EFFECT OF AGROFORESTRY FRUITS COMMERCIALIZATION ON THE INCOME OF SMALL SCALE FARMERS IN KWALE AND KILIFI COUNTIES, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been submitted in this or any other academic institution for award of any degree.

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Recommendation

This thesis has been submitted with our approval as university supervisors.

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DEDICATION

I dedicate this work to my beloved parents, Mr Nicodemus Mwembe and Mrs Beatrice Mbeyu whose support, compassion and love was a source of inspiration for doing this work.

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ABSTRACT

In the past ten years, Kwale and Kilifi Counties have been hit by adverse climatic changing patterns where small scale farmers have been severely affected. This has resulted to poor agricultural yields as the small scale farmers mainly depend on the deteriorating staple food farming. Agroforestry is seen as the best alternative to boost land productivity and small scale farmers' income. Despite agroforestry interventions by the government and non-governmental organizations as a sustainable land use system, the level of produce commercialization in Kwale and Kilifi counties is still low, while most of the population lives below the poverty line, majority of them being rural households. The main objective of the study is to contribute towards improved livelihood of small holder farmers through commercial agroforestry in Kwale and Kilifi counties. Specifically it was intended to characterize the agroforestry small scale farmers and the existing systems practiced; to determine the factors affecting the choice of agroforestry fruits market outlets, to determine the factors influencing the extent of agroforestry fruits commercialization and its effect on small scale farmers' income in Kwale and Kilifi Counties. Systematic sampling method was used to sample farmers for an ultimate selection of 208 respondents. Data was collected from Kilifi South, Kilifi North and Matuga Sub counties. Respondents were selected in Mtepeni, Junju, Kibarani, Mnarani, Tezo, Watamu wards in Kilifi South and Kilifi North respectively. In Matuga sub county respondents were selected from Tiwi and Tsimba wards. Primary data was collected using semi-structured questionnaires. Descriptive statistics, multivariate probit, household commercialization index, tobit regression and the Cost Benefit Analysis (CBA) analytical techniques were used for data analysis. Majority of the farmers with commercial agroforestry systems chose high value market outlets like town markets while most subsistence farmers sold at farm gate and middle men. Factors that significantly influenced produce commercialization were age, education level, labour hours, land size, farmer group, credit access and market distance. Commercial agroforestry positively impacted small scale farmers' income as indicated by the Cost Benefit Analysis results where farmers who ventured into commercialization had a BCR of 2.7 while farmers with subsistence systems had a BCR of less than 1. The agroforestry small scale farmers are thus encouraged to embrace commercial farming as the benefits outweighed the costs in Kwale and Kilifi Counties. The high transaction costs involved in the commercialization process also needs to be addressed by the relevant stakeholders so as to encourage more agroforestry small farmers enter into market participation.

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LIST OF ABBREVIATIONS

ABD	Agriculture Business Development
ASDSP	Agricultural Sector Development Support Program
FAO	Food and Agriculture Organization of the United Nations
HCDA	Horticultural Crops Development Authority
HCI	Household Commercialization Index
IFAD	International Fund for Agricultural Development
ILO	International Labour Organization
KCIDP	Kilifi County Integrated Development Plan
KCIDP	Kwale County Integrated Development Plan
KIA	Kenya Investment Authority
MGDs	Millennium Development Goals
TIST	The International Small Group and Tree Planting Program
WAC	World Agroforestry Center
WFP	World Food Program

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Nearly two-thirds of people living in developing countries are farm family members who depend on tree resources and small scale agriculture (FAO, 2015). In recent times, agricultural productivity has reduced due to climate change as well as soil degradation due to deforestation. Increasing land degradation and reduced ability of tree resources to provide commodities has resulted in a 15% decrease in agricultural productivity (Gama *et al.*, 2013). This has led to food insecurity as well as reduced incomes for small scale farmers.

Tree resources on farms support economic production and consumption opportunities. However, the resources are depleting at a faster rate resulting in an approximately 51% loss of tree species (World Resources Institute, 2016). The depletion has caused a global concern. The annual tree losses within the tropics alone, is estimated at 15.2 million hectares (FAO, 2010). Large-scale and subsistence agriculture contributes to 40% and 33% of farm tree losses, in the tropics and sub tropics respectively (Himlal *et al*., 2016).

In Kenya, tree clearing is still rampant where land for cultivation is a priority (KFS, 2017). Population pressure, improper government policies and disruption of indigenous traditional land-use management practices, contributed to accelerated tree depletion and loss of biodiversity, (William *et al*., 2007). The continuous clearing of farm tree resources without proper management has resulted to a diminishing stock of tree species. Population growth also generates increased demand for fruits supply, building materials, and fuel wood which are traditionally extracted from trees.

The government of Kenya and development partners have promoted agroforestry to address the increasing dependence on tree resources. Policies and practices relating to tree resources in Kenya have shifted gradually to embrace modern agroforestry practices for substantial land-use (WAC, 2017). Agroforestry is a land use system where trees are grown in association with agricultural crops and livestock in a spatial arrangement (Nair & Garrity, 2012). Agroforestry is an interactive system where both trees and crops give useful outputs to the farmer. There is inter-dependence between the different components of agroforestry. Agroforestry systems strive to maximize

positive interactions between trees and crops while minimizing negative interactions (WAC, 2017). As such, agroforestry offers many benefits which include; diversification of farm revenues, landscape enhancement, soil and stream conservation, crop and livestock protection and promotion of biodiversity.

The 7% tree cover in Kenya is way below the 10% recommended cover by the United Nations (KEFRI, 2016). The impact of deforestation is evident in the Coastal region which supports 17% of Kenyan population (KEFRI, 2016). As a result, rural livelihood problems have increased due to the various pressures on clearing trees for crop and livestock production. Kwale and Kilifi counties have been predominantly known for mango trees production. However, due to the high demand of fuel and building materials the available trees are also diminishing (Okeyo *et al.*, 2010).

Arable land in the two Counties is 56% while the remaining 44% can be utilized under irrigation (KCIDP, 2018). The land is 50% occupied by natural pastures, 21% by subsistence crops production, 2% for commercial production and the remaining 27% with homesteads. Agroforestry trees constitutes only 7% of the subsistence crops land area and 0.5% of the commercial land production area (KCIDP, 2018). This implies that the utilized arable land for agricultural purposes is only 23% which is half of the arable land in Kwale and Kilifi Counties.

