farmers and other actors in Bungoma County, Kenya. Multistage sampling was employed to identify a sample of 384 respondents. Primary data collection was accomplished through observations and interviews using a pretested semi-structured questionnaire. Data were analyzed using STATA. The results indicated that African nightshade was the most commonly produced AIV at 73.9%, followed by cowpeas at 68.8%, spider plant at 63.3%, jute mallow at 34.4%, and vegetable amaranth at 21.9%. Smallholder AIV farmers had links to various market actors such as retailers, wholesalers, processors, and final consumers. However, these farmers also faced several challenges including transaction uncertainties, limited access to market information, and high