CHARACTERIZATION, DETERMINANTS OF MARKETING CHANNELS AND COLLECTIVE ACTION AMONG PIGEON PEA FARMERS IN MACHAKOS COUNTY, KENYA

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Characterization, Determinants of Marketing Channels and Collective Action among Pigeon Pea Farmers in Machakos County, Kenya

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other University

Signature……..Date……

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This thesis has been submitted for examination with our approval as the University Supervisors

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DEDICATION

I dedicate this study to my parents for teaching me life prospects and hard work, my husband, siblings, supervisors, and sponsors for their unending support during my studies.

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ACRONYMS AND ABBREVIATIONS

CA	Cluster Analysis
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
HDI	Household Diversity Index
HHH	Household Head
KCSAP	Kenya Climate Smart Agriculture Project
FBO	Farmer- Based Organization
MLR	Multinomial Regression Model
MoALFC	Ministry of Agriculture, Livestock, Fisheries and Cooperatives
NIE	New Institutional Economics
PCA	Principal Component Analysis
PCR	Principal Component Regression
CA	Cluster Analysis
MNL	Multinomial Logit
PM	Probit Model
SPSS	Social Package for Social Sciences

ABSTRACT

Smallholder farmers are among the key players in pulse production in Kenya and require consideration when developing policies for improving the sector. Pigeon peas is a traditional crop that has a potential to increase food security and generate income through commercialization. It grows in arid and semi-arid climatic conditions. Pigeon pea farmers have been focusing on subsistence farming without the transition towards commercialization. This can be explained by farmer characteristics, choice of marketing channels, and the collective action among pigeon pea farmers. The objectives of the study were to analyze farmer characterization, determine the choice of marketing channels, and examine the determinants of collective action among pigeon pea farmers. The study was conducted in Machakos County, in Mwala, Yatta, and Masinga sub-counties. A sample of 310 pigeon pea farmers was selected using a purposive sampling technique. A structured questionnaire was administered to individual farmers to collect data. The Principal Component Analysis (PCA), Cluster Analysis (CA), multinomial logit (MNL), and Probit Models were used to analyze the data. The PCA results indicated a KMO of 0.557, a BTS of 437.278 and a p value of 0.000 to show the sampling and suitability of the model. There were three distinct clusters and were named as low production, average production, and high production. The distinguishing factors of these clusters were age, access to credit, distance to the market, land size, amount of pigeon peas sold, and group membership. The results from MNL showed revealed that majority of the farmers chose rural retailers as their main marketing channel (53.9%), followed by brokers (17.7%), rural and urban wholesalers (11.6%), and those who sold directly to consumers (9.4%). There was no export market available for farmers. However, there were a number of farmers who did not sell pigeon peas but produced for home consumption only. The choice of a marketing channel was significantly ($P< 0.0005$) determined by socioeconomic factors such as gender, age, monthly income, access to information, distance to the market, land size, the quantity produced in the previous season, dry pigeon peas sold, and group membership. The results further showed that 39.3% of the farmers were in producer groups. The decision to join producer groups was determined by age, source of income, access to credit, land size, and access to market information. The study thus, concluded that Pigeon pea farmers were not homogenous. Farmers sold majorly using rural retailers' marketing channel, export channel was missing and that farmers were only in producer groups. There were no marketing groups for pigeon peas. Therefore, the study recommended that interventions and policies be tailored to specific clusters since pigeon pea farmers are not homogenous. It was further recommended that the National and County Governments need to establish export markets for pigeon peas. The need for export channels is to encourage farmers to sell their crop at better prices and encourage them to produce commercially. There is also need to strengthen the local markets. There were no market groups for pigeon peas, and therefore, the study recommends the need to persuade farmers to join more producer groups and establish marketing groups and link them to markets.

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Agricultural development is key to ending extreme poverty and boosting prosperity towards a food secure world. Growth in agriculture is more effective in raising income compared to other sectors, especially in regions with high poverty levels (Abraham, 2015). Many smallholder farmers may struggle to provide a meal a day for their families. However, agriculture driven-growth, reduction of poverty, and food insecurity remain at risk because of challenges facing the agricultural sector, such as climate change and weather patterns (FAO, IFAD, UNICEF, WFP, & WHO, 2020). Agriculture significantly contributes to the economy of Kenya, accounts for about 25% of the total GDP, and employs over 70% of people in the rural areas (KNBS, 2020).

Population in Kenya has kept rising in recent decades and is stretching the food and agricultural systems, causing climate change and urbanization challenges. Arid and semi-arid areas in Kenya include the Lower Eastern region, South coast (Kilifi County), and Northeastern region of Kenya and receive little rainfall that result in low agricultural production. Thus, these areas are vulnerable to food insecurity, which is exacerbated by climate change, erratic weather patterns, poor inputs, decreased production, and imperfect markets (Kogo *et al*., 2021). Marketing remains a challenge as farmers do not have organized markets for most commodities and thus have little earnings for those practicing commercial production (Pambo, 2014). Agriculture in sub-Saharan Africa is characterized by production of crops mostly for subsistence and a little surplus left for sale. African agriculture requires transforming semi-subsistence farming to high-level commercialization to reduce poverty and hunger in an effort to become food secure *(*Karanja *et al.*, 2019).

Development strategies in Kenya such as Agricultural Sector Transformation and Growth Strategy (2019-2019) recognize the contribution of smallholder agriculture to food security, nutrition, national income, and employment (Kenya M., 2024). This can

possibly be achieved by enhancing the potential of neglected crops such as pulses, e.g. cowpeas, pigeon peas, green grams etc.

Pulses are among the crops grown for consumption and for commercialization. They are among the crucial crops that grow in harsh climatic conditions and are produced at minimal rainfall of about 500mm to 1000mm (Bellin, 2016). Asian and African countries produce high quantities of pulses for consumption and income generation. Pigeon peas are ranked sixth globally in terms of acreage and production. It is tolerant, growing in hot and semi-arid conditions. According to FAOSTATS (2021), the annual production of pigeon peas annually is 0.501 million tons with India as the leading country producing 0.389M tones. Other countries include Myanmar, Malawi, Kenya and Tanzania.

Pigeon peas rank as the third important legume in Kenya after cowpea and common beans (Pal *et al.,* 2016). However, production of pigeon peas is uncertain and fluctuates seasonally. For instance, when seasons have favorable and adequate rains, the production is usually high while seasons with poor and low rains, the production faces risks and uncertainties. Most farmers intercrop pigeon peas with other food crops since it is a perennial crop (Matere *et al*., 2016). Moreover, farmers are primarily engaged in other income generating activities, which enable them to access inputs for their production.

In 2019, Kenya had a total output of 87,912 metric tons of pigeon peas. A total number of 87,380 metric tons were consumed at home while 532 metric tons were sold in export markets (FAOSTAT Report, 2019). The rest, (87,380 tons of pigeon peas) were consumed at home and the surplus sold locally. In 2022, the production was 96,145 tons and in 2023, the production was 92,061 (FAOSTATS, 2023). This implies that there is a need to explore better-paying marketing channels for pigeon peas in Kenya. In 2016, Machakos County, produced an average of 751kg/ha, which is approximately 90% of 148,400 tons produced in Kenya during the same period (Pal *et al.,* 2016). Out of the total grains produced in Machakos, 70% of the produce were sold after it was dried and graded (Pal *et al.,* 2016).

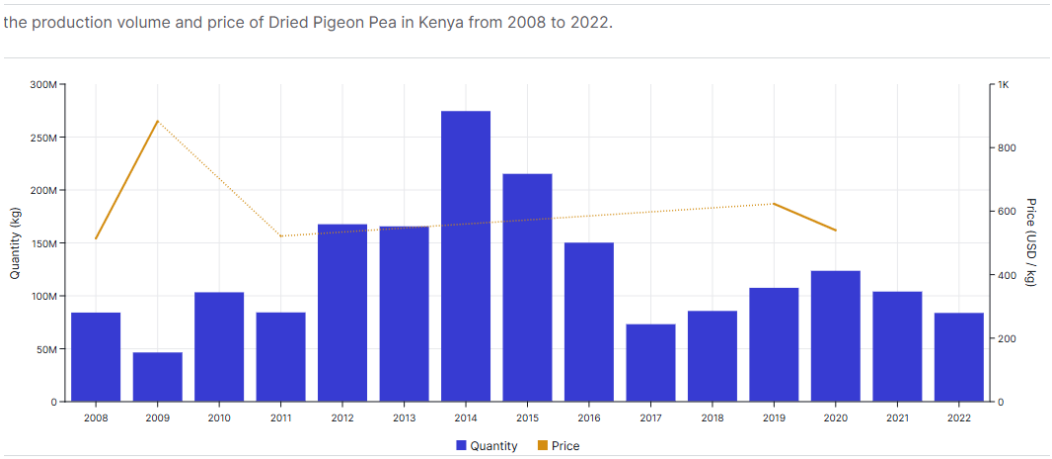

Figure 1.1: Pigeon Pea Production and Price Trends from 2008-2022

Pigeon pea is a drought-tolerant crop. It has a potential of improving food security and also be commercialized to generate income. However, farmers face various challenges as they sell the surplus produce such as unestablished markets, poor prices, lack of established marketing channels and few or no collective actions that are useful in bargaining of better prices (Pambo, 2014). Additionally, there is insufficient information regarding pigeon pea farmer typologies, the availability of reliable marketing channels, and collective action in pigeon pea production in Kenya (Lu, 2017). With poor and unestablished markets, media and groups, farmers lack the bargaining power for better prices and thus, low profits are realized (Pal *et al.*, 2016).

Smallholder pigeon pea farmers can be characterized by using different aspects such as demographics, personal attributes, production trends, and the marketing systems. Characterization helps to determine the typologies or the classes of farmers exhibiting different attributes. This is important because it helps to depict trends that exist between farmers in the same environment to enhance targeted decision-making processes. It also helps to identify the various clusters to introduce appropriate interventions such as improved technologies and policy support. Therefore, characterizing pigeon pea farmers enabled the study to identify different pigeon pea farmers with relatively similar characteristics, which could be grouped together.

Marketing channels are essential as they enable the movement of goods from the production site to the final consumer (Bellin, 2016). Proper marketing channels bridge

the gap in time, place, and possession between producers and consumers. Just like any other agricultural crop, pigeon peas are traded in both formal and informal markets. Smallholder pigeon pea farmers are able to access local markets such as brokers, rural retailers, direct consumers, rural wholesalers and urban wholesalers. These markets can be accessed easily since they are familiar to the farmers (Munyao & Munyao, 2016).

Marketing channels for pigeon peas are not fully developed. Most farmers sell their produce through market players, such as brokers/middlemen who buy at the farm gate, rural retailers, urban and urban wholesalers, and open-air traders. Most of the produce is traded in small quantities since farmers focus on subsistence production rather than commercialization. Hence, they only sell the surplus (Karanja *et al.*, 2016). Despite pigeon peas being a traditional crop with a potential for trading locally and internationally, the marketing channels for pigeon peas remain underdeveloped. There is limited knowledge on pigeon pea marketing and its potential for commercialization. Thus, the study helps to provide the information on the factors influencing the choice of marketing channels among pigeon pea farmers in Machakos County.

Evidence from research shows that smallholder farmers face market challenges and can possibly overcome them if they organize themselves into farmer groups, cooperatives, and other forms of organizations (Gyau *et al.*, 2016). When farmers decide to form groups and act collectively, they are in a good position to lower the transaction cost, access the right market information, secure new technology, and tap high-end markets with better profits (Mutura *et al.*, 2016). This gives smallholder pigeon pea farmers and advantage since they are able to compete with established and large-scale farmers (Gyau *et al.*, 2014). Furthermore, farmer-based organizations support capacity building, innovation setting, access to information, and training on good farming practices. Research also indicates that collective action helps farmers to reduce the entry barriers to the markets by improving the bargaining power (Mutura *et al.*, 2016). Regardless of the importance and benefits from collective action, few farmers join such groups. Even for the participants, the commitment and participation ingroup activities vary based on the perceived benefits and motivations.

Farmer groups are critical because they enable producers to sell their produce in an easier way, especially in rural areas where infrastructure is a major challenge (Lu, 2017). According to Fischer & Qaim (2014), promoting collective action for farmers through groups enables them to increase the range of gains through proper utilization of resources and earn benefits of economies of scale. With high expectations of the returns realized, farmers are motivated to join the groups. Thus, this study identified the factors that motivate farmers to make a decision for joining farmer groups. The study also provides information and strategies that can be used to improve performance and sustainability of pigeon pea production in Kenya. Therefore, improving the marketing channels and collective action for pigeon pea farmers will enhance production and help farmers to realize improved returns from their enterprise. Many farmers grow pigeon peas for subsistence purposes. However, improving the market operations will enable them to increase surplus production for sale, and ultimately enhance commercialization. Therefore, this study sought to examine the typologies of the pigeon pea farmers, the choice of marketing channels and the determinants of collective action.

1.2 Statement of the Problem

Smallholder farmers forms part of the larger population in Kenya. According to Kihoro *et al*. (2016), success in agricultural growth is partially achieved by expanding market opportunities. In Kenya, farmers producing pigeon peas practice subsistence farming and only sale the surplus when it is realized. The production is in small-scale, with poor quality seeds and lack of access to market information and this has contributed to the increased poverty levels (FAO, IFAD, UNICEF, WFP, & WHO, 2020). Pigeon pea farmers face various challenges such as inadequate inputs, poor credit access, high transaction costs, imperfect competition, inaccessible marketing channels, undeveloped farmer groups, and low prices of their produce (Pambo, 2014). Overcoming these market barriers calls for farmers to consider marketing channels that can maximize margins at low cost and collective action by joining farmer groups to enable them bargain for better prices (Pambo, 2014). Marketing channels vary in incentives offered by prices, quantity requirements, and mode of payments, marketing,

and transport costs. Hence, farmers are possibly influenced by various factors in selecting the preferred marketing channel.

Existing literature has majorly focused on pigeon pea productivity (Kwena *et al.*, 2021, Samba *et al.*, 2021, and Wambua *et al*., 2021), but less has been done regarding characterization of pigeon pea farmers, their choice of marketing channels, and collective action. In addition, there exists a knowledge gap regarding the marketing channels and the factors influencing the choice of the channels. Furthermore, there is scarce information on collective action among pigeon pea farmers in Machakos County. There is need, therefore, for farmers to operate in groups in an effort to increase their bargaining power and enjoy other benefits of collective action.

Characterizing farmers, knowledge of the proper marketing channels and practicing collective action is vital for the farmers, traders, government, and development agents that advocate for competitive and profitable channels. Therefore, this study addresses these knowledge gaps by characterizing pigeon pea farmers, assessing the factors influencing the choice of marketing channels, and the determinants of collective action in Machakos County, Kenya.