The main agroforestry fruits produced in the two counties include; mangoes, coconuts and cashew nuts (KCIDP, 2018). The Coastal and Eastern Kenya account for 70% of the mangoes produced in Kenya (KIA, 2012). Kwale and Kilifi Counties are predominant mango tree producers due to their favourable climatic conditions for tropical fruit growing. The cashew nut and coconut industry in the region have been in a decline since the policy and structural changes regarding the fruits in the 1980's (KCIDP, 2018). On the contrary, mango tree fruits have the highest value chain returns compared to other horticultural commodities in Kenya. They contribute to 56% of the gross income obtained from horticultural commodities at an estimated value of KES 1.7 billion annually (HCDA, 2011).

Kenya is the 8th biggest mango producer globally. However, 40% of the produce is lost due to post harvest handling incapacities and undefined market outlets (KIA, 2012). Kwale and Kilifi Counties increased the area under mango cultivation from 7,863 hectares in 2011 to 9,928 hectares in

2017(KCIDP, 2018). The quantity of mangoes produced increased from 141,505 to 154,229 metric tonnes in that period. The income returns consequently increased from 1.4 to 2.4 billion shillings per annum (KCIDP, 2018). At Kwale and Kilifi Counties the Ngowe variety have a higher market potential. It accounts for 70% of total mangoes produced in the two Counties.

The average annual income per household from agroforestry activities in the two counties conducted in a baseline survey is KES 24,000(KALRO, 2014). The agroforestry farmers are characterized with low commercialization levels of their produce which results to low incomes from the enterprises (KCIDP, 2018). On farm agroforestry activities had the largest proportion of household income followed by livestock rearing activities at 35% and 30% respectively (KALRO, 2014). The average household income in the two Counties from on farm and off farm activities increased from KES 111,023 in 2003 to KES 519,588 per annum in 2017(ASDSP, 2017).

Agroforestry is one of the most important measures for mitigation of food shortages (Nair, 2014). It has the potential to enhance diversification of farm production and increase income generation at the household level. Improved food productivity and crop diversification represent a buffer mechanism against harvest failure due to climate changes and other environmental hazards (FAO, 2010). The trees provide an additional source of subsistence, cash and contribute to crop and livestock production. Such diversification reduces the risk of total economic disaster should the food crop fail, as would be the case if farmers specialized in growing a single food crop. Therefore, understanding local usage of agroforestry trees is essential to come up with easily acceptable commercial farm enterprises in Kwale and Kilifi counties.

1.2 Statement of the problem

A large proportion of Kwale and Kilifi counties is semi-arid. Many of the people living in these counties depend on agriculture as their economic activity with a majority of them being small scale farmers. Due to reduced rainfall and prolonged drought periods, crop and livestock production cannot sustain food availability for most households thus turning to charcoal burning as a compensatory economic activity. Increasing demand for fruits exerts more pressure on the tree resources available. The two Counties cannot sustain the mango fruits all year demand from residents and visiting tourists. The unsatisfied market gap is further enhanced by various socio economic and institutional bottlenecks faced by small scale farmers in accessing potential profitable markets. Despite the government and non-governmental organizations intervening with agroforestry as a sustainable land use practice, commercialization of agroforestry fruits is low and the market outlets for the fruits are still not clearly defined in Kwale and Kilifi Counties.

1.3 Objectives of the study

1.3.1 General Objective

The main objective of the study is to contribute towards improved livelihood of farm families through commercial agroforestry in Kwale and Kilifi Counties.

1.3.2 Specific Objectives

i) To characterize the small scale farmers practicing agroforestry and the existing systems practiced in Kwale and Kilifi Counties.

ii) To determine the factors affecting choice of agroforestry fruits market outlets used by small scale farmers in Kwale and Kilifi Counties.

iii) To determine the factors influencing the extent of agroforestry fruits commercialization and its effect on household incomes in Kwale and Kilifi Counties.

1.4 Research Questions

i. What are the characteristics of agroforestry small scale farmers and the commonly practiced agroforestry systems in Kwale and Kilifi counties?

ii. Which are the factors affecting the choice of agroforestry fruits market outlets by small scale farmers in Kwale and Kilifi Counties?

iii. What are the factors that affect agroforestry fruits commercialization and its effect on household incomes in Kwale and Kilifi counties?

1.5 Justification of the study

Kwale and Kilifi Counties were selected because of favourable tropical climatic conditions for mango tree growing. Due to the increasing demand of mango fruits agroforestry has the potential to cater for these needs. Agroforestry has a huge potential to enhance production sustainability and farm households incomes. It can act as a driver to the achievement of the food and nutrition security goal among Kenya's big four agenda. The study is significant in that it gives insights of the contribution of agroforestry to urban and rural households. The study provides constructive additions to the existing knowledge on the subject where the new focus is on the commercial aspect. It provides baseline information with a potential value in the design of appropriate financial incentives for promoting the wider cultivation of mostly preferred suitable mango tree varieties in Kwale and Kilifi counties and other similar areas. Findings of this research can be utilized by the national and county governments or other researchers who may have an interest in the growth and development of commercial agroforestry as a sustainable land use practice. The government may use the findings to formulate policies focused on farmer capacity building on agroforestry practices as an income generating activity.

1.6 Scope and limitations of the study

This study focuses on the commercial aspect of agroforestry fruits in Kwale and Kilifi Counties. The target population were the mango small scale agroforestry farmers. Despite the fact that agroforestry research has been conducted in Kenya, there is little current research information about commercial agroforestry in Kwale and Kilifi counties. Lack of formal education was a challenge in accurate data capturing from the respondents which was be solved by using enumerators who understood the local languages.

1.7 Operational definition of terms

Agroforestry Refers to the growing of more than ten mango trees by a small scale farmer.

Commercialization Is the volume above 25% of mango fruits that enters the exchange market.

Extension services Refers to the technical knowledge on agroforestry practice offered to farmers.

Household income Refers to the income earned from farm production and off-farm income like salaries and wages.

Small scale/ Smallholder A farmer with less than four acres of land.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of agroforestry

Throughout the world, at one period or another in its history, it has been the practice to cultivate tree species and agricultural crops in intimate combination. According to Zomer *et al*. (2009), trees are found in forty six percent of all agricultural lands. Tree planting on farms is particularly prevalent in Southeast Asia, Central and South America. Tree products derived from agroforestry resources are critical to the livelihoods of approximately 1.4 billion impoverished people in the world (FAO/IFAD/ILO, 2010).

Agroforestry produces a variety of commodities and services. These include food, medicine, shelter, fruits, fodder and fuel wood (ICRAF, 2009). Little of these however enters the exchange market due to various constraints. Planting trees in agricultural lands is relatively efficient and cost effective compared to other tree production strategies. It provides a range of co-benefits important for improved farm family livelihoods and agricultural profitability, (FAO, 2010). In Utange Mombasa, farmers grow maize, mango and pawpaw trees on the same farmland (Jaetzlod *et al*., 2012). There is however very few fruit processing industries in the region where demand is high both from the locals and visiting tourists.

Agroforestry systems are practiced in many forms. The commonly practiced forms include; home gardens, shelterbelts, alley cropping, mixed cropping, tree apiculture and Taungya (Nair *et al.*, 2012). KFS (2017) indicates that in Busia County Kenya, farmers have planted *Sesbania sesban* on terraces to control soil erosion, provide fuel wood and income. In Kwale and Kilifi Counties traditional ‘Kayas’, sacred ‘grooves’ and ‘shrines’ were located in trees (Githitho, 2004). Elders decided how the Kaya trees could be used and which trees could be cut (Matiku, 2005). Restrictions on cutting trees were stipulated in customary tenure rights. Customary laws and beliefs are however diminishing under the pressure of modernization. Therefore, there is need to appraise the problem from a modern perspective.

Practicing agroforestry by farmers requires knowhow on several factors. Farmers attitude, believes and education level have a significant influence on practicing agroforestry (Erick *et al.,* 2015). According to Endrias *et al.* (2013), farm size and labour availability have a positive effect on farmers embracing agroforestry. In most of the Kenyan communities trees belong to men irrespective of who plants them (FAO, 2015). Among some localities in Kwale and Kilifi Counties women are not allowed to plant trees as it is seen as an act of land ownership (Chemuku *et al.,* 2017).

The initial research purpose stressed priority in tropical forestry (Daniel *et al.,* 2014). However, emphasis should be given to combined production systems which would integrate trees and food crops in order to optimize farm land use. A combination of the systems will have both an immediate and long term food and income impact to farmers. Factors that affect spread of agroforestry systems differ across countries (Alberto *et al*., 2017). The emphasis is thus for studies that are location specific in examining factors affecting agroforestry practice by farmers.

Practicing of agroforestry technologies is correlated to investment decisions on the farm. The profit motive plays an important role in the investment decision. Projected profitability is singled out as the fundamental factor influencing the undertaking of agroforestry technologies (Endrias *et al*., 2013). However, most rural households in Kwale and Kilifi Counties do not keep any financial records of their agroforestry ventures.

2.2 Classification of agroforestry systems

Agroforestry systems are mainly classified under the structure, function and the socio economic scale.

2.2.1 Structural classification of agroforestry systems

Agroforestry can be classified into three major systems which are agrisilvicultural systems, silvopastoral systems and agrosilvopastoral systems (Nair, 2012). The agrisilvicultural system entails the combination of growing agricultural crops and trees on the same farm land. The farmer thus finds a way to incorporate both perennial trees and annual herbaceous crops which results to a symbiotic benefits relationship between the two enterprises. This system is most prevalent at the South Coast of Kwale and Kilifi Counties where farmers usually plant mango trees among cassava and maize crops.

Silvopastoral systems involves the integration of trees, pasture and livestock production by the producer in the same piece of land (Nair, 2012). The farmer uses the cut and carry harvesting method to feed the livestock when the trees are still young. This method thus protects the trees from being spoiled by the livestock until they mature. When the trees have finally matured the farmer can now use the open-grazing method livestock. The animals can benefit from the shade provided by the grown trees during sunny days. The system is mainly practiced in the northern hinterland of Kwale and Kilifi Counties because the area is mostly semi-arid thus suitable for livestock rearing.

Agrosilvopastoral system is a three unit structure which include the tree-crop-livestock unit. The farmer divides his land to accommodate all the three enterprises. With such a system the farmer benefits from the manure produced by the animals and uses it as fertilizer for the trees and crops planted. Such systems are mainly characterized by home gardens where the farmer has a combination of all the units in his farm land (Muriisa, 2017). However, majority of the households in Kwale and Kilifi Counties do not take home gardening as serious commercial enterprises as they only practice it for their subsistence consumption.

2.2.2 Functional classification of agroforestry systems

Agroforestry systems can be classified into the production and sustainability functions. This means that agroforestry systems have a productive role as well as a service role of maintaining production systems. Land-use systems, can be described in terms of its product outputs like energy, shelter, food, and cash, (FAO, 2010). The function of the trees will thus be mainly for producing the desired commodities by the farmer.

The service roles of trees is also taken as a factor contributing to the production of agroforestry outputs. Services offered by trees such as soil fertility maintenance necessitates the sustainability of crop production. Although output production is crucial when undertaking agroforestry, it is the sustainability characteristic which makes it important compared to other land use approaches (ICRAF, 2009). Furthermore, agroforestry systems produce more than one output from the various combined enterprises. Agroforestry systems thus combine the productive and service functions in varying degrees. The agroforestry system can either have a service or productive function depending on the relative dominance of its serving role.

2.2.3 Socio-economic classification of agroforestry systems

Agroforestry systems are grouped into commercial, intermediate and subsistence systems (Edmund *et al*., 2012). Scale of production, level of technology applied and management are used as a socio-economic criteria for classifying agroforestry systems. Commercial agroforestry is where output production is mainly for sale. A good example in Kwale and Kilifi Counties is the planting of mango trees mainly for fruits selling (Mwakio *et al*., 2017). These fruits however are taken mostly when fresh and highly susceptible to perishability due to lack of proper storage facilities. Farmers are thus unable to tap the lucrative market potential fostered by the hot climate which requires an all year supply of fresh fruits.