1.3 Objectives

1.3.1 General Objective

The overall objective of this study was to characterize smallholder pigeon pea farmers, assess factors influencing the pigeon pea farmers' choice of marketing channels and to examine the determinants of collective action among pigeon pea farmers in Machakos County, Kenya.

1.3.2 Specific Objectives

The specific objectives of the study were:

1. To characterize smallholder pigeon pea farmers in Machakos County.
2. To examine the socioeconomic factors affecting the choice of marketing channels by pigeon pea farmers for pigeon peas in Machakos County.

3. To examine the socioeconomic determinants of collective action among pigeon pea farmers in Machakos County.

1.4 Hypotheses Tested

The following hypotheses were tested in this study:

1. There are no variations among pigeon pea farmers in Machakos County.
2. Socioeconomic factors have no significant effect on the choice of smallholder pigeon pea marketing channels in Machakos County.
3. Socioeconomic factors have no significant effect on the decision to join farmer groups in Machakos County.

1.5 Justification of the Study

A study on pigeon pea farming is important, given its role in improving farmers' livelihoods food production and income generation. Pigeon peas grow in arid and semi-arid areas where production of other crops might be difficult since it is rain-fed. As such, farmers with few resources and poor infrastructure tend to suffer more compared to farmers located in areas with good infrastructure and better rains. Characterization of farmers enables policy makers and relevant stakeholders to understand what type of support farmers require. An analysis of the factors influencing the choice of various marketing channels helps the decision makers to devise the right innovations that link farmers with low or without resources to the markets. Furthermore, the results from the study will provide insights on the appropriate interventions that can be employed to encourage farmers to form or join the existing farmer groups or cooperative organizations to enable them bargain better prices for their produce. Additionally, this study contributes in improving the value chain of pigeon peas in Machakos county to provide support to the farmers to transit from subsistence farming towards commercialization. This would contribute to Bottom-Up Economic Transformation Agenda (BETA) and the SDGs. If pigeon peas production increases, there is more food and thus contributing to the achievement of the SDGs of eradicating no poverty and zero hunger. It also contributes to the agricultural sector

and the KCSAP stakeholders in the implementation of their project in improving the pigeon pea value chain in Machakos County, Kenya.

1.6 Organization of the Thesis

Chapter 1 provides a general overview of the role of agriculture in Kenya's economy, particularly pigeon peas, and its importance to smallholder farmers in Kenya. It also has a statement of the problem, objectives, hypothesis tested, and justification of the study. Chapter 2 reviews the literature of previous studies related to characterization, marketing channels, and collective action. Chapter 3 explains the methodology of the study, sampling procedure, study area, data collection, and analysis. Chapter 4 provides the results and discussion of the study, while chapter 5 presents the summary, conclusions, and recommendations for further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter covers the overview and conceptual framework that forms the basis for analyzing pigeon pea farmers' characterization, choice of marketing channels, and the collective action. It begins by discussing farmer characterization, choice of marketing channels and collective action.

2.2 Characterization

2.2.1 Overview of Farmer Characterization

Characterizing smallholder farmers is done to find out farm typologies for informed decision-making. Farmers can be characterized based on their demographic information, labor availability, facilities, machinery, work distribution, supply, and usage of farm inputs (Nyambo *et al.*, 2019). Organizing farmers is essential as it helps to decide and implement the appropriate policy options available to make production more efficient. The uniqueness of every farmer is important as typology appreciates variability between the farmers. Farmers have different approaches to farming, and their experiences vary during operations. Farmers are distinctive, but they can be grouped to fit various categories.

Grouping farmers makes it possible to design the appropriate technical solutions and provide the relevant policy interventions (Nyambo *et al.*, 2019). It also enables classifying those adopting technology and those who may not have adopted the new technologies (Kuivanen *et al*., 2016). Market, institutions, labor, technological level, credit size, education, and organizational practices are among factors that may help to categorize farmers. Most farmers use almost similar practices to grow pigeon peas. The assumption made in this study is that pigeon pea farmers are homogenous in socio-economic and institutional factors.

2.2.2 Conceptual Framework of Farmer Characterization

Smallholder farmers can be classified using various factors. Farmers adopt different strategies based on biophysical, socioeconomic factors, technology, and extension services at the micro-level. According to Nyambo *et al*. (2019), most farmers operating in almost similar conditions at their farms need relatively common recommendations. Understanding the behavior of farmers makes it easy to create informed decisions and incorporate appropriate technology. Extension services and policy developed are implemented for farmers based on their requirements and diversity. Pigeon pea farmers can be grouped based on their social, economic, and institutional characteristics. Farmers with relatively similar traits are grouped in the same clusters. In Kenya, smallholder farmers are majorly affected by socioeconomic factors such as age, credit size, level of input use, technology, and access to markets (Iragaba *et al.*, 2020).

2.2.3 Prior Studies on Farmer Characterization

Goswami *et al*. (2014) investigated farm types and their economic characterization in complex agroecosystems for informed extension interventions in West Bengal, India. The study used a questionnaire to collect data from 144 households to determine the dominant types of farms based on their sources of income. The study used multivariate statistical technique of Principal Component Analysis (PCA) and Cluster Analysis (CA) to characterize the agroecosystems. The results showed that some farmer clusters with high system gross return, higher cost of cultivation, and higher cost-benefit ratio. Other clusters were characterized by low gross return and average system net return but better cost-benefit ratio. The study recommended that the stakeholders and policy makers should ensure precise advisory services, agricultural inputs, credit access, and information for informed decision-making for farmers.

Kuivanen *et al.* (2016) conducted a study on the characterization of the diversity of smallholder farming systems, their constraints, and opportunities for innovation in Northern Ghana. The study classified 70 smallholder farms in two districts of Ghana. The study used multivariate statistical techniques of PCA and CA to identify different typologies of smallholder farming systems. The results showed farm types can be

classified in terms of land use, labor, income, and livestock ownership. Some households had more resources for farming activities, while others relied on minimal resources for production. The study showed that analyzing farmer typologies helps to create a practical framework to ensure the identification of the types of households for the prospects and restrictions towards the target agricultural interventions and innovations.

Woomer *et al.* (2016) studied small-scale farming systems and its characterization in West Kenya (the former western province). The study aimed to characterize farming operations and conditions among household farmers. The study interviewed 291 respondents using a questionnaire. The overall summary statistics were calculated, and then stratified by three criteria; household resource endowment, agro-ecological zone and sex of household head. The results showed significant contrasts between women and men-led households. Families where men were the head had 0.4ha of land smaller and earned $168 less compared to the households led by women. The manure applied was obtained from livestock, and women used it more on legumes. The study concluded that agro-ecological zones in western Kenya are heavily dependent upon maize-based agriculture but differ in farm commodities, operations management, and opportunities for effective intervention. The study recommended the stated farming systems: legume integration, crop diversity, and animal enterprise, and promises to compare it with expected future research on farming systems.

Nantima *et al.* (2016) conducted a study to characterize pig production systems along the Kenya-Uganda border covering four districts. A spatial random sampling was employed to collect data from 645 households using a structured questionnaire. Descriptive statistics were used to analyze data using SPSS and Microsoft Excel. Results showed that most farmers owned small pig herds that were tethered. The results also showed women were the ones taking care of the animals while either women were the main decision makers or both men and women collaborated to make the decisions. The study concluded that characterizing the pig farmers was necessary to understand the constraints faced by pigs. Solutions such as adopting biosecurity measures to reduce disease risks especially the ASF risk were recommended.

Musafiri *et al*. (2020) studied an analysis of farming system typologies in Tharaka Nithi County to establish agricultural greenhouse gas emissions potential from rain-fed farms. A sample of 300 farmers was selected for the study using a multistage sampling procedure. The data collected was analyzed using PCA and CA. Results showed that six farm types existed, whereby the level of household education, hired labor, income from farming activities, access to extension services, and group membership were the main factors influencing the farm typologies in the area. The research concluded that interventions and policies focused on climate smart agriculture should target not only the soil-fertility management technologies but also the socio-economic attributes.

From the reviewed literature, most studies have focused on the farmers and the farming systems of other crops. Hence, there exits scarce information regarding typologies of pigeon pea farmers. Therefore, this study sought to fill in this knowledge gap by characterizing pigeon pea farmers.

2.3 Choice of Marketing Channels

2.3.1 An Overview of the Choice of Marketing Channels

Just as smallholder farmers are heterogeneous, markets in which these farmers participate are diverse. Farmers are characterized by their size, geographic location, size, connection to the markets, power relations, and the institutional factors (Kihoro *et al.,* 2016). Most farmers in the sub-Saharan Africa have constraints of choices of marketing channels as it depends on their functionality and, the ability and willingness to participate in input and output markets. Thus, when markets offer the right incentives, farmers are likely to increase their engagement with them by using their assets effectively. Moreover, when the infrastructure is efficient, farmers are able to transport their products to the market at a reasonable cost. However, when one component of the market is missing, farmers may not be willing to participate in the market (Pambo *et al.,* 2014). This suggests that markets should remain accessible to the farmers and be profitable to enhance their inclusion in the long term. Despite the challenges farmers face in the markets, they have to survive even under unfavorable conditions because of their contribution towards food security.

Marketing channels are essential in determining how a product moves along the value chain. Pigeon pea farmers would choose the most convenient channel, which incurs low transaction costs and profits. The channel might be long if a dealer buys the crop in large amounts and sells them to a distributor or a wholesaler who in turn sells it to a retail trader and ultimately sells it to the final consumer (Kihoro *et al.*, 2016). As a result, the profits realized are low because the longer the chain, the lower the profits. However, the channel might have shortcuts where the retailer buys directly from the wholesaler and sell it to the final consumer. High-value markets offer premium prices to the products, especially the processed products that have been added value to the primary product (Liu, 2020). These high-value markets would offer better prices and extend opportunities to smallholder farmers to increase their income from pigeon pea production. Therefore, institutions should support smallholder farmers to utilize such opportunities through proper interventions.

Pigeon pea farmers might hypothetically sell their crop to rural retailers, direct consumers, rural assemblers, urban wholesalers, brokers, and exporters. Assemblers, brokers and wholesalers may act independently or as agents for a large volume collector (Kaimba *et al*., 2020). Wholesalers are located at the rural areas who buy from brokers or rural retailers to build volumes that they can sell in bulk to urban wholesalers or exporters. Retailers might also sell to rural or urban wholesalers in bulk. These marketing channels are available to pigeon pea farmers and thus farmers have to make a choice on which marketing channel they can choose for their produce.

However, marketing channels for pigeon peas are not well-structured and require some logistical improvements such as transport and storage (Segetlija *et al.*, 2011). The available marketing channels for pigeon peas are poorly governed, resulting in a lack of or low commercialization and hence low profits (Segetlija *et al.*, 2011).

2.3.2 Conceptual Framework on Choice of Marketing Channels

Marketing systems perform depending on the organization of marketing channels involved. The number of actors, information sharing, and degree of coordination within the channel determines the marketing costs and margins (Pambo *et al.*, 2014). The choice of a marketing channel is determined by the socio-economic attributes,

farm level factors of the product attributes, and institutional elements (Muthini *et al.*, 2015). Product attributes include the variety used, selling price, quantity produced and quantity sold, all of which influence the enterprise mix. Socio-economic and personal aspects of the farmers affect their attitudes, resource availability, tastes, and preferences (Kihoro *et al.*, 2016). They are essential in making marketing decisions in order to achieve the targeted welfare objectives of their livelihoods. Specific socio-economic attributes of the farmers include age, education, marital status, level of income, source of income, occupation, size of the household, land size etc. Moreover, policies and interventions formulated by the research organizations and Nongovernmental organizations (NGOs) help in moderating the choice of the marketing channel (Liu, 2020). Institutional factors such as access to road, extension services, mode and cost of transport, access to credit, and access to marketing information influences the farmers' ability to participate in the market (Segetlija *et al.*, 2011). Therefore, the marketing channel chosen is determined by various factors such as personal attributes, farm level product attributes, socio-economic, and institutional attributes.

2.3.3 Prior Studies on the Choice of Marketing Channels

Mmbando *et al.* (2016) undertook a study on the choice of marketing channels of maize and pigeon pea smallholder farmers in the Northern and Eastern regions of Tanzania. The study used a sample of 562 farmers. Analysis of data collected was done using Multinomial Logit. Results indicated that the choice of marketing channel is affected by transaction costs, family income, extension services, and social capital. The study concluded that the choice of marketing channel is affected by socioeconomic factors such as demographic information, education, extension services, social capital, and family income. The study therefore, recommended that transaction costs be reduced through policies and focus on improving access to productive assets, credit, appropriate technology, information, and the formation of well-organized farmer groups to enhance better access to markets.

Kihoro *et al.* (2016) studied green gram marketing channels and producers' choice of marketing channels in the Mbeere sub-county, Kenya. Data was collected from a

sample of 266 households. Multinomial Logit Model was used to analyze the data. The results indicated that 70% of the farmers grew green grams, sold their produce to rural retailers and wholesalers, and sold as individuals. It was concluded that the farmers' choice of marketing channel was determined by socioeconomic, institutional, and farm-level factors. The study recommended identification and prioritization of unique farmer-trader relations to enhance adaptive resilience and increase marketing channels for farmers. Promoting market-based signals such as prices was also recommended.

Donkor *et al*. (2018) studied the determinants of participation of farmers in direct marketing channels for cassava in the Oyo state of Nigeria. The study targeted 400 local cassava farmers and collected data through a questionnaire. Results were analyzed using the Bivariate Tobit model in the empirical analysis of the generalized dataset. The results revealed that farmers' choice of marketing channel was affected by human, social, and physical capital to sell their cassava through an intermediary or directly to processors. The study recommended improvement of road networks in rural regions, enhance farmers' participation in direct marketing channels, and encourage farmer associations to promote farmers to participate in indirect channels.

Geoffrey *et al.* (2014) studied the factors influencing marketing outlets for small-scale pineapple farmers in Kericho County. Cross-sectional data was collected through interviews. A sample size of 100 pineapple farmers was used in the study. Descriptive statistics and multinomial logit model were used to analyze the data. The results showed that gender, group marketing, prices, amount of produce, contractual marketing, and vehicle ownership affected the choice of a marketing channel. Thus, the study concluded that there is need for women empowerment so as to engage them in choosing pineapple marketing outlets. The study therefore, recommended affirmative action such as creating gender awareness by empowering women to participate in pineapple marketing. Further, the study recommended that group marketing should be adopted to improve the bargaining position of the pineapple farmers.

The literature review shows that there is a paucity of information regarding the choice of marketing channels among pigeon pea farmers. Therefore, the study attempted to fill in this knowledge gap by examining the factors influencing the choice of marketing channels among pigeon pea farmers.

2.4 Collective Action

2.4.1 An Overview of Collective Action

Farmers need to improve crop production and marketing systems for their own economic development. However, they face various challenges and require intervention to access markets that offer reasonable prices for their products. Value chain for most products face production and market challenges such as low prices, limited market information, technological access, and large production volumes (Series, 2017). According to Barrett *et al.* (2016), challenges faced by smallholder farmers have led to a low-level equilibrium poverty trap. This means that farmers have low per capita because of poverty levels that may not allow them to save and invest, leading to a poor growth rate in the National income (Barrett *et al*., 2016). Markets in underdeveloped regions suffer from institutional flaws that support farmers to connect to better markets. Farmers in most rural areas lack organization of farmer groups, associations, and cooperatives that could support their farming and thus enhance their access to better markets. Available markets experience undeveloped institutions such as poor contract execution, imperfect information, and high transaction costs (Barrett *et al*., 2016).

The new institutional economics (NIE) indicates that market players have the power to lower transaction costs and eventually do away with the low-equilibrium trap. This issue can be achieved by coordinating non-market mechanisms that reduce transaction costs and strengthen the institutional environment (Ombogoh *et al*., 2016). Solving these challenges requires institutional reforms to enhance service provision, market growth, and infrastructure development. This responds to the challenges faced by smallholder farmers such as access to markets with better prices, information, and advanced technology (Liu, 2020).

Collective action inform of farmer groups has been identified as a potential strategy to support farmers to produce and achieve large-scale benefits and markets (Ochieng *et al*., 2018). It enables farmers to obtain a bargaining power for their products and thus get better prices, which result to better returns. When farmers work together for a common goal, they attract support such as training, improved seeds, access to markets, extension services, improved information on quality and quantity, increased social capital, and thus better living standards. Creating such platforms can also help initiate policy changes and influence farmer groups toward achieving a common goal (Vellema *et al.*, 2013). Therefore, collective action achieved through farmer groups can increase income and economic growth by enforcing contracts, lowering transaction costs, and providing sufficient information on markets (Ochieng *et al*., 2018).

2.4.2 Conceptual Framework of Collective Action

Collective action involves a process of moving from multiple cognition to collective cognition. This is whereby individuals move from separate cognitive agents with various views to a collective unit where they share the same attributes, beliefs, and values. The concept of collective action suggests that members of a group can realize insights that are unattainable by one individual (Ombogoh *et al*., 2016). Therefore, a trigger towards a common goal initiates collective action. Farmers can realize this by forming farmer groups objectively. It can be achieved by identifying factors that determine a farmer's decision to join a marketing group. Acting collectively helps farmers to reduce the transaction costs, increase the bargaining power, access credit, and access marketing information (Ochieng *et al*., 2018). The success of the group is determined by every member's effort and their commitment to participate. In regard to this, the study will assess the determinants of collective action among pigeon pea farmers.

2.4.3 Prior Studies on Collective Action

Gyau *et al*. (2016) studied the determinants of participation in collective action for a case study of smallholder avocado farmers in Kandara and Gatanga districts in Muranga County, Kenya. A multistage sampling technique was employed to select

301 avocado farmers who were interviewed using a structured questionnaire. A binary choice decision was used to model the group participation. The data was analyzed by the use of logit models. Results showed that the decision to participate in a group was influenced by age, education, gender, perceptions on knowledge, and improved technology. The study concluded that it was necessary to educate farmers through trainings, seminars, and workshops before forming any farmer group to ensure that they understand the importance and the impact of collective action. The study recommended the need for development practitioners and government organizations to intervene through the farmer groups and understand the perceptions of the farmers and their expectations.

Fischer & Qaim (2014) carried out a study to investigate the determinants of cooperative organizations through a case study of banana farmers in Kenya. Data were collected using a questionnaire and was analyzed using a Tobit model. Results showed that groups played a crucial role in enhancing banana production and commercialization. There were adverse effects of gender on farmer groups, which could be solved if women were to join the groups. Groups with women showed a positive effect on income share controlled by females. The study observed that farmer groups are capable of stimulating smallholder commercialization in a gender-sensitive way. It also recommended for the need to appreciate trends in various situations to assist policy instruments towards mainstreaming gender in collective action.

Kola *et al.* (2014) investigated the determinants of collective action for greenhouse vegetables in Albania. A total of 200 respondents were selected and interviewed using a structured questionnaire. Data was analyzed using a binary logistic model. Results showed that collective action was determined by human and social capital, leadership, and challenges faced by farmers. The study recommended that support should be given to government agencies to ensure better targeting of the potential farmer groups, increase the stock of social capital, and design the capacity-building and leadership experience.

Takayama *et al.* (2018) conducted a study to examine the determinants of collective action in irrigation managements systems in the rural communities of Japan. A dataset

of 104523 rural communities was obtained from Rural Community Card, World Census of Agriculture and

Forestry (2000). The data was analyzed using the random-effects ordered Probit Model. Results showed that collective action in irrigation systems is determined by distance to the market, area of paddy field, share of non-farmers and the elder people, and the social capital.

The study concluded that the determinants of collective action had a significant relationship with the farm households and the diversity in the community. The study recommended that policies aimed at suppressing the deteriorating collective action in irrigation systems were required to enhance social ties and promote their community-level social capital.

The reviewed studies showed that farmers are motivated by various factors to join farmer groups, and the membership decision varies from one person to another. These studies suggest that enforcing contracts, lowering transaction contracts, and providing adequate information would motivate farmers to join groups. Therefore, improving institutions and policies would promote individual farmers and sector growth since collective action would help overcome challenges and connect individual farmers for the common good.

2.5 Conclusion

The reviewed literature has shown an existence of knowledge gap regarding various aspects of smallholder pigeon pea farming. First, characterization of pigeon pea farmers is not well known or documented. Secondly, information regarding the choice of marketing channels among pigeon pea farmers remain scarce. Collective action among pigeon pea farmers is not well developed. The studies show what has been studied and what is missing in the pigeon pea value chain. Pigeon pea farmer characterization is lacking from the studies. Marketing channels for pigeon peas seems inadequate and what prompts farmers to choose a particular channel. Collective action in pigeon pea farming seems inadequate as there lacks developed producer groups and marketing groups.

Thus, the study sought to fill in these gaps by characterizing pigeon pea farmers, establishing the determinants of the choice of marketing channels and assessing the factors determining the decision to participate in collective action among pigeon pea farmers in Machakos County, Kenya.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter discusses the research methodology used in the study. It starts with farmer characterization, choice of marketing channels, and determinants of collective action among pigeon pea farmers in Machakos County. It includes the theoretical framework, description of variables and their measurements, study area, population and sampling techniques, types of data, and analysis.

3.2 Household Pigeon Pea Farming Characterization

3.2.1 Theoretical Framework for Household Characterization

Characterization of farmers forms the basis for analyzing objective one. The household theory is used to describe household characterization. The theory states that farmers primarily focus on household economic activity that maximizes their utility. It also stipulates that farmers have to make decisions based on production, cost, consumption, and marketing (Huffman, 2011). Farmers have different preferences regarding the quantities and qualities of resources they use in production, marketing choice, and the challenges they face. Therefore, it is essential to identify various categories of farmers for appropriate recommendation domains and policy interventions that can lead to achievement of maximum utility. Different farmers undertake farming activities for various reasons such as consumption and commercialization (Mwema & Crewett, 2019). However, commercialization of pigeon peas can be improved and promoted if farmer typologies were to be identified to understand the specific farmer needs in a better way.

3.2.2 Econometric Specification of Farmer Characterization

Principal Component Analysis

Multivariate statistical technique of Principal Component Analysis and Cluster Analysis was used to characterize smallholder pigeon pea farmers. These techniques were used to identify various household typologies that form a comprehensive database (Swathi & Pothuganti, 2020). The components are less than or equal to the number of the original set of data. The correlated data set is transformed into linearly unrelated values known as the principal components (Jolliffe *et al*., 2016). The PCA assumes dependence on the normality of data being used, sampling adequacy, and the overall factorability of the matrix (Jolliffe *et al*., 2016). The function of PCA is to reduce dimensions more accurately to define the difference between correlated parameters and to separate uncorrelated dimensions where each group involves linear variables (Swathi & Pothuganti, 2020). This method was used since it describes the variance in a single data set (Swathi & Pothuganti, 2020).

In this study, the socioeconomic factors of smallholder pigeon pea farmers such as education, age, gender, group membership in farmer groups, household size, land size, off-farm income, production yield, use of inputs, existing markets, distance to the nearest markets, and transport costs were used in the analysis to identify different clusters of smallholder pigeon pea farmers.

The PCA context involves a set of data with observations on the *k* numerical variables for the *m* individuals. These values of data thus defines the *k* *m*-dimensional vectors. Supposing x is a factor of random variable m and the transpose of x^T of X. Therefore,

$$x = \lfloor x_1, x_2, \ldots, x_t \rfloor^T \ldots\ldots\ldots 3.1$$

The first step is to identify the linear function of $a_1^T x$ from x elements that has the highest variance, where, a_1 is a vector of m constants $a_{11}, a_{12}, \ldots, a_{1n}$ such that:

$$a_{1=a_{11}x_1}^T + a_{12}x_2 + \ldots a_{1n}x_n = \sum_{j=1}^{m} a1jxj \ldots\ldots\ldots 3.2$$

The transformation of the above equation forms the new n random variables known as the principal components (PC) (Jolliffe *et al*., 2016). PCs were then identified to put the highly correlated variables into factors that can be easily interpreted. The PCs were arranged from the highest to the lowest variance, where the first PC describes the highest variance proportion of the data. The next highest PC would explain the second PC and so on. The following equations were used to give the values of the PCs:

$$PC1 = a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n = \sum_{j=1}^{n} a1jx_{ji} \quad \text{.....3.3}$$

$$PC2 = a_{21}x_2 + a_{22}x_2 + \cdots + a_{2n}x_n = \sum_{j=1}^{n} a2jx_{ji} \quad \text{.....3.4}$$

Where: X_1, X_2, … x_n are the original variables and a_{jj} are the eigenvectors. The vectors represent the variances of PCs. The covariance or correlation matrix of the data set derives the coefficients $a_{jj,}$ which are the eigenvectors. Thus, the coefficients are calculated by use of the following equation:

$$|C\text{-}\lambda 1| = 0 \quad \text{..... 3.5}$$

Where C is the correlation matrix, λ is the eigenvalue, and I is the identity matrix. The PC coefficients in the PCs are given by equation 3.6.

$$|C - \lambda 1|^{x_{jj}} = 0 \quad \text{..... 3.6}$$

Therefore, in the Principal Component Regression (PCR) analysis, PCs are the predictor variables in a Multiple Linear Regression (MLR). The PCR model is shown in equation 3.8.

$$Y = \alpha + \beta_1 PC_1 + \beta_2 PC_2 + \cdots \beta_n PC_n \quad \text{..... 3.8}$$

Where: Y is the dependent variable, α is the model intercept, and βs' are the regression coefficients.

Cluster Analysis

After establishing the principal components, the study employed cluster analysis (CA) to characterize smallholder pigeon pea farmers. The components from PCA were used as inputs in CA. Cluster Analysis involves using an extensive range of methods to explain the groups represented by the data sets (Thrun, 2018). Hierarchical method was adopted to establish the ability of the model to select the clusters automatically based on the variables. This method was preferred in the study since there was no prior knowledge of the smallholder pigeon pea farmers and their farming systems. The categories of the clusters would be established through data sets of variables that might be unrelated between each other and homogenous (Thrun, 2018). The analysis computed the connection between the pair of observations using a distant coefficient such as an efficient means to test their validity. The function of cluster validity indices organizes the appropriate number of clusters in the data regarding the previously selected conditions (Thrun, 2018).

The cluster analysis used the components from PCA using the K-mean technique because it helps best in getting the most realistic groups (Thrun, 2018). The ward technique was preferred since it partitions the dataset into pre-defined distinct non-overlapping subgroups or clusters (Thrun, 2018). This method is majorly applied by analyzing the variance test (Thrun, 2018). The variance between clusters was identified to check the difference between them using Analysis of Variance (ANOVA) (Thrun, 2018).

3.2.3 Estimation Procedure for Characterization of Smallholder Pigeon Pea Farmers

In the first stage, 18 variables were selected and used to describe the attributes of pigeon pea farmers and were used for PCA as shown in Table 3.1. The interrelated variables were condensed to a set of interdependent factors known as the principal components. The factors were then rotated through a varimax method and the highly correlated variables were placed under the similar factor. The factors with an eigenvalue of more than one were retained and explained. The second step was the cluster analysis. The retained factors in PCA were used as inputs in CA. Farmers with

the same characteristics were grouped together to form a cluster using hierarchical method. A dendrogram was used to show the number of clusters. Furthermore, a one-way Analysis of variance was computed to identify the differences in variance between the clusters. Table 3.1 shows the variables used in the model.

Table 3.1: Variables Used in Characterization of Pigeon Pea Farmers

Variable	Description	Variable Measurements
Gender	Gender of the respondent	1=Male 0=Female
Age	Age of farmers	Number of Years
Marital status	Married or not	Yes = 1, No = 0
Access to credit	Whether farmers access credit or not	Yes = 1, No = 0
Size of household	Members in the household	Number of members
Education level	The level of education	1=Lower education level 2=Higher level
Source of income	The main source of income	1=Farming 2=Non-farming
Type of road	The type of road, tarmac or all	1=Tarmac 2= All weather road
Distance to market	Distance to the nearest market	Number of kilometers
Land size	Farmer's size of land owned	Number of acres
Variety used	The variety of pigeon peas used	1=Local varieties 2=Improved varieties
Access to information	Access to agricultural and marketing information	Yes = 1, No = 0
Quantity from last season	Quantity produced in the last season	Number of 90-kg sacks
Quantity sold	Quantity sold by the farmer in 90-kg sack	Number of 90-kg sacks
Buyer services	Does the buyer offer any service	Yes = 1, No = 0
Group membership	Whether in a group or not	Yes = 1, No = 0

3.3 Choice of Marketing Channels for Pigeon Pea Farmers

3.3.1 Theoretical Framework for Choice of Marketing Channels

The study employed Transaction Cost Economics (TCE) and Random Utility theories. A producer participating in the market incurs costs such as taxes, transport, and other marketing costs (Greve *et al*., 2015). According to TCE theory, lack of institutions to

govern the formal exchange prompts the intermediaries to take advantage of the farmers, which raises the transaction costs. Farmers thus have to choose options that lower the transaction costs (Greve *et al.*, 2015). The random utility theory assumes that a decision-maker maximizes utility by selecting an appropriate option that derives higher level of utility. A service or a product that maximizes utility is determined by comparing the marginal utility of two or more alternatives and choosing the one with the highest utility within the budget limit. Therefore, the decision is determined by the alternatives that provides the highest level of satisfaction. And thus, farmers will take the marketing channel that is within the budget and satisfies them.

3.3.2 The Choice of Marketing Channel Econometric Specification

Different studies use different models to assume the probability of the data distribution. Multinomial Probit Model (MNP) assumes that errors are identical and are independently distributed (Wang *et al.*, 2018). However, the multinomial logit (MNL) model accepts that errors can be independent of different alternatives. This results in the property of independence between alternatives useful to the decision-maker (Wang *et al.*, 2018). The MNL model is used when dealing with various alternatives, unlike binary models where only two choices exist. The MNL model is useful in estimating the probability of selecting a certain alternative from a group of alternatives (Wang *et al.*, 2018). It was preferred in the study because a pigeon pea farmer was required to mention the main marketing channel used in selling pigeon peas. However, MNP may be more complex than MNL because it lacks optimality to approximate the probability of choices. Thus, MNL is preferred due to its easy computation, β-coefficients interpretation, and derivatives being in closed form (Wang *et al.*, 2018). This study therefore, adopted MNL to estimate the factors affecting the choice of marketing channels among pigeon pea farmers in Machakos County, Kenya. Farmers try to make coherent decisions and maximize their utility subject to their choices. In this case, the utility is taken as a random variable to account for the unknown. Equation 3.6 represents an individual taking alternative *j*, and it is denoted by U_{ij}. According to Gujarati (2007), U_{ij} represents the deterministic component $(V_{ij}$) and a random part ε

$$U_{ij} = (V_{ij} + \ )\varepsilon \quad \text{..... 3.9}$$

Where V_{ij} is the supposed utility and the U_{ij} is a vector that attributes relatively to j. ε represents the disturbance term. There are different alternatives for farmers to choose from, and thus they have to select the one with the highest utility.

The following equation represents the choice of a marketing channel:

$$P_{ij} = \beta_0 + \beta_1 X_1 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots \beta_k X_k \ + \varepsilon \quad \text{..... 3.10}$$

Where, *i* take the values 1, 2, 3 representing the choice of marketing channel that includes direct consumers =1, rural retailers = 2, rural and urban wholesalers = 3, brokers =4, and exporters =5. X_i represents factors that affect the choice of marketing channels, β are the parameters to be estimated, while ε is the disturbance term. Then j represents the choices.

3.3.3 Estimation Procedure for the Choice of Marketing Channel

Multinomial logit model analysis helps to predict the relationship between a dependent variable and a set of explanatory variables. The choice (dependent variable) is a set of alternatives and the factors influencing the choice (independent variables). In this case, the dependent variable is the choice of the marketing channels such as direct consumers, rural retailers, brokers, rural and urban wholesalers, and exporters. The multinomial logistic model was adopted because it estimates the probability of choosing an alternative from a set of alternatives. In this study, MNL was used to determine the factors influencing the choice of a marketing channel, whereby, the farmer has several options to choose from. Table 3.2 shows the variables used in the MNL model on the choice of marketing channels.

Table 3.2: Variables Used in the Multinomial Logit Model

Variable	Description	Variable measurements
Gender	Gender of the respondent	1=Male 0=Female
Age	Age of the respondent	Number of years
Marital status	Married or not	Yes = 1, No = 0
Education level	Level of education of the household head	1=Lower education level 2=Higher education level
Source of income	Main source of income of the household head	1=Farming 2= non-farming
Monthly income	Total income of the farmer per month	Amount of shillings per month
Access to information	Access to marketing information	Yes = 1, No = 0
Credit access	Do farmers access credit	Yes = 1, No = 0
Distance to the tarmac	Distance to the nearest tarmac road	Number of kilometers
Distance to the market	Distance to the market	Number of kilometers
Land size	Size of the land owned by the farmer	Number of acres
Variety used	Variety of pigeon peas grown by the farmer	1= Local varieties 2=Improved varieties
Quantity last season	Quantity produced last season	Number of 90-kg bags
Quantity sold	Quantity sold by farmer	Number of 90-kg bags
Group membership	Whether a farmer is in a group or not	Yes = 1, No = 0

3.4 Collective Action for Pigeon Pea Farmers

3.4.1 Theoretical Framework of Collective Action

Collective action is based on decision theory and collective action theory. The decision theory assumes that individuals come together and engage in activities that benefit them collectively or as an individual (Koechlin, 2020). Decision theory deals with the underlying reasoning of the choices made by agents and the one, which suits their interests best. Decision theory enables farmers to choose whether to be in collective

groups or act individually (Koechlin, 2020). The decision of a farmer to join a farmer group involves two mutual and exclusive alternatives. A farmer can choose to join a group or not. Therefore, collective action happens when individuals combine efforts to overcome market constraints and make decisions to achieve the desired output based on their interests. Collective action might be perceived differently by farmers based on costs and benefits.

This makes decision-making easier for those willing to join groups. Groups require sanctions that guide the members to be responsible to avoid incentives that cause free riding among some members. For example, a group can have services that they offer to its members and it is financed through the tax on collective sales. If this is not honored, then the collective action is threatened. Therefore, understanding the factors that influence the members to join groups is essential in collective marketing and other activities to enhance the group performance.

3.4.2 Econometric Specification of the Determinants of Collective Action

Models that estimate the phenomena whereby the dependent variable is binary, that is, only two option of either joining a group or not, have are preferred. When an individual is faced by a choice to make, he or she must have a reaction that is influenced by certain factors. The individual then makes a decision to join a Farmer-Based Organization (FBO) or not. In regard to the utility theory, the decision to join a farmer group is based on the maximization of utility whereby the farmer will participate. The farmer will participate if $U_i > U_k$, where U_i and U_k represent a member and a non-member, respectively. The probability to join a group is expressed by equation 3.11

$$(Y = 1|X) = (U_i > U_k) \quad \text{3.11}$$

The Probit model helps to predict the probability that an event will occur. Even though it is similar to logit model, probit model is based on the probit function. It shows the relationship between predictors and probability that an event will occur ranging from one to zero. Other models such as logistic models can be used but probit is preferred because of the maximum likelihood that maximize results to fit the regression coefficients.

Therefore, the study used probit model to identify the factors influencing the decision of a farmer to join a farmer group or not. This is shown by the following equation 3.12

$$Y\ (1,0) = \alpha 1 + \beta_1 X_1 + \ldots\ldots + \beta_n X_n + \varepsilon \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.12$$

Where Y represents the decision of a farmer to join a farmer based organization or not, β is the beta coefficient, X represents the factors influencing the decision while ε_i is the disturbance term.

3.4.3 Estimation Procedure for the Collective Action

Probit model is used to predict a relationship between a dependent variable and explanatory variables. The dependent variable takes one or zero. It estimates the probability that an event will occur or will not occur. Probit regression works with the assumption of linear relationship between the dependent and independent variables. For instance, the probability of a pigeon pea farmer adopting collective action or not. In this case, a farmer joining a group will be 1 and not joining a group will be 0. Probit model uses the maximum likelihood to maximize results that fit the regression coefficients. Thus, it works with the assumption of a linear relationship between the dependent and the independent variables. It is assumed that pigeon pea farmers decide to participate in collective action to increase their bargaining power to get better prices and hence better returns. Variables used in the model were presented in Table 3.3.

Table 3.3: Variables used in the Probit Model for Collective Action

Variable	Description	Variable Measurements
Gender	Gender of the respondent	1=Male 0=Female
Age	Age of the respondent	Number of years
Marital status	Married or not	Yes = 1, No = 0
Education level	Level of education of respondent	1=Lower education level 2=Higher education level
Size of household	Members of the household	Number of members
Source of income	The main source of income	1=Farmingonly 2=Non-farming
Monthly income	Income of the farmer per month	Amount expressed in logs
Distance to the market	Distance to the market in kilometers	Number of kilometers
Credit access	Access to credit	Yes = 1, No = 0
Land size	Size of the land owned by the farmer	Number of acres
Variety used	Variety of pigeon peas grown by the farmer	1=Local races 2=Improved varieties
Quantity last season	Quantity produced last season in 90-kg bags	Number of 90-kg bags
Quantity sold	Quantity sold by farmer in kilograms	Number of 90-kg bags
Access to information	Access to market information	Yes = 1, No= 0

3.4 Testing for Endogeneity

According to Arbia (2016), endogeneity occurs when the error terms of independent variables are correlated with the dependent error terms i.e., $E[X'\varepsilon] \neq 0$. In a case model with endogeneity, the OLS estimates of the β's are no longer unbiased. It would result from variable omission, misspecification of the model, or specification error. For example, access to credit can be an outcome variable that may depend on the source of income, this could be correlated with an error term of the dependent variable. Based on the robustness of the estimates, endogeneity test was done on the variable "group membership" as a factor to consider, using the two-stage endogeneity test (Tadesse and Bahigwa, 2015). Two instrumental variables were used selected because of the suspicion of having a strong influence on the group membership but without a significant effect on the outcome. When the model lacks endogeneity, an IV estimation is performed to inflate the asymptotic variance of the estimators. A generalized

residual was predicted from the first-stage estimation, as an inverse Mill's ratio of the predicted value of group membership. Further, the generalized residual was included in the second-stage that estimated the outcome variables. Therefore, the endogeneity issue was tested based on whether the generalized residual was statistically significant in the second stage regression. A two-stage test was done to detect the endogenity problem using the ESTAT ENDOG command. Results showed that the suspected variables were exogenous. The results are presented in the appendix showing that the null hypothesis could not be rejected of the lack of endogeneity.

3.5 Data Sources and Collection

3.5.1 Study Area

The study was conducted in Machakos County, Kenya. Mwala, Yatta, and Masinga sub-counties were selected to represent the study sites. The County borders Nairobi, Kiambu, Embu, Kitui, Makueni, Kajiado, and Muranga's Counties. It stretches from latitudes 0º 45' south to 1º 31' South and longitudes 36° 45' East to 37° 45' East. Machakos County has 1,098584 people and 264,500 Households covering an area of 6,208 square kilometers (KNBS, 2019). In Mwala sub-county, the population is 181,896, in Yatta the population is 172,583, while Masinga has a total population of 148,522 (KNSB, 2019). The local climate is semi-arid, with a hilly terrain of 1000-2100 meters above sea level. However, some people live below the poverty line. The average temperature ranges from 17^0C to 27^0C. The climate in the three sub-counties varies, thus favoring high production of pigeon peas. The county practices subsistence agriculture where maize is intercropped with other drought-resistant crops such as pigeon peas, sorghum, and millet (Bosire *et al.*, 2019). There are significant market days with large amounts of produce being traded, such as fruits, vegetables, and other foodstuff. Figure 3.1 shows the map of Kenya where data was collected.

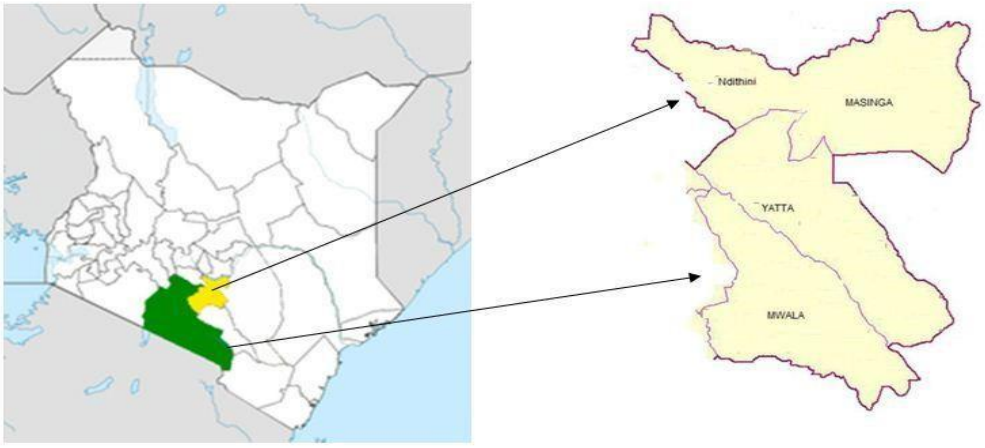

Figure 3.1: Machakos County Map

Source: (Google, 2021)

3.5.2 Research Design

The study used a purposive sampling of the respondents. This design was adopted since the sample was collected from pigeon pea farmers who grew and sold pigeon peas to represent the whole population. The researcher is also able to collect data within a shorter period. Additionally, it helps the researcher to accommodate a large sample, maintain the confidentiality of the data, and still provide accuracy in the responses.

3.6 Sampling Procedure

3.6.1 Sampling Frame/Population

The sampling frame of the study involved the pigeon pea producing households in Machakos County, specifically in Yatta, Masinga, and Mwala sub-counties. The target population was the smallholder farmers growing and marketing pigeon peas in Machakos County.

3.6.2 Sampling Technique

The respondents were selected using a simple random sampling procedure. Machakos County was purposely selected since it was among the implementing sites of the KCSAP project which sponsored the study and due to the presence of pigeon pea farmers. The Fischer's formula was used to calculate the study sample depending on the population and resources available. Equation 3.13 was used to estimate the sample size used in the study.

$$n = \frac{p\,(1-p)z^2}{d^2} \quad \text{..... 3.13}$$

Where, n is the population sample size, d desired level of precision (acceptable error in the estimate), p (estimated) proportion of the population growing pigeon peas in Machakos county, z the abscissa of the normal curve that cuts off an area at the tail (1.96-at 95% Confidence Interval).

Therefore, the study assumed that (0.25) of the population in Machakos county practices pigeon pea farming. At a 95% confidence interval, Z-value is 1.96

$$n = \frac{0.25\,(1-0.15)\,1.96^2}{0.05^2} = 310 \text{ respondents} \quad \text{.....3.14}$$

3.7 Data Collection

A structured questionnaire was used to collect data from the respondents. The questionnaire had information on demographic characteristics of the pigeon pea farmers, pigeon pea marketing channels, and collective action. The questionnaire was developed and pre-tested to establish its relevance and validity to the study, then administered to the farmers to get information about individual farming of pigeon peas.

3.8 Data Analysis

The study employed descriptive statistics and econometric models to present the relationship between various variables used in the study. The descriptive statistics such

as frequencies and percentages were used to summarize the socioeconomic attributes of pigeon pea farmers. Data was collected, entered, and cleaned using SPSS software. The econometric models such as PCA, CA, MNL, and Probit were used to characterize the pigeon pea farmers, establish the determinants of the choice of marketing channels and collective action respectively. The study variables were then derived from the data collected.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents results and discussions of the study. Section 4.2 presents the descriptive results of the socioeconomic characteristics of the pigeon pea farmers. Section 4.3 shows the econometric results of the principal component analysis, while section 4.4 presents the cluster analysis. Section 4.5 shows results for the Multinomial Logit Model results, and finally section 4.6 presents findings for the Probit model.

4.2 Characterization of Farmers

4.2.1 Descriptive Summary of the Households

Table 4.1 shows the results of socio-economic characteristics of pigeon pea farmers. Results showed that both males and females participate in pigeon pea farming. However, men are more involved in pigeon pea farming (53.5%) compared to women (46.5%) in the study area. This can partially be attributed to the assertion that pigeon pea farming is labor intensive. Hence, men seem to engage more in pigeon pea farming compared to women.

The results further indicated that the majority of the respondents (88.3%) had attained lower education level while 11.7% of them had attained higher education level. About 11.6% of the respondents attained tertiary education while 1.3% of them realized university education. However, a small percentage of about 1.9 of the respondents had not received any formal education. A good proportion of the respondents (92.6%) grew pigeon peas for both consumption and income generation purposes while about 7.4% of them grew pigeon peas for consumption only. Majority of the farmers (96.1%) relied on farming as their main source of income and the rest on non-farm activities.

Table 4.1: Socio-Economic Characteristics of Households

Characteristic	Category	Mean	Frequency	Percentage
Gender	Male		165	53.5
	Female		145	46.5
Age		46.0		
Household size		5		
Monthly income		18693.0		
Land size		3		
Years producing the pigeon peas		9.5		
Distance to the market		2.4		
Marital status	Married Not married			
Education level of the respondent	Lower education level		274	88.3
	High education		36	1.7
Source of income	Farming		298	96.2
	Non-farming		12	3.8
Access to credit	Yes		214	69
	No		96	31
Variety used	Local varieties		23	7.4
	Improved varieties		1	0.3
Access to information	Yes		103	33.2
	No		51	16.5
Grows pigeon peas	For consumption		23	7.4
	For consumption and sell		287	92.6
Type of pigeon peas sold	Green		7	2.4
	Dry		260	90.3
	Both		20	7.3
Quantity sold the previous season		2		
Group membership	No		109	35.2
	Yes		201	64.8
Type of groups	Self-help group		98	48.76
	Farmer-based organization (FBO) and cooperatives		87	39.30
	SACCO		3	1.49
	Cooperative		7	3.48
	Church group		14	6.97

Source: Author's computation based on 2021 survey data.

The majority of the respondents (82.6%) grew local varieties such as *Kionza and kalonzo* in the local dialect, followed by Katumani (7.4%). The results also indicated that other varieties such as M*baazi 1*, *Mbaazi 2*, and *Mbaazi 3* were also grown in Machakos County. A group in Mwala sub-county (FGD) reported an ongoing efficacy trial using *Mbaazi 2* sponsored by the KSCAP project and was still waiting to get results on the crop performance to compare with the performance of the local varieties and Katumani seed from KALRO. The results further showed that the majority of farmers in the study area had access to credit (69%) while about 31% of them had no access to credit facility. This can possibly be attributed to poor information access, lack of collaterals, or long distance to where the credit providers reside. The results showed that friends were the main source of agricultural information (33.3%), followed by government officials at 29.4%, and family members (16.5%). Other farmers got information from farmer groups (8.7%) which they were part of. However, some farmers and key informants (Agricultural officers) reported the existence of different groups such as farmer-based organizations, SACCOS, and church groups.

The majority of the pigeon pea farmers sold their produce to rural retailers (58%), brokers (19.2%), rural and urban wholesalers (12.5%), and direct consumers (10.1%). Farmers reported that they sold their crops to rural retailers because they were more reliable and available at any time compared to brokers who visited their farm gates. Occasionally, farmers reported that the crop does well in the area because of low rainfall. However, they did not have the appropriate information on how they could commercialize their operations. Farmers also reported that they practiced mixed cropping with crops such as maize, sorghum, and beans. Thus, calculating the exact land size for growing pigeon peas was a challenge. Further, 2.4% of the farmers sold green pigeon pea pods, 90.3% sold dry pigeon pea grains, while 7.3% of the farmers sold both green and dry peas. In regards to group membership, 201 farmers representing 64.8% of the sampled respondents belonged to self-help groups, farmer-based organizations, SACCOs, cooperatives, and church groups while 109 farmers were not in any group (35.2%). Farmers in the self-help groups and the farmer-based organizations reported to have borrowed money for production and other personal purposes such as paying school fees for their children. The other groups were for

welfare activities such as funeral arrangements. Farmers who were members of producer groups and cooperatives constituted 39.3% of the sample.

4.3 Principal Component Analysis Results

Prior to PCA, Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity (BTS) were undertaken to assess the sampling adequacy and suitability of the model. The KMO value obtained was 0.558 and a BTS value of 437.278 with a P-value of 0.000, indicating the sufficiency of data for PCA. This is shown in Table 4.2.

Table 4.2: Results of the Kaiser-Meyer-Oklin and Bartlett's Test of PCs

Kaiser-Meyer-Oklin Measure of Sampling Adequacy	0.558
Bartlett Test of Sphericity Chi-square	437.278
Degrees of Freedom	153
P- Value	0.000

Source: Author's computation based on 2021 survey data.

Further, the Kaiser rule of eigenvalues was employed to determine the number of factors to be retained. Usually, the factors with eigenvalues greater than one are retained and explained (Pugno & Verme, 2012). The Table 4.3 below shows the eigenvalues and components explained.

Table 4.3: Components and Total Variance explained

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	2.0952	0.4733	0.1164	0.1164
Comp2	1.6218	0.1231	0.0901	0.2065
Comp3	1.4986	0.2098	0.0833	0.2898
Comp4	1.2887	0.0521	0.0716	0.3614
Comp5	0.9836	0.0592	0.0687	0.4301
Comp6	0.9873	0.1182	0.0654	0.4955
Comp7	0.9431	0.0351	0.0588	0.5543
Comp8	0.9402	0.0467	0.0569	0.6112
Comp9	0.8772	0.0827	0.0543	0.6655
Comp10	0.8945	0.0619	0.0497	0.7152
Comp11	0.7825	0.0667	0.0463	0.7614
Comp12	0.7658	0.0063	0.0425	0.804
Comp13	0.7594	0.0954	0.0422	0.8462
Comp14	0.6640	0.0258	0.0369	0.8831
Comp15	0.6381	0.0753	0.0355	0.9185
Comp16	0.5628	0.0425	0.0313	0.9498
Comp17	0.5202	0.1366	0.0289	0.9787
Comp18	0.3836	0.1134	0.0213	1.0000

Source: Author’s computation based on 2021 survey data.

In this study, four factors adhered to the criterion and were retained as shown by the scree plot shown in Figure 4.1.

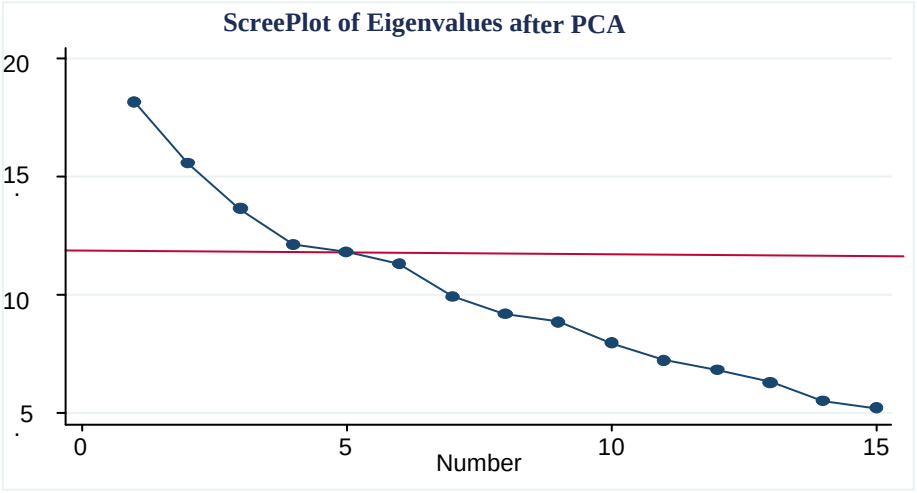

Figure 4.1: Scree Plot for the Eigenvalues. Source: Author's computation

Four factors were retained as shown in Table 4.4. They accounted for 36.14% of the total variance as they represent a substantial variation. Table 4.4 shows the factors retained in the factor loadings.

Table 4.4: Principal Components Factor Loading

Factor and Item Description	Factor Loadings	% Variance Explained
Factor 1: Infrastructure factor		**11.64%**
Type of road	0.4784	
Land size	0.4514	
Distance to market	0.3305	
Factor 2: Socio-demographic factor		**9.01%**
Age	0.3981	
Gender	0.3459	
Marital status	0.3117	
Number of household members	0.4167	
Factor 3: Socio-economic factors		**8.33%**
Education of household	0.4266	
Occupation of household	0.4238	
Source of income	0.3129	
Factor 4: Marketing factors		**7.16%**
Quantity sold	0.3200	
Access to information	0.3531	
Group membership	0.3175	
Total Variance explained		36.14%

Source: Author's computation based on 2021 survey data.

The first retained component was named the infrastructure factor and accounts for about 11.64% of the total variance. It had three items, namely type of road (0.4784), land size (0.4514) and distance to the market (0.3305). The second component retained was named the socio-demographic factors, with four items accounting for 9.01%. The items contained in the element include age (0.3981), gender (0.3459), marital status (0.3117), and the number of household members (0.4167). The third one was named socio-economic factors, with three items accounting for 8.33%. The items were the education of the respondent (0.4266), occupation of the respondent (0.4238), and source of income at 0.3129.

The last component was named the external factors, with three items accounting for 7.16%.

The items include the quantity sold (0.3200), access to information (0.3531) and the group membership (0.3175). Therefore, the factor loading makes it clear that infrastructure, socio-demographics, education, income factors, and external factors of group membership and buyer services were essential factors in characterizing pigeon pea farmers.

4.4 Cluster Analysis Results

The four components retained in the PCA were used as inputs in the cluster analysis to characterize the pigeon pea farmers. The farmers were grouped in three distinct clusters as shown by the dendrogram in Figure 4.2.

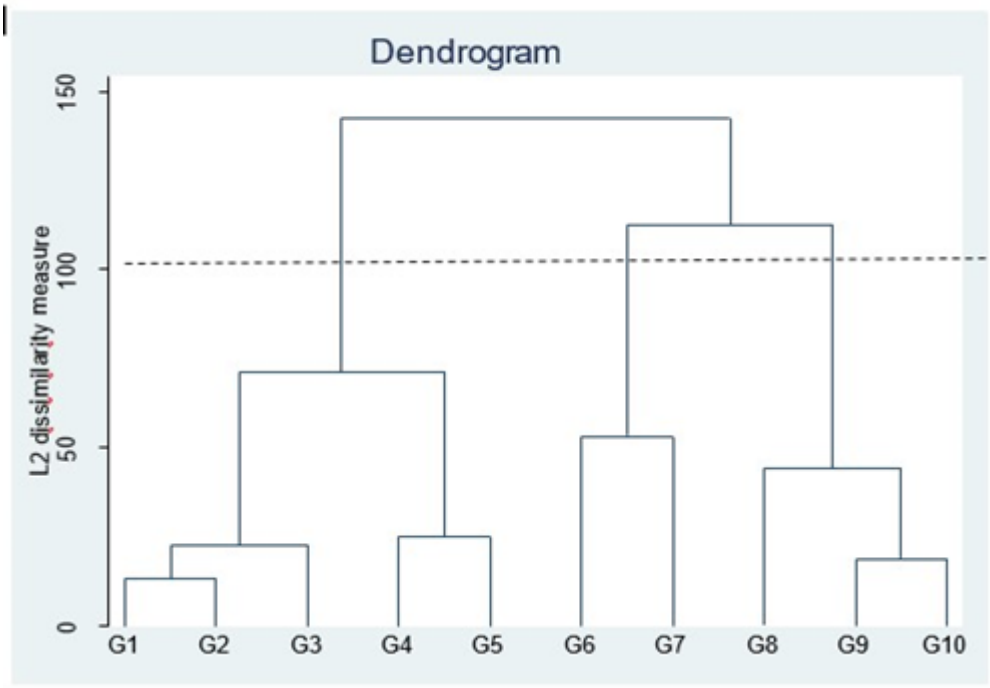

Figure 4.2: Dendrogram of the Retained Factors

Table 4.5 presents the results of cluster analysis (CA). The results showed that pigeon pea farmers were heterogeneous in nature and can be classified based on various socioeconomic characteristics. The Analysis of Variance (ANOVA) done at 95% showed three distinct clusters of pigeon pea farmers based on various characteristics.

Table 4.5: Characteristics of the Clusters Based on the Means

Socio-economic Characteristics	Cluster 1	Cluster 2	Cluster 3	F value	Prob > F
Cluster frequency	**90**	**115**	**82**		
Gender	0.4	0.4	1.0	1.5	0.224
Age	46.1	48.7	51.0	2.44	**0.009**
Marital status	1.3	1.2	1.4	0.36	0.695
Access to credit	0.8	0.4	0.6	4.42	**0.013**
No. of household members	5.3	6.0	6.2	3.89	0.214
Education level of respondent	2.2	1.1	1.0	0.59	0.555
Main occupation of respondent	2.1	2.2	1.1	4.63	0.105
Source of income	2.0	1.1	1.0	0.05	0.950
Type of road	1.0	2.0	1.7	15.62	**0.074**
Distance to the market	1.7	3.6	4.6	5.02	**0.007**
Land size	2.4	4.2	7.1	67.57	**0.000**
Variety used	1.1	6.2	6.0	2.41	0.291
Access to information	1.9	0.1	1.6	2.83	0.168
Quantity produced the last season	0.5	1.5	3.1	8.27	0.702

Socio-economic Characteristics	Cluster 1	Cluster 2	Cluster 3	F value	Prob > F
Amount of pigeon peas sold	0.2	0.5	2.2	0.73	**0.004**
Buyer services	0.1	0.3	0.3	12.35	**0.089**
Group membership	0.4	0.7	1.0	11.58	**0.000**
Cluster distribution	**31.36%**	**40.07%**	**28.57%**		

Source: Author's computation based on 2021 survey data.

4.4.1 Typologies of the Pigeon Pea Farmers

Pigeon pea farmers were grouped into three distinct clusters namely; low agricultural production, average agricultural production, and the high agricultural producers as shown in Table 4.5.

Cluster 1 represented low agricultural production with 90 households, accounting for 31.36% of the study sample. Farmers in this cluster had the lowest average age of 46 years compared to clusters 2 & 3. According to the findings, the majority of respondents were married, had at least attained secondary school education, with a minimum of five household members. The households depended on small, family-owned businesses as the main source of income, implying that farming is not their main economic activity. Total production of pigeon peas was relatively low in this cluster, that is, half (0.5) bag of 90 kgs compared to other clusters. The results further show that the amount of pigeon peas sold is low at an average of 0.2 bag of 90 kgs. The households in this cluster are located closer to the markets at a mean distance of 1.7 kilometers. As a result of their proximity to the market, roads near these homes are likely to be paved. They have relatively less land, with an average of 2.4 acres, and thus low production based on the acreage and total production. This cluster showed low involvement in farmer groups in various groups because most of the farmers were involved in individual activities such as businesses.

Cluster 2 represented farmers with average agricultural production. The cluster had the highest (115) number of farmers, representing 40.07% of the total respondents. The respondents in this group had at least attained a primary school education. Farmers in this cluster had relatively greater access to land compared to farmers in cluster 1, with an average of 4.2 acres. The distance to the market was longer (3.6 km) compared

to distance covered by farmers in clusters one and three. Therefore, farmers were more involved in farming with an average production of 1.5 bags of pigeon peas. The amount sold was higher (one bag) compared to the amount sold by farmers in cluster 1. This indicated that as distances increased away from the market, more farmers were involved in farming, producing more and therefore sold more compared to farmers in cluster 1. Results further showed that most farmers were relatively involved in different groups for various activities.

Cluster 3 represented farmers associated with high agricultural production. The cluster had 82 households, representing 31.01% of the total study sample. Many farmers in this cluster were married, with an average of six household members. Farmers depended heavily on farming as their main occupation and source of livelihood. This was indicated by the high level of production of pigeon peas with an average of 3.1 bags compared to the amount of pigeon peas produced by farmers in the other clusters. The farmers sold relatively more (2.2 90-kg bags) based on the production compared to farmers in other groups. They were located away from the market; covering an average distance of 4.6 km. In this case, farmers had higher access to land, with at least 7.1 acres of land per household. Therefore, they were engaged in different agricultural activities and thus had high production.

4.4.2 Factors Influencing Variations in Characterization of Pigeon Pea Farmers

The results from principal component analysis show distinctive factors determining pigeon pea farmer typologies.

The age of the respondents varied significantly among clusters ($P < 0.005$). Farmers in cluster 2 were much older, implying that they had experience in growing pigeon peas, followed by cluster 3 and then cluster 1. Aged farmers tend to prefer growing pigeon because it is a traditional crop that is multifunctional and has the potential to generate income. This is an indication that experience was a determining factor in making decisions based on growing pigeon peas.

Access to credit differed significantly between the farmer clusters. Farmers in cluster one and three showed that they have access to credit. Farmers in cluster 1 were closer

to town and thus had high access to information on where they could access credit. Farmers in cluster three showed that they could access credit. This is supported by the study done by Adeyonu *et al.* (2019) which revealed that farmers who have access to credit facility are able to increase their productivity and thus have more to sell.

Distance to the market varied significantly ($P < 0.001$) among the pigeon pea farmer clusters in Machakos County. Farmers in cluster 1 were closer to the market and thus had more options for selling their pigeon peas in the market compared to those in clusters 2 and 3. Astatike & Gazuma (2019) argued that households far away from the market are likely to have high production because of large acreage but reduced marketing opportunities compared to those closer to the market because they can participate in different off-farm activities. Farmers close to the market can access information and services from buyers and agricultural officers compared to those farther away.

The results further showed that land size significantly determined pigeon pea farmer clusters ($P < 0.000$). Cluster 3 had more access to land compared to clusters 1 and 2. Farmers with more land intensified their production, and therefore more was available for marketing. Land plays a vital role in agricultural production and marketing. Having considerable land implies more production and thus more pigeon peas for sale. This results in more income and, therefore, better living standards for the farmers. Farmers with greater access to land can use it as collateral for other services, such as access to financial assistance.

The results showed that there was a significant variation between farmers in the three clusters based on the amount sold ($P< 0.0048$). Farmers in cluster one produced less amount of pigeon peas with an average 0.5 90kg-bag compared to clusters two and three who produced 1.5 and 3.1 bags respectively. This determined the amount of surplus production available for sale. Therefore, farmers in cluster three had more pigeon peas available for sale compared to other clusters (0.5 and 2.2 bags). They are associated with large land size and therefore more production (3.1 bags, 90kg-bag). The average amount sold by farmers in cluster 3 was 2.2 bags. The amount sold

depended on the surplus amount sold. Therefore, the variation between farmers is the three clusters significantly depends on the amount of surplus available for sale.

Group membership also varied significantly ($P < 0.000$) across the clusters. Farmers in cluster 3 participated in farmer groups compared to those in clusters 1 and 3. Farmer groups are important for farmers as they can get different benefits, such as market information, training from agricultural officers, and price changes. Farmers in groups can easily be trained by different agencies to support their production and marketing. According to Adeyonu *et al.* (2019), training farmers promotes group marketing and bargaining for better prices for their products. Those who market in groups have increased bargaining power and better marketing terms. Due to the current challenges faced by farmers in production and marketing, government agencies and donor agencies have been interested in transforming agriculture through farmer groups, which are the best channels to reach more farmers (Abdul-Rahaman & Abdulai, 2018). Therefore, farmer group membership is critical for all smallholder farmers who wish to produce for commercialization.

4.6 Choice of Marketing Channels in Machakos County

The results of this study revealed that out of the 310 farmers interviewed, 287 (92.5%) farmers produced pigeon peas for both subsistence and for commercial. The remaining 23 (7.5%) grew only for food. Table 4.6 shows the marketing channels in Machakos County. Therefore, in determination of the marketing channels, only the participants who sold the pigeon peas were considered. The level of commercialization was low among the farmers, and therefore, the study used the main marketing channel used by the farmer.

Table 4.6: Pigeon Pea Marketing Channels

Marketing Channel	Frequency	Percentage
Direct Consumer	29	9.4
Rural retailer	167	53.9
Rural and urban wholesalers	36	11.6
Broker	55	17.7
Export	0	0

Source: Author's computation based on 2021 survey data.

Rural retailers, brokers, direct consumers, and rural and urban wholesalers were the main types of marketing channels used by farmers to sell their crop. The majority of the respondents sold to rural retailers, followed by brokers, rural and urban wholesalers, and direct consumers. However, there were no farmers selling to exporters. Table 4.7 shows the goodness of fit for the MNL model used for analysis.

Table 4.7: Results from the Multinomial Logit Model

Number of observations	310
LR Chi^2	82
Prob>Chi2	0.0005
Log-Likelihood	273.49

Source: Author's computation based on 2021 survey data.

The coefficients were simultaneously equal to zero, indicating a good fit of the model. The chi-square value of 82 was significant with a p value of 0.0005, implying that all the variables in the model explained the dependent variable adequately.

Table 4.8 shows that education level, source of marketing information, and group membership significantly and positively influenced rural and urban wholesalers as the choice of marketing channel.

Table 4.8: MNL Parameter Estimates for the Determinants of the Choice of Pigeon Pea Marketing Channels in Machakos County

	Rural retailers			Rural and Urban Wholesaler			Broker		
Variable	**β-Coef**	**Std error**	**P value**	**β-Coef**	**Std error**	**P value**	**β-Coef**	**Std error**	**P value**
Gender	0.69	0.476	0.01	-1.089	0.60	0.37	-0.421	0.535	0.03
Age	-0.19	0.76	0.00	0.988	0.946	0.006	0.211	0.864	0.81
Marital status	-0.27	0.283	0.33	-0.026	0.312	0.935	-0.373	0.342	0.28
Education level	0.11	0.331	0.03	0.596	0.367	0.005	-0.099	0.359	0.78
Occupation of the HHH	-0.49	0.304	0.11	-0.978	0.594	0.099	-0.166	0.331	0.62
Monthly income	-0.000	0.00001	0.00	-0.0002	0.0002	0.000	0.009	0.000	0.00
Access to information	0.11	0.162	0.51	0.317	0.186	0.364	0.052	0.181	0.77
Credit access	-0.39	0.523	0.46	0.375	0.682	0.002	-0.315	0.596	0.57
Distance to the tarmac	0.09	0.127	0.50	0.034	0.155	0.826	-0.312	0.134	0.92
Distance to the market	0.07	0.103	0.51	0.059	0.133	0.654	0.094	0.118	0.00
Land size	2.22	0.571	0.00	1.455	0.761	0.056	1.361	0.6	0.82
Variety used	-0.04	0.188	0.83	0.232	`	0.356	-0.039	0.21	0.85
Quantity produced last season	-0.94	0.541	0.04	-0.111	0.625	0.858	-0.336	0.555	0.54
Dry pigeon pea sold in sacks -	1.01	1.881	0.00	-1.696	2.196	0.440	-0.182	2.092	0.03
Group membership	0.87	0.618	0.16	0.738	0.72	0.006	1.65	0.656	0.61
_cons	4.14	3.404	0.23	-4.795	4.303	0.265	0.226	3.851	0.95

No. of observations = 310 Pro>Chi2=0.0005 Log likelihood= -273 *, **, ***represents the significance of coefficients at 10%, 5% and 1% respectively. The reference category is direct consumer

10%*, 5%** and 1%*

Table 4.8 shows the parameter estimates for the determinants of the choice of marketing channels in Machakos County. Factors that were statistically significant included gender, age, education level, monthly income, credit access, distance to the market, land size, quantity produced the previous season, dry pigeon peas sold, and group membership. Gender and age influenced the choice of rural retailers and rural and urban wholesalers marketing channels. Monthly income influenced the choice of all the three marketing channels. Dry pigeon peas sold affected the choice of rural retailers and brokers marketing channels. However, coefficients from multinomial logit model are hard to interpret because the values are explained relative to the base outcome. (Muthini *et al*., 2015). Therefore, marginal effects were computed to examine the change of values on the probability of observing an outcome.

Table 4.8 shows the computed marginal effects for the analysis.

Table 4.9: Marginal Effects of the MNL Regression for the Determinants of the Choice of Pigeon Pea Marketing Channels in Machakos County

	Rural retailer			Rural and urban wholesaler			Broker		
	dy/dx	Std error	P	dy/dx	Std error	P	dy/dx	Std error	P
Gender	0.136	0.063	**0.050**	-0.047	0.039	0.228	-0.039	0.052	0.04
Age	0.124	0.099	**0.010**	0.098	0.059	**0.002**	0.036	0.082	0.66
Marital status	-0.001	0.038	0.670	0.0227	0.018	0.214	-0.023	0.036	0.52
Education level	-0.001	0.037	0.104	0.148	0.118	0.229	-0.039	0.032	0.21
Occupation of the HHH	-0.028	0.053	0.600	-0.054	0.047	0.252	0.051	0.036	0.15
Monthly income	0.000 0	0.0000	0.000	2.07E-07	1.23E-06	**0.000**	2.70E-06	1.56E-06	0.00
Access to information	-0.003	0.019	0.890	0.021	0.01	0.672	-0.011	0.017	0.53
Credit access	-0.076	0.073	0.300	0.066	0.045	**0.008**	-0.008	0.061	0.89
Distance to the tarmac	-0.019	0.014	0.170	-0.008	0.009	0.368	-0.036	0.011	0.48
Distance to the market	0.022	0.013	**0.090**	0.002	0.009	0.746	0.023	0.011	0.03
Land size	0.251	0.084	**0.001**	-0.038	0.055	0.488	-0.087	0.068	0.34
Variety used	-0.019	0.023	0.201	0.024	0.018	0.17	-0.006	0.018	0.31
Quantity produced last season	-0.168	0.077	**0.003**	0.058	0.041	0.153	0.063	0.05	0.26
Dry pigeon pea sold in sacks	0.099	0.241	**0.000**	-0.085	0.129	0.512	-0.125	0.201	0.04
Group membership	-0.046	0.065	0.449	0.021	0.04	**0.002**	0.131	0.05	0.70

The results showed that gender had a significant positive influence on choosing rural retailers but had negative influence among brokers. This indicates that male pigeon pea farmers had a higher probability of choosing rural retailer by 13.6% compared to women who would choose brokers as the marketing channel (3.9%). Households headed by males tend to take risks thus are capable of looking for markets that are more competitive such as rural retailers for better prices. Equally, households headed by females are likely to be confined at home because of other household duties, which hinder them from searching for alternative markets. This finding agrees with that of Geoffrey *et al.* (2014) who revealed that male-headed households chose local markets

to sell their pineapples in Kericho County. This is further explained by the fact that females have specific constraints at home that limit them from accessing better markets for their crops.

The age of the respondent significantly influenced the choice of rural retailers and, rural in addition, urban wholesaler as the choice of marketing channels. As age increases, farmers get more informed and thus a higher chance of selecting rural retailers and rural and urban wholesalers compared to selling to brokers by 12.4% and 9.8% respectively. Older farmers might have a stronger network than the young ones because of the many years of trading. This finding concurs with the study by Arinloye *et al*. (2015) who found that older farmers are more likely to make decisions more easily because of their accumulated knowledge, capital, and long-term relationship with their buyers. They could also have other resources such as land and credit access that enable them to make informed decisions on where to sell their crop.

Further, the results showed that the approximate monthly income was a significant factor in determining rural retailers, rural and urban wholesalers, and brokers as a choice of a marketing channel among pigeon pea farmers. A unit increase in income levels increases the chance of selecting either of the channels. This implies that households with more income can invest more in agricultural activities that can yield more crop for selling. Karanja *et al.* (2019) indicated that increased income in a household increases the chances of farmers participating in agricultural activities. They can also access essential services such as extension services, training, and purchase of inputs, capital investment, appropriate technology, and market information.

Access to marketing information had a significant and positive influence on the choice of rural and urban wholesalers. Access to a reliable source of marketing information increases the chances of a farmer selling pigeon peas to rural and urban wholesalers by 4%. Lack of market information is a challenge for farmers. For example, farmers receiving information from brokers cannot be classified as having access to marketing information because the legitimacy of the information cannot be guaranteed. This is in tandem with the study by Karanja *et al.* (2019) who indicated that access to reliable

source of market information provides information on competitive marketing channels.

Distance to the market significantly and positively influenced brokers as a choice of pigeon pea marketing channel in Machakos County. Distance covered by pigeon pea farmers to reach the market increases the probability of choosing brokers as the marketing channel by 6.6%. If the market is located far away from the farmers, it becomes difficult to travel, as they have to incur transport costs, thus reducing the frequency and willingness to travel to the market. This affects the choice of the marketing channel. The finding is in line with the study by Apandi *et al.* (2017) who found out that distance influenced the choice of a marketing channel among the pineapple farmers.

Credit access had a positive relationship with the probability of choosing rural and urban wholesalers. Farmers who can access credit have enough resources to cover both production and marketing costs. Therefore, a change from a situation of no credit to accessing credit increases the probability of selecting rural and urban wholesalers by 6.6%. Farmers who accessed credit were able to purchase production inputs such as improved seed and fertilizers, which increase the yield and thus more marketable surplus. This is in agreement with the study by Kihoro *et al*. (2016) who found that credit access enabled farmers to make a decision on the marketing channel to use for their green grams.

Land size was a key factor in smallholder pigeon pea production and marketing. Some farmers owned land while others used family land for production, and those with larger land sizes grew more pigeon peas and thus had more surplus for sale. The results indicated that a unit increase in land increased the probability of choosing rural retailers, wholesalers, and brokers by 46.1%, 33.1%, and 38.9% respectively relative to direct consumers. Land determines the quantity of pigeon peas grown bearing the fact that the crop is grown through mixed cropping. This result was in agreement with that from Kihoro *et al*. (2016), which revealed that land size was among the factors influencing the choice of marketing channels of green grams in Mbeere south, Embu County, Kenya. Farmers with less land had restrictions on the land under pigeon peas,

thus less crop for marketing, which affected the decision of choice of marketing channel. The finding is in tandem with the study by Donkor *et al.* (2018), that the choice of marketing channels is affected not only by price but also by land sizes. Quantity produced the previous season significantly influenced the choice of a marketing channel ($P< 0.05$). An increase in the amount produced in a month reduces the probability of choosing to sell through rural retailers by 42.6%. Therefore, farmers with high amounts of produce would not choose rural retailers compared to those with less amounts produced. This observation is in agreement with Chalwe (2011), who studied the factors influencing the bean producer's choice of marketing channels in Zambia and found that the beans produced were sold to private traders compared to those sold to brokers. Geoffrey *et al.* (2014) also found that the quantity produced positively influenced the choice of a marketing channel.

The results further showed that quantity sold had a significant influence on the choice of rural retailers and brokers. An increase in the amount available for sale increased the probability of choosing a rural retailer by 9.9%. This brings the aspect of economies of scale whereby there is the reduction of cost of producing one item due to increased number of units to be produced. When there is more to produce and sell, the cost reduces as the fixed costs remain the same. On the other hand, a decrease in the amount available for sale by 12.5% increases the chance of selling pigeon peas to brokers. This finding was in tandem with the study by Geoffrey *et al.* (2014) who found out that increased amount of pineapple produced were sold to the local markets.

Group membership significantly influenced the choice of rural and urban wholesalers as the choice of pigeon pea marketing channel. Being a member of a group increased the probability of choosing rural and urban wholesalers by 2.1%. Farmers in groups practice collective action, which is usually emphasized by institutional economics. They receive adequate information on production and marketing trends such as price and extension services.

4.7 Determinants of Collective Action among Smallholder Pigeon Pea Farmers

The respondents of this study indicated that they were in different groups. However, the study considered only farmers who were members of farmer-based organizations

and cooperatives. This was achieved by examining the determinants of a farmer's decision to join a producer group. Table 4.10 shows results from the probit model on the factors influencing the farmers' decision to join a farmer-based organization in Machakos County. The likelihood function testing the hypothesis shows that the coefficients were simultaneously equal to zero at 147.65, 5 degrees of freedom, and a P-value of 0.0001. Endogeneity was tested and the variables used were exogenous (refer to appendix 1).

Table 4.10: Probit Regression Model Estimates of Factors Influencing Pigeon Pea Farmers' Decision to Join a Group in Machakos County

Group Membership	Coef.	Std. Err.	P val
Age	-0.0176	0.2958	**0.005**
Gender	0.1909	0.1797	0.381
Marital status	0.1280	0.1017	0.208
Education level of the respondent	0.2404	0.1016	**0.069**
Size of the Household	0.0275	0.0434	0.073
Occupation of respondent	0.0245	0.1409	0.862
Source of income	0.5182	0.1889	**0.006**
Monthly income	0.0000	0.0000	0.655
Distance to the market	0.0236	0.0439	0.591
Distance to nearest extension service	-0.0485	0.0427	0.256
Access to credit	0.3414	0.2114	**0.006**
Land to size	0.5337	0.2284	**0.019**
Variety used	-0.0859	0.0589	0.144
Quantity produced last season	0.0458	0.0249	0.117
Type of pigeon peas sold	0.2487	0.3059	0.416
Dry pigeon peas sold (sacks)	0.5953	0.5750	0.301
Access to market information	0.1515	0.0706	**0.032**

No. of observations = 310 Pro>Chi2=0.0001 Log likelihood= 147
,*represents the statistical significance of coefficients at 5% and 1% respectively.

The parameter estimates from the probit model gives direction and not the probability of change. Therefore, marginal effects are preferred since they measure the actual effect of a unit change of the explanatory variable on the farmers' choice to join a group. Hence, the marginal effects were used in the study to evaluate the effect of the

unit change expressed as the percentage change of the probability of deciding to be in a farmer-based group as shown in Table 4.11.

Table 4.11: Marginal Effects of the Probit Regression Model for Pigeon Pea Farmers Decision to Join a Group

Variable	dy/dx	Std. Err.	P val
Age	0.0587	0.0907	**0.0051**
Gender	0.0631	0.0581	0.1726
Marital status	0.0414	0.0333	0.2087
Education level of the respondent	0.0790	0.0313	**0.0681**
Size of the Household	0.0421	0.0144	0.2633
Occupation of respondent	0.0086	0.0462	0.8625
Source of income	0.1694	0.0626	**0.0060**
Monthly income	0.0000	0.0000	0.7722
Distance to the market	0.0086	0.0146	0.5911
Distance to nearest extension service	-0.0100	0.0133	0.2552
Access to credit	0.1065	0.0621	**0.0090**
Land to size	0.1754	0.0748	**0.0191**
Variety used	-0.0289	0.0191	0.1433
Quantity produced last season	0.0145	0.0082	0.2194
Type of pigeon peas sold	0.0811	0.1000	0.4161
Dry pigeon peas sold (sacks)	0.1954	0.1871	0.3233
Access to market information	0.0491	0.0237	**0.0311**

The results showed that age of the respondent significantly ($P < 0.01$) and positively influenced the decision of a farmer to join a group. Tolno *et al.* (2015) argued that age has a positive influence on the decision of a farmer to join a group. This is because an increase in the age of a farmer increases the probability of making a decision to join a farmer group by 5.87%. Mukundi *et al.* (2013) who investigated the role of collective action in production of sweet potatoes and market orientation reported that older farmers are likely to join farmer groups compared to the young ones. Moreover, Tolno *et al.* (2015) also argued that older farmers have accumulated adequate knowledge to understand the importance of participating in groups, which can add more agricultural knowledge and opportunities based on the previous interactions.

Education level of the respondent ha a positive and significance on the decision a group. A change in the education level significantly influenced the decision by a farmer to join a farmer group by 7.9%. This research finding was in agreement with

the study by Donkor *et al.* (2018) who found out that farmers who had higher levels of education were more likely to join farmer groups.

The source of income positively and significantly ($P < 0.01$) influenced the farmers' decision to join a group. Farmers who depended on farming as the main source of income were likely to be part of a farmer group compared to those who relied on off-farm activities as their source of income. This finding was in tandem with that of Fischer & Qaim (2014) which revealed that banana farmers who depended on farming were more likely to join farmer groups and organizations. Groups provide knowledge and opportunities that are important to farmers in both production and marketing.

Credit access influenced farmers' decision to join groups positively. One unit increase in the household's access to credit increases the probability of joining a group by 10.65%. This implies that farmers who are in groups are likely to access credit. The results collaborated with that of Simon *et al*. (2015), who showed that access to financial credit influenced the Western Kenya farmers doing indigenous chicken to join a group. This is because poor households might have challenges in meeting the group membership demands and dynamics. Thus, accessing credit helps them to access financial capacity to participate in collective action. Credit plays an important role in linking farmers to networks and platforms that facilitate information access, technology, and crucial inputs necessary in production.

Land size significantly influenced the decision of pigeon pea farmers to join a farmer-based organization. Increasing the land owned by the farmer by one-acre increased the probability of a farmer to join a group by 17.54%. This is possibly attributed to the fact that farmers with large sizes of land require a high level of support based on production inputs, extension services, and marketing information compared to their counterparts. Therefore, the need to join a farmer group is necessary in providing assets such as social capital and knowledge sharing. The finding is in line with the previous study conducted by Mutonyi (2019) who reported that landholdings positively influence group membership. He added that farmers with huge acres of land could utilize their land for different farming options, which can take a shorter time and bring income compared to pigeon peas, which is a perennial crop.

Access to market information had a positive and significant ($P < 0.01$) influence on the farmer's decision to join a group. Different sources of market information were considered such as farmer groups, mobile phones, buyers, agricultural officers, and buyers to elicit the factors determining the decision to join a group. Thus, a unit change in the source of market information influenced the decision to join a farmer group by 4.91%. Farmers who depended on groups to gain market information were likely to be members of farmer groups.

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the results, conclusion, and recommendations of this study.

5.2 Study Summary

Pigeon peas rank third after cowpeas and green grams in production of pulses in Kenya. Pigeon peas in Kenya are grown for food consumption and the surplus is sold in the markets. The purpose of the study was to characterize pigeon pea farmers, assess the factors influencing the choice of marketing channels, and examine the determinants of collective action among pigeon pea farmers in Machakos County, specifically in Mwala, Masinga, and Yatta sub counties. Information on the existing marketing channels was scarce, and thus more insights on the factors influencing a farmer to choose a particular marketing channel was needed. Thus, the study sought to address this knowledge gap by giving information on characterization of pigeon pea farmers, the factors influencing the choice of pigeon pea marketing channels, and the determinants of collective action in Machakos County, Kenya. The study adopted simple random sampling technique to select 310 pigeon pea farmers. Data was collected using a structured questionnaire, entered in a statistical software, SPSS, cleaned and analyzed using STATA. Descriptive statistics were computed to compare the socioeconomic characteristics of the pigeon pea farmers. Principle Component Analysis (PCA) and Cluster Analysis (CA) were used to characterize the pigeon pea farmers. The multinomial Logit Model was used to establish the factors affecting the choice of marketing channels while Probit model was used to determine the factors influencing collective action among pigeon pea farmers.

The descriptive statistics showed that about 53.5% of men and 46.5% of women were involved in pigeon pea farming. The average age of the farmers was 48.1. All the interviewed farmers grew pigeon peas whereby, 92.5% grew for both food and

commercial purposes. Only 7.5% grew for food only. The pigeon peas varieties grown were local land races such as (*Kionza and Kalonzo*), and improved ones including Katumani, *Mbaazi 1, Mbaazi 2 and Mbaazi 3*. The marketing channels used included rural retailers (58%), brokers (19.2%), direct consumers (10.1%), rural and urban wholesalers (12.5%). Even though the literature showed exports as a potential marketing channel, none of the farmers used this channel to sell pigeon peas. The results further showed that 64.8% farmers were members of groups while 35.2% were not in any form of a group. The principal component analysis and cluster analysis results showed that smallholder pigeon pea farmer was heterogeneous in nature and can be grouped into four clusters. Infrastructure factors, socio-demographic factors, socio-economic factors, and the marketing factors were the main factors that explained the variation of pigeon pea farmers. The first cluster was the low agricultural production accounting for 31.36% of the study sample. The amount of pigeon peas produced by farmers in cluster 1 was an average of 0.5, 90kg-bag and the amount sold was 0.2, 90kg-bag. This was relatively low, compared to production in other clusters. The second cluster was the average agricultural production, accounting for 40.07% of the total study sample. Production of pigeon peas from the previous season in this cluster was 1.5 bags, (90kg-bag). The third cluster was the high agricultural production accounting for 31.01% of the total production. The amount available for sale was 2.2 bags, which marked the highest average sales compared to clusters one and two. The factors influencing variation of farmers include age, access to credit; distance to the market, land size, quantity sold, and group membership. The multinomial logistic results showed that the distance to the extension services, the number of household members, and the quantity produced, influenced the choice of marketing channels for pigeon peas and land size. The Probit model results showed that age, source of income, access to credit, land size, source of marketing information determined collective action in pigeon pea farming in Machakos County, Kenya.

5.3 Conclusion

The results from PCA and CA characterized pigeon pea farmers into three clusters, i.e. low production (31.36%), average production (40.07%), and high production (28.57%) pigeon pea farmers. Therefore, it was concluded that pigeon pea farmers are

not homogenous but rather heterogeneous. It was observed that some farmers accessed credit while others did not. Further, some farmers were in producer groups while others did not participate in form of farmer groups. Therefore, the study concluded that there is need to provide affordable credit facilities to enable farmers to commercialize pigeon pea farming which is a potential venture that can give better returns and increase income generation.

The findings on the choice of marketing channels showed export-marketing channel was absent and there was no group marketing. Farmers sold their produce to local channels such as direct consumers, rural retailers, brokers, and rural and urban wholesalers. It was observed that there was no awareness on the proper and profitable marketing channels that can motivate farmers to commercialize. Group marketing was lacking and this limited channels that can offer good returns for the produce.

The results from Probit model showed that only 39.3% of the farmers were in producer groups. However, there are no marketing groups developed to market pigeon peas. Farmer groups can boost marketing of pigeon peas. Thus, group membership is significant and can help to minimize market constraints and imperfections. Collective action enables group marketing, which is a key to commercialization. It further helps farmers not only to sell, but also to access other services such as credit facilities, farmer training, and access to information. Therefore, the study concluded that export markets and group marketing were not developed.

5.4 Recommendations

Based on the conclusions drawn from the discussions, interventions and policies need to be tailored to specific clusters since pigeon pea farmers are not homogenous. The government should improve infrastructure such as access to extension services, access to financial services, and transport systems depending on the clusters. Policy interventions such as the “Agricultural Policy 2021” targeting the farmers should be enhanced to address systemic issues facing the pigeon pea sub-sector and farmers in the respective typologies.

Further, there is need for the National and County Governments to establish export markets and strengthen the local marketing channels for pigeon peas. Therefore, enhancing the export system and strengthening the local markets would possibly help farmers to commercialize pigeon pea production. Due to the low level of collective action of pigeon pea farmers and absence of market groups, there is need to persuade farmers to join producer groups, establish marketing groups, and link them to the markets. Further, the study recommends capacity building through strengthening farmer groups, increase farmer trainings, and sensitize group membership.

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APPENDICES

Appendix I: Test for Endogeneity

Ho: Variables are exogenous

Robust score chi2(1)	chi2(1) =9.09137	P=0.0026
Robust regression F(1,265)	F(1,96)= 9.51713	P= 0.0023

Appendix II: Results from the IVProbit

	Group					
Membership	**Coefficient**	**Std. err.**	**z**	**P**	**[95% conf.**	**interval]**
Gender	-0.21609	0.174287	-1.24	0.215	-0.55768	0.125509
Age	0.010627	0.006126	1.73	0.083	-0.00138	0.022633
Marital status	0.027572	0.103654	0.27	0.79	-0.17559	0.23073
Education level	0.069544	0.098656	0.7	0.481	-0.12382	0.262907
No of members	0.090497	0.041786	2.17	0.03	0.008598	0.172397
Main occupation	0.164623	0.139747	1.18	0.239	-0.10928	0.438522
Source of income	0.2591	0.211339	1.23	0.22	-0.15512	0.673316
Distance to market	-0.08852	0.051526	-1.72	0.086	-0.18951	0.012472
Dist to extension service	0.137366	0.05371	2.56	0.011	0.032096	0.242636
Access to credit	-0.58485	0.222755	-2.63	0.009	-1.02145	-0.14826
Land size	-0.01389	0.029216	-0.48	0.634	-0.07115	0.04337
Variety grown	0.004632	0.059727	0.08	0.938	-0.11243	0.121695
Quantity last season	0.007834	0.04332	0.18	0.086	-0.07707	0.092741
Quantity sold	0.070349	0.353689	0.2	0.842	-0.62287	0.763567
Dry sacks	0.047697	0.090338	0.53	0.598	-0.12936	0.224755

Appendix III: Questionnaire for Smallholder Pigeon Pea Farmers

Introduction

Good morning/afternoon, I welcome you to this survey. My name is Catherine Ndumi Musyoka a master's student from Jomo Kenyatta University of Agriculture and Technology (JKUAT). I am a researcher in Jomo Kenyatta University of Agriculture and Technology (JKUAT) pursuing MSc. Agricultural and Applied Economics. I am pursuing a study to identify the issues faced in smallholder pigeon pea marketing in Machakos county in collaboration with Kenya Climate Smart Agriculture Project. You have been identified as a respondent to participate in the survey and be part of the research. Your participation is voluntary and all the information provided will remain confidential if you agree to participate. The data collected will be used for academic purposes only. General Information

Name of Enumerator: …….

Phone Number: ……...

Date of Interview: …….... County: …… Sub county: …….

Ward: …….

Respondent details

Respondent Name: ……...

Relationship with the household head: 1=Self ☐ 2=Spouse ☐ 3=Child ☐

4=Parent ☐ 5=Worker ☐

Education level of the respondent: 1=Primary ☐ 2=Secondary ☐ 3=Tertiary ☐
4=University ☐ 5=No formal education ☐

SECTION A: Demographic Information of the Farmer

S. No	Question	Indicator
1.	Gender	Male ☐ Female ☐
2.	Age	
3.	Marital status	1=Married ☐ 2=Single ☐ 3=Divorced ☐ 4=Widowed ☐
4.	Education level	1=Primary ☐ 2=Secondary ☐ 3=Tertiary ☐ 4= University ☐ 5= No formal education ☐
5.	Number of household members (State number)	
6.	Number of children (State number)	
7.	Occupation of the household head	1=Farming only ☐ 2=Government Employed ☐ 3=Private employed ☐
8.	Occupation of the spouse	1=Farming only ☐ 2=Government Employed ☐ 3=Private/NGO employed ☐ 4=Business person ☐ 5=N/A
9.	Main source of income for the household	1=Farming only ☐ 2=Government Employed ☐ 3=Private/NGO mployed 4=Business person ☐ 5=N/A ☐
10.	Approximate monthly income in the household in Ksh.	
11.	Approximate distance to the nearest market in KM	
12.	Type of the road	1=Tarmac ☐ 2=Murram ☐
13.	Condition of the roads	1=Good ☐ 2=fairly good ☐ 3=Bad
14.	Approximate distance to the nearest tarmac road in KM	
15.	Distance to the nearest	☐

	extension service provider	
16.	Main source of agricultural information	1=Friends ☐ 2=Family members ☐ 3=Government officials 4 = Farmer ☐ group/Association 5=TV/Radio 6=Mobile ☐ phone ☐ 7=Agrovet 8=Others (Specify)……. ☐
17.	Medium of sharing information	1=Face to Face ☐ 2=Social media ☐ 3=Radio ☐ 4=Television ☐ 5= Others (Specify)…….

SECTION B: Production (Tick where appropriate)

S. No		
1.	Size of Land in acres	
2.	Type of land owned	1=Own; 2=Rented in/Leased; 3=Communal/Family
3.	Type of crops grown in the household	1=Cereals ☐ 2=Legumes ☐ 3=Vegetables ☐ 4=Fruits ☐
4.	Animals kept in the family and number	1=Goats ☐ 2=Cattle ☐ 3=Sheep ☐ 4=Poultry ☐ 5=Sheep ☐ 6=Rabbits ☐
5.	Varities of pigeon pea grown in Machakos	1=Katumani ☐ 2=”Kat 777” ☐ 3=Mbaazi-1 ☐ 4=Mbaazi ☐ 2 5=Mbaazi ☐ 3 6=Local races ☐
6.	Reasons for growing pigeon peas	1=For consumption ☐ 2=Income generation ☐ 3=For prestige ☐ 4=Both 1&2 ☐
7.	Mode of pigeon peas production	1=Mixed farming ☐ 2=As a single crop ☐
8.	What size of land do you use to produce pigeon peas?	
9.	Quantity produced in the last season in 90-kg sack	
10.	Highest level of production ever realized in sacks	

11.	How long have you been growing pigeon peas in years?	
12.	Are you willing to continue producing pigeon peas in the next five years?	1=Yes ☐ 2=No ☐
13.	If yes (from above) state why	1=Ready food ☐ 2=Potential for higher income ☐ generation3=Others Specify)…….
14.	If no (from above), what is the major reason	1=Lack of good markets ☐ 3= not profitable ☐ 3=Poor production levels ☐ 4=Others (Specify)……..

SECTION C: Marketing

Do you sell pigeon peas? Yes ☐ No ☐

What type of pigeon peas do you sell? 1=Green only ☐ 2=Dry only 3=Both ☐

If green, how many buckets?

If dry, how much do you sell per season? 1=1 90kg-sack ☐ 2=2 sacks ☐ 3=3 sacks ☐ 4=More than 3 sacks ☐

If no, why don't you sell? 1= Produced only for consumption ☐ 2=Low quantities produced ☐ 3=Poor prices ☐ 4=Others specify …….

Do prices vary in different seasons? 1=Yes ☐ 2=No ☐

Which means do you use to access market information?

1=Radio ☐ 2=TV 3=Buyer ☐ =Neighbour ☐ 5=Extension officer ☐ 6=Farmer group ☐ 7=ooperative ☐ 8=Ministry of agriculture offices ☐ 9=News paper

10=Church 11=Mobile phone 12=Internet

Access to information 1=Yes 2=No

Please indicate the extent of usefulness of the information

	1	2	3
Source of information	Not useful	Useful	Very useful
1=Radio			
2=TV			
3=Buyer,			
4=Neighbor			
5=Extension officer			
6=Farmer group			
7=Cooperative			
8=Ministry of agriculture			
9=Newspaper			
10=Church			
11=Mobile phone			

SECTION D: Marketing Channels

Where do you sell your pigeon peas?

1=Direct consumer 2=Rural retailer 3=Rural and urban wholesaler 4=Broker 5=Exporter

Why do you prefer to sell to the buyer (s) selected and level of satisfaction?

Reason	
Better prices	
Reliability of the channel	
Readily available	
Personal relations and conduct	
Communication and information sharing	
Quantity demanded	
Quality demanded	

Rate the level of satisfaction

Reason item	Unsatisfied	Neutral	Satisfied
Better prices			
Reliability of the channel			
Readily available			
Personal relations and conduct			
Communication and information sharing			
Quantity demanded			
Quality demanded			

Who delivers the pigeon peas to the buyer?

1=The producer ☐ 2=The buyer comes to the producer himself or herself ☐

3=Broker ☐ 4=An agent ☐

Do the buyers offer any other services? Yes ☐ No ☐ If yes, what service?

	Reliability of the service		
Service	Not reliable	Neutral	Reliable
Marketing information			
Transport			
Credit			
Others (specify)			

How are the pigeon peas transported to the market?

Mode of transport
Codes ☐
1=Bicycle ☐
2=Motor bike ☐
3=Cart (*mkokoteni*) ☐
4=Donkey ☐
5=Pick up ☐

6=Lorry ☐ 7=Human potters

How often do you sell your pigeon peas?

How often do you go to the market to sell? 1=Daily ☐ 2=Twice per week ☐ 3=Once a week ☐ 4=Once a month ☐ 5=Once in three months ☐ 6=Others, specify……

Do you do the following activities after harvest?

Activity	1=Yes 2=No	If yes, why? 1= For easier storage 2=Fetch better prices 3=To prevent pesticide attack
Splitting (*Kuvua*)		
Sorting		
Grading		

Storage of the pigeon peas

Do you store the crop? Yes ☐ No ☐	If yes, state length of storage 1=1 month ☐ 2=2 months ☐ 3=3 months ☐ 4=More than months ☐	If yes, state why 1=For future consumption ☐ 2=To sell when prices rise ☐ 3=To sell as a group ☐	If yes, state the type of store 1=House store ☐ 2=Wooden/Brick store ☐ 3=Traditional granary ☐

If you do not store, what is the main reason?

Have no storage facility ☐ I sell on harvest ☐

Not enough surplus to store ☐

Fear of loss of produce from pesticides ☐

Theft ☐

I produce on contractual basis ☐

SECTION E: Collective Action

S. No	Question	Indicator
1.	Are you a member of any group?	Yes ☐ 2=No ☐
2.	If yes, how many?	1=1 ☐ 2=2 ☐ 3=More than 2 ☐
3.	Which type of group(s) do you belong?	1=Self-help group ☐ 2=Farmer based organization (FBO) ☐ 3=SACCO ☐ 4=Cooperative ☐ 5=Church group
4.	Year of existence of the group in years	
5.	Do you have specific group for pigeon pea marketing?	1=Yes ☐ 2=No ☐
6.	If yes, where do you sell?	1=Rural retailer ☐ 2=Rural and urban wholesaler ☐ 3=Exporter ☐ 4=Other ☐
5.	Does the group has objectives?	1=Yes ☐ 2=No ☐
6.	If yes, what is the main objective?	1=Improve production ☐ 2=Improve marketing ☐ 3=Pigeon pea marketing ☐ 3=Improve social welfare

7.	What are the activities of the group? (*Tick where appropriate*)	1=Bargaining for better prices ☐ 2=Farmer training ☐ 3=For extension services ☐ 4=Access information ☐ 5= Go for field trips ☐ 6=Welfare activities ☐
8.	Does the group achieve the objectives?	1=Yes ☐ 2=No ☐
9.	If yes, how frequent?	1=Very frequent ☐ 2=Frequent ☐ 3=Not frequent ☐
10.	If No, state why?	1=Non-cooperation from members ☐ 2=Poor access of resources ☐ 3=Conflicts in ideology between members ☐
11.	What is the frequency of the meetings?	1=Weekly ☐ 2=Bi Monthly ☐ 3=Monthly ☐ 4=Quarterly ☐ 5=Annually ☐ 6=More than a year ☐
12.	Frequency of members attending the meetings	1=Very regular ☐ 2=Regular ☐ 3=Not regular ☐
13.	How long have you been in the group?	
14.	Total number of members in the group	
15.	Gender of the majority members	1=Male ☐ 2=Female ☐
16.	How are leaders are elected?	1=Consensus ☐ 2=Election ☐ 4=Nomination ☐ 5=Interviews ☐
17.	Is education level considered in electing leaders?	1=Yes ☐ 2=No ☐
18.	If yes, state the level considered for most leaders	1=Primary ☐ 2=Secondary ☐ 3=Tertiary ☐ 4=University ☐ 5=Not applicable ☐
19.	Is age considered in electing the leaders?	1=Yes ☐ 2=No ☐
20.	If yes, state the average age of the	
	leaders in years	
21.	How long do the leaders stay	

	in office in years?	
22.	Does the group engage in welfare activities?	1=Yes ☐ 2=No ☐
23.	If yes, which ones?	1=Education ☐ 2=Hospital bills ☐ 3=Funeral arrangements ☐ 4=Church activities ☐ 5=Support sick members ☐ 6=Perform cultural activities ☐ 7=Table banking ☐
24.	Do you borrow financial support as an individual group member?	1=Yes ☐ 2=No ☐
25.	State reasons for your borrowing (*Tick where appropriate*)	1=Improve production ☐ 2=Value addition ☐ 3=Improving marketing ☐ 4=personal development ☐ 5=Pay for education from specialists ☐ 6=Attend agricultural field trips ☐
26.	Reasons for borrowing from the group (*Tick where appropriate*)	1=Lower interest rates ☐
		2=High amount of borrowing ☐
		3=No collaterals required ☐
		4=Shorter period of processing ☐
		5=Longer periods of repayment ☐
		6=Fellow Members guarantors ☐

SECTION F: Which of the following social attributes affect the success of the group?

S. No	Social attributes	1=Yes ☐ 2=No ☐
1.	Size of the group	1=Yes ☐ 2=No ☐
2.	Age of group members	1=Yes ☐ 2=No ☐
3.	Sex of the majority of the members	1=Yes ☐ 2=No ☐
4.	Objectives of the group	1=Yes ☐ 2=No ☐

5.	Involvement and responsibility of the group members	1=Yes ☐ 2=No ☐
6.	Group expectation	1=Yes ☐ 2=No ☐
7.	Believes and perceptions of the members	1=Yes ☐ 2=No ☐
8.	Communication to and between the members	1=Yes ☐ 2=No ☐
9.	Cooperation of the members	1=Yes ☐ 2=No ☐
10.	Level of education of the members	1=Yes ☐ 2=No ☐
11.	Corruption in the group	1=Yes ☐ 2=No ☐
12.	Political influence	1=Yes ☐ 2=No ☐

Thank you. Your participation in this survey is highly appreciated.

Key Informant Questionnaire

Date:

Sub county:

Name of key informant:

Introduction:

Good morning/afternoon and welcome to our group discussion session. My name is

Catherine Ndumi Musyoka a masters' student from Jomo Kenyatta University of Agriculture and Technology (JKUAT) studying MSc. in Agricultural and Applied Economics. I am conducting a research in Marketing channels and collective channels in pigeon pea marketing in Machakos County, Kenya. The research helps to understand the critical issues affecting pigeon pea marketing in Machakos county. The information provided will be purely for academic purposes. Feel free to share the information and the issues affecting pigeon pea farmers and marketing in Machakos county.

Theme 1: Pigeon Pea Farming

What are the main activities you are involved in?

What do you do to encourage farmers in farming?

How do you reach the farmers?

How often do you carry out farmer training?

If yes, how often?

Do farmers respond to the call for trainings?

Has there been training on pigeon pea farming?

From your experience and knowledge, what are some of the effective strategies and programs your office has done to support farmers?

What is the main marketing channel for pigeon peas in this region?

What are other marketing channels available in the region?

Are there farmers who sell under contractual basis?

Are there exporters who buy from farmers in the region?

If yes, which companies?

Do they buy randomly or under contractual basis?

Do farmers have farmer groups for pigeon peas?

If yes, how do the groups benefit them?

Has the government done anything to support farmers in improving pigeon pea marketing?

Are there registered groups for marketing?

What are different groups existing in the region?

How do they benefit farmers in farming and marketing?

Are there specific groups for marketing pigeon pea marketing?

If yes, what are the benefits of selling through groups?

What are the advantages of using groups for marketing?

Do you encourage farmers to form groups and do you support them?

What are the main challenges faced by the farmers?

What are the probable solutions to the problems faced by farmers?

Remarks ……

Thank you for your participation