Intermediate agroforestry systems prevail where the owner produces both for commercial and subsistence use. The cash crops cater for the farmer's family cash needs while the subsistence crops provide daily food needs to the household's members. Most of the agroforestry systems in developing countries can be grouped as intermediate systems (FAO, 2010). This is because most small scale farmers do not have enough land to purely practice commercial plantation agroforestry systems.

Subsistence agroforestry systems are practiced where the farmer is mainly focused in meeting the household's basic needs (FAO, 2010). The family members are usually the providers of labour. In case of surplus produce of commodities, the farmer sells to the nearby market to supplement the family needs. The level of agroforestry fruits commercialization in Kwale and Kilifi Counties is, however, not well established in most rural households.

2.3 Agroforestry systems methods

The commonly practiced agroforestry methods include; alley cropping, improved fallows, home gardens, growing multipurpose trees and shrubs, boundary planting, farm woodlots, orchards, shelterbelt, fodder banks, conservation hedges, live fences, tree apiculture, mixed cropping and taungya (Nair, 2012). This study focused on alley cropping and mixed cropping agroforestry system practices.

2.3.1 Alley cropping

Alley cropping is the growing of trees in rows while growing crops between the trees rows, (Rahman *et al*., 2009). The spacing between the rows should be designed to accommodate the mature size of the trees while leaving room for the planned alley crops. According to a study done

by TIST (2011), a spacing of at least 5m between rows of mango trees is recommended. When the farmer is planting sun-loving crops like maize the alleyways need to be wide enough to let in plenty of light when the trees have matured (Rahman *et al*., 2009).

Alternatively the farmer can plan to change the cropping sequence as the trees grows. This is because as the trees grow they decrease light availability to the crops. When the trees are still small the farmer can utilize sun loving crops like maize. As the trees grow big and the canopy closes the farmer can now practice vegetable farming which requires less sunlight. To balance the trade-offs between the trees and crops, careful planning and skillful management is required from the farmer (Rahman *et al*., 2009). In alley cropping agroforestry system a cut- and- carry livestock feeding system is the better management practice than grazing as it allows the farmer to maintain the security of the crops.

Due to favourable conditions for mango trees growing in Kwale and Kilifi Counties alley cropping can be farmer beneficial (KCIDP, 2018). This is because the indigenous Ngowe mango variety trees grow tall enough to provide the required sun shine to the maize and cassava crops which are the main staples. Other big canopy mango tree species like the dwarf variety can be utilized with vegetable farming to provide shade to the vegetables. To balance the trade-offs between the trees and crops careful planning and skillful management is required from the farmer.

Alley cropping practice in the two Counties helps to diversify farm income, boost crop yields and provide crop protection. Common examples of alley cropping plantings include mango trees in between food crops (Craig *et al*., 2018). Pruning of the trees should be done regularly where the pruned leaves can be added to the soil to improve soil fertility. In drier areas a spacing of 7m between tree rows is required to reduce nutrients and water competition between trees and crops (TIST, 2011). This thus will enable the northern drier parts of the two Counties to effectively practice the technology.

2.3.2 Mixed Cropping

Mixed cropping refers to the management of multipurpose trees in association with annual crops on the farmer's garden. According to Muriisa (2017), most farms are systems consisting of herbaceous crops and woody perennials. It encompasses the crop-tree unit land use practice within the farmer's farmland intensively managed by the farmer's family labour. The intimate mix of

diversified agricultural crops and multipurpose trees fulfils most of the fundamental needs of the farmer's needs (Muriisa, 2017).

Mixed cropping aids in avoiding soil fertility deterioration due to mono cropping farming systems (Muriisa, 2017). It produces sustained yields in a resource-efficient way as the labour costs are covered from within the family members. Thus mixed cropping is an economically efficient, ecologically sound and biologically sustainable agroforestry system.

A vital characteristic of food production in mixed gardening is the maintenance of an almost continuous production throughout the year from the unit (ICRAF, 2009). The crops combination with different production cycles is such that an uninterrupted supply of produce is maintained. However, mixed gardening is often overlooked as an important source of food security and income generation in Kwale and Kilifi Counties. Most of this production is for home consumption thus a gap existing in form of the untapped commercial potential where in high produce seasons the surplus can be marketed.

2.4 Agroforestry commercialization concept

Agroforestry commercialization is the percentage of output produced sold to the targeted market. It is the transition from subsistence to commercial oriented agriculture by small scale farmers. According to Siziba *et al*. (2011), smallholder farmers' participation in commercial agricultural markets is still low in Sub Saharan Africa despite researchers advocating for it. According to Rostow's economic development model agriculture is subdivided into the subsistence, semi-subsistence and commercialized stages (Rostow, 1959). Most of the farmers in Kwale and Kilifi Counties fall in the second stage where they produce for home consumption and sell the surplus. Upgrading to the third level is thus of paramount importance to increase small scale farmers income.

Small scale farmers' commercialization is not necessarily linked to transformation of producing of high value cash crops (Oya, 2017). Introducing long term agricultural crops like fruit trees in the farm lands can be termed as commercial oriented agriculture. For many years locals in Kwale and Kilifi Counties have been relying on the maize crop which is now deteriorating due to climate change. This has thus negatively affected the income levels and food security of small scale farmers in the region. According to Hailua *et al.* (2015), a lot of studies on commercialization of agricultural crops have positively influenced farmers' income. Increasing small scale farmers'

food production and incomes is one of the major challenges Sub-Saharan countries are facing (WAC, 2017). Agroforestry fruits can act as a buffer to boost small scale farmers' income in the region which is projected to increase when the farmers diversify their production systems.

Fruit tree production have been widely adopted in most developing countries (Folaranmi, 2009). The targeted trees in this study are mango trees. The fruits can be value added in form of fruit cleaning, sorting and grading for a higher market value. The challenges that arise in most developing countries is unpredictability of fruit harvest seasons, poor infrastructure for market access and low technical skills among smallholder farmers (Folaranmi, 2015). However, commercialization of mango fruits have a huge potential to improve small scale farmers income in developing countries.

2.5 Effect of agroforestry commercialization

Agricultural commercialization is an important driver for alleviation of rural households' poverty in developing countries (Aragie *et al.,* 2014). According to Okezie (2012), the effect of agricultural commercialization is categorized into three orders where the first is immediate effect on household incomes. The second effect is on improvement of health and nutrition levels of households due to increased incomes. The third is on the macro-economic level where it can result to positive or negative economic effects to the country. According to Jamnadass *et al.* (2011), agroforestry commercialization stimulates commodities diversity in the market.

Agroforestry fruits not produced for home consumption stimulate trade between farm households and other market participants (Cheikh *et al.,* 2014). Agroforestry commercialization thus improves the link between the input and output markets. The input providers comprise of agrovet dealers and extension officers whereas the output side comprises of the local, urban and regional markets. At the macro level, commercialization of agroforestry fruits can result to infrastructural development which facilitates smooth trading between market participants.

In order to compare the incomes between commercialized and non-commercialized sugar households in a Western Kenya study, descriptive statistics was employed (Kennedy *et al.,* 1987). The results revealed that commercialized farmers had higher incomes thus more able to spend on non-food expenditures as compared to the non-commercialized farmers. However, this study did not factor in the costs associated with commercializing agriculture. A comparative analysis study on the effect of agricultural produce commercialization on the per capita income of small scale

farmers in Kenya was conducted (Von Braun, 1995). The Ordinary Least Squares method was used to analyze the factors affecting per capita income among the selected households. The outcome revealed that commercialization contributed to higher per capita incomes among households thus significantly reducing rural poverty. However this study did not take into consideration the determinants of commercialization. It assumed that commercialized and non-commercialized farmers had the same characteristics which is not usually the case.

Commercialization of agroforestry produce has spillover effects to both locals and the surrounding external environment (Ruth *et al*., 2017). As a result of trade, institutions like banks and micro finance providers have to come in place to facilitate trade through provision of credit and banking of surplus cash. Such institutions won't be limited to the farmers practicing commercial agroforestry only but used by other people within the region.

2.6 Market nature of agroforestry fruits

Agroforestry fruits trade has been going on for centuries (Shomkegh *et al*., 2016). In the developing countries most small scale farmers have been introduced into agroforestry without consideration of their target markets. This is in contrast with industrialized countries where agroforestry extension is focused on markets of the fruits (Andre *et al*., 2017). Linking farmers to potential markets is thus of paramount importance to unlock the benefits of agroforestry.

In Kenya the gap between farmers, extension officers and policy makers is so wide thus limiting tapping of the economic potential of agroforestry fruits (Palapala *et al*., 2016). Most of the extension officers are knowledgeable on the scientific propagation of trees but lack marketing expertise of the produce (Palapala *et al*., 2016). The farmers thus lack basic knowledge to fully realize the economic potential of agroforestry. This implies that for improvement of smallholders' incomes through agroforestry capacity building, value addition and profitable marketing strategies have to be fully explored in Kenya.

Agroforestry markets in Africa are characterized by asymmetric information, producer limited market power and high transaction costs (IFPRI, 2017). The technical and institutional factors of marketing have not been fully taken into consideration (IFPRI, 2017). Due to the small scale nature of farmers in Kwale and Kilifi Counties the cost of meeting standardization for global markets is high. Striving to achieve the unfulfilled local and international markets should thus be of focus to agroforestry related stakeholders.

A study on the determinants of market participation among small scale farmers was conducted in Kenya (Omiti *et al*., 2009). The study used a truncated regression by not factoring in the farmers who did not participate in produce selling. The results showed that low commercialization among rural households was due to market failures mainly being high transaction costs. Small scale farmers would thus prefer venturing into food crops producing rather than speculating on commercial crops farming due to the uncertainty involved. However, the study did not consider the effect of group marketing in tackling the high transaction costs barrier.

Another study in analyzing the factors affecting commercialization by small scale farmers and its impact on rural households' welfare was conducted in Kenya (Mathenge *et al*., 2010). The double hurdle model was used in analyzing the decision to participate and output sold in the market. The results showed that majority of the households which sold a high proportion of their produce exited poverty. The fact that most rural households in Kwale and Kilifi Counties produce for subsistence consumption, orientation to commercial farming can help to boost small scale farmers' income and reduce poverty.

2.6.1 Mango agroforestry and the main market actors in Kenya

Kenya produces 581,290 tonnes of mangoes under an area of 47,000 hectares a year (HCDA, 2011). The mango tree does well in arid and semi-arid regions. Kenya has one of the longest mango seasons from November to February which is the high season. The Coastal region has the advantage of another mango short season from June to August (Owuor, 2015). According to Njuguna *et al*. (2012), improved grafted mango varieties have become important nutritious cash crops in the Kenyan semi-arid regions.

In Kenya, 98% of the mangoes produced are domestically consumed while the remaining 2% finding its way to the export markets (Msabeni *et al.,* 2010). The average price of mangoes per kilogram in Kwale and Kilifi Counties is KES 30 (KCIDP, 2018). An approximate revenue of KES 150 million is obtained from the exported produce annually (Msabeni *et al.,* 2010). Most of the farmers in Kwale and Kilifi Counties rely on informal networks to obtain market information thus at a risk of getting incorrect information. Better market information enables farmers to target the most profitable markets thus boosting their profits (Adijah *et al*., 2012). Enabling mango farmers to meet the required quality standards in the international market is of paramount importance to increase small scale farmers' revenue.

Export of tropical fruits from Sub Saharan developing countries created a revenue of 12.8 billion dollars (FAO, 2015). However, majority of small scale farmers are excluded from the value chain due to low economies of scale, insufficient market information and poor market linkages (FAO, 2015). Even the emergence of supermarkets as key buyers of horticultural produce, small scale farmers still find themselves unable to meet the minimum requirements for produce supply. The market outlets in Kenya consist of many players thus making them inefficient to producer needs (GoK, 2010). The inefficiency of the market outlets hits hard on farmers during the glut production seasons where the commodity is produced in plenty by farmers as they have to sell their produce at lower prices.

The main market outlets of the mango produce in Kwale and Kilifi Counties are through; direct farm gate selling, middlemen, local retail markets and town markets (HCDA, 2011). Under the direct selling farmers sell their produce to local customers, rural retailers and urban traders. In the second outlet middle men walk from farm to farm buying the fruits from the various farmers. The middle men use their own transport means to fetch the produce. The mango market outlets are largely dominated by brokers (HCDA, 2011). Farmers use their own means of transport to access the rural retail and town markets. In the processors and exporters market outlets, the buyers establish commodity supply contracts with farmers which bounds them to supply after certain durations (HCDA, 2011). However, in Kwale and Kilifi Counties majority of the mango farmers are small scale producers thus not able to abide with the terms and conditions required in these two market outlets.

Due to the advantage of having two mango seasons Kenya has the advantage of supplying its international markets when the other main mango producers like India and Pakistan are off season (Panda & Sreekumar, 2012). However, due to the sanitary and quality specifications in this markets very few producers access them. Many farmers in Kwale and Kilifi Counties thus sell their produce in the local markets with main being the Kongowea market in Mombasa. Transport costs are usually high due to the sensitive nature of the mangoes to physical injuries and environmental influences. Most farmers ferry their produce in old sacks which affect the quality of the commodity thus reducing its market price (Korir *et al*., 2013). Producer marketing groups have the potential to coordinate farmers to profitable markets at lower transaction costs. However, most mango

farmers' in Kwale and Kilifi Counties are not organized into any farmer groups and market their produce individually.

2.7 Theoretical Framework

The study is based on the theory of the farm household and the utility theory of maximization.

2.7.1 Theory of the farm household

The study bases in th**e** theory of the farm household behavior as it gives a clear understanding of the determinants of farm production and consumption by the respective household. The farm household is both a production and consumption unit as part of the commodities produced is consumed while part of it is sold to meet the daily financial requirements of the household. In developing countries the farm household is tasked with continually adapting to the changing external environment which has an influence on the farmer's decisions (Mendola, 2007).

Due to market imperfections in low income countries the household's production, consumption and labour allocation decisions are inseparable (Kamel, 2014). The farm household has to work with not well defined developing markets which are basically disconnected across time and location. The theory thus gives the insights of the farm household response to the environment in terms of production, consumption and labour allocation.

According to Mendola (2007), the farm household is a rational enterprise which makes production decisions with the sole purpose of maximizing profits. However, in the case of market imperfections the farm household is assumed to sacrifice expected profit for its own food security. This is because for rural farm households the risk management to participate in commercialization is in most cases very costly. The rural farm household is therefore tasked with a choice between utility maximization, profit maximization and risk aversion.

2.7.2 Utility Maximization Theory

The study settled on the utility maximization theory as it focuses both on the production and consumption objectives of the household. The utility theory is based on the assumption that farmers' decision to select a particular choice is based on maximum satisfaction attained. Rational individuals are assumed to be profit driven. According to Keith (2018), the utility maximization theory is a preference based approach in terms of how an individual makes choices in undertaking a particular decision. The Utility maximization theory allocates numerical ranking to each possible

choice. For instance, if there are y alternatives ranked in order from the first to the last, an individual assigns 0 to the worst choice utility, 1 to the next better utility and so on.

Letting $X_{i,}\ i = 0,1,2,3....n$ factors then the utility function of an individual is satisfied by 1 to n factors. $U = f(X_1, X_2, X_3, \ldots\ldots X_n)$ (1)

Where X is the alternative chosen by a particular household. The household head chooses one alternative, X_1 to X_n based on the maximum profit attained.

Farm households are both producers and consumers of their own agricultural produce. Production is influenced by consumption expenditures thus decision on choosing a particular system has to meet the profit and utility satisfaction motive. Utility is derived from the household's consumption of goods and the profitability of produce sale.

The utility maximization model of the household is based in the expected value of the non-observable underlying utility function that ranks the preference of the *ith* household according to the selected agricultural system. The non-observable underlying utility function can be represented by:

$E[\ U_{it}(S_i, M_i, F_i,\ L_i)\ T_i$ (2)

Where *E* refers to the expectations operator,

t represents the technology choice,

The agricultural system is chosen by the farmer (*t = 1* when agroforestry commercialization is practiced and *t = 0* when agroforestry commercialization is not practiced),

i represents the farm household.

Utility (U_i) is derived from the observable farm and household characteristics. Where;

S represents farm size,

M stands for market distance,

F stands for family size, age, off farm income, educational level of the household heads and the observable technology characteristics,

L represents labour and

T standing for land tenure characteristics and access to credit.

The farm household opts between,

$E[U_i 1]$ and $E[U_i 2]$ (3)

Where E [U_i1] stands for alley cropping and

E [U_i2] represents mixed cropping.

The household decision maker normally has the knowledge of his/her utility function but the researcher is usually not aware of the exact form. Train (2003) therefore came up with the term representative utility. The farmer chooses an alternative,

$$U_{iw} > U_{jw} \quad \forall \quad j \neq i \tag{4}$$

Where j and i are different choices from the choice set C_w and w is the household's decision maker. The Probit and Logit models are usually used to analyze such decisions which comprise two mutually exclusive alternatives (Gujarati, 2007).

Since there are certain things of a decision maker's utility function that the researcher does not know Train introduces the representative utility function,

$$V_{jw} = V(X_{jw}, S_w) \tag{5}$$

Where X_{jw} are attributes of the alternatives and

S_w are attributes of the decision maker.

The fact that V depends on the characteristics the researcher doesn't know it is sensible that,

$$V_{jw} \neq U_{jw} \tag{6}$$

Utility can be thus decomposed as, $U_{jw} = V_{jw} + \varepsilon_{jw}$ (7)

Where ε_{jw} constitute the factors that affect utility but are unknown to the researcher. They are thus not included in V_{jw}.

ε_{jw} is the difference between U_{jw} and V_{jw}. It can be taken as an error term.

If the household head decides to choose the alternative i then the probability will be,

$$P_{iw} = P_r\,(\varepsilon_{iw} - \varepsilon_{jw} < V_{iw} - V_{jw}) \quad \forall \quad j \neq i \tag{8}$$

i = 1 if the statement is true i.e the farmer will practice a particular agroforestry technology and i = 0 if the farmer wont choose it.

The probability that the household undertakes a particular agroforestry system is a function of the independent variables and the utility achieved.

$$P_{iw} = F(X_{iw}) + U_{iw} + \varepsilon_{iw} \tag{9}$$

The linear reduced form of the equation is thus:

$$Y = B_0 + \sum (B_{iw} X_{iw} + B_{jw} X_{jw} + U_{iw}) + \varepsilon \quad (10)$$

Where Y is the income from AF, B_0 is the intercept term, B_{iw} and B_{jw} are the parameters to be estimated, X_{iw} and X_{jw} are the independent variables that influence income from agroforestry. U_{jw} is the utility achieved from the chosen enterprise.

2.8 Conceptual Framework

The conceptual framework shows the relationship between the variables in the study. It shows how the socio economic, institutional and intervening variables affect the agroforestry system practiced, the quantity of agroforestry commodities produced, the level of agroforestry produce commercialized and the market outlet selected. The quantity of commercialized produce will also be influenced by intervening factors like government trade policies. If the policies are favourable like low tax rates to agroforestry products it will increase the level of quantity commercialized. The agroforestry quantity level sold will determine the market outlet selected. The price offered by the market outlet selected will influence the household income of small scale farmers.

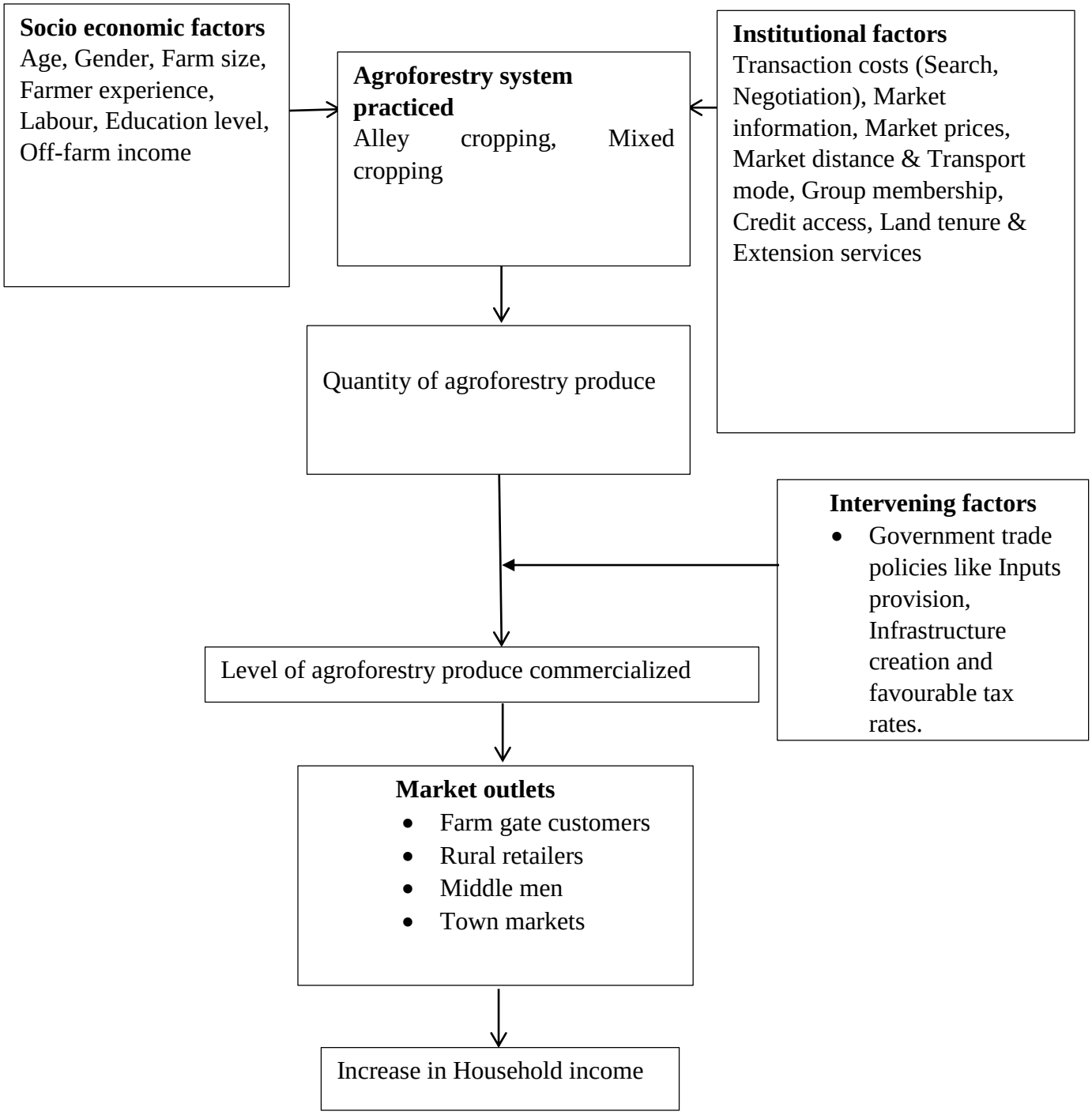

Figure 1: Conceptual framework

CHAPTER THREE

METHODLOGY

3.1 Description of the study area

The study was conducted in Kwale and Kilifi counties in Kenya. They border the Indian Ocean sea line in the south and the Lamu, Tana River and Taita Taveta counties respectively in the north. Kwale County lies between a longitude of 39º 27º and 6º 74º, and a latitude of 4º 10º and 27º 98º South. Kilifi county lies between a longitude of 39º05º and 40º 14º East, and a latitude of 2º20º and 4º0º South.

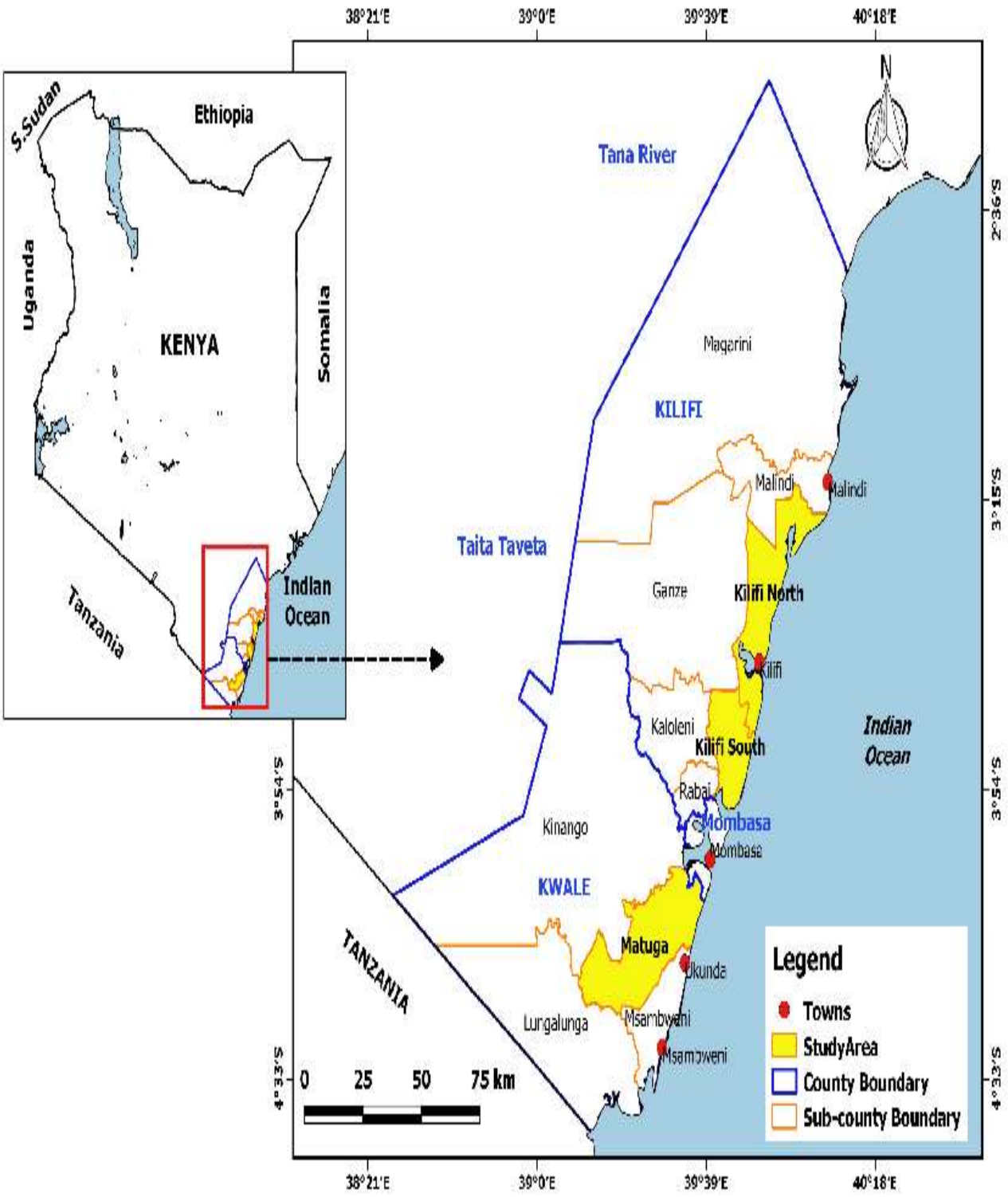

Figure 2: Map of the study area

Source: Geography Department, Egerton University

The two counties have a total area of 20,880Km^2.Total population of people in the study area according to the Population and Housing Census (2019) is 866,820 and 1,443,787 in Kwale and Kilifi Counties respectively. It has a total of eleven sub counties with Msambweni, Matuga, Kinango and Lunga Lunga sub counties found in Kwale. Kilifi North, Kilifi South,Ganze, Malindi, Magarini, Rabai and Kaloleni sub counties are located in Kilifi County.

The South Coastal belt receives an annual rainfall of between 800mm-1600mm while the northern drier parts of the two counties receives between 300mm-800mm per year. The annual temperature in the region is between 21^{o}C and 30^{o}C in the South Coast belt and between 30^{o}C and 34^{o}C in the northern parts. The main vegetation in the area is the savannah woodlands where drought resistant shrubs survive. Majority of the households practice agriculture for subsistence consumption with a few farmers who venture into cash crop farming. The main perennial crops grown are mango and coconut trees.

3.2 Research design

The study implemented a cross-sectional household survey to obtain data. This thus allowed collection of primary data.

3.3 Population of the study and the respondents

The targeted population for the study were the agroforestry small scale farmers in Kwale and Kilifi Counties. The respondents of the study were subsistence practicing small scale agroforestry farmers and those who had commercial enterprises.

3.4 Sampling procedure and sample size

The study used the systematic sampling approach in selection of the respondents. Kwale and Kilifi counties were chosen because of the favourable tropical climatic conditions for mango trees growing. Samples were purposively drawn from three sub counties namely; Kilifi North, Kilifi South and Matuga because mango farming is prevalently practiced in the selected sub counties. The wards were randomly selected from the chosen Sub Counties. Systematic sampling was used to select farmers from the list given by the Ward Agricultural Officers. The y^{th} farmer is chosen where y is the sampling interval.

It is calculated as $y = \frac{N}{n}$. (11)

Where n is the sample size and N is the population size. Each farmer in the population thus had an equal probability to be selected.

The targeted sample size was determined using a formula by Cochran (1963).

$$n = \frac{pq(Z^2)}{e^2} \quad (12)$$

Where n = Sample size p = 0.5 is the maximum possible proportion of agroforestry farmers in the study area,

q = 1-0.5 = 0.5 therefore pq produces the maximum sample size,

Z = 1.96 (value for the selected alpha level at 95% confidence level and e= 6.8% (acceptable margin of error).

The sample size for the targeted farmers was;

$$n = 0.5 \times 0.5 \times \frac{(1.96)^2}{0.068^2} = 208 \quad (13)$$

Table 4: Sample distribution

County	Sub County	Wards	Sample size
Kilifi	Kilifi South	Mtepeni	26
		Junju	26
	Kilifi North	Kibarani	13
		Mnarani	13
		Tezo	13
		Watamu	13
Kwale	Matuga	Tiwi	52
		Tsimba	52
Total			**208**

3.5 Data collection

Data was collected using semi-structured questionnaires administered on a face to face method to the selected respondents. Both open and closed ended questions were administered to aid in getting the relevant information required. Questions asked in the questionnaires were based on the study variables which included; agroforestry systems practiced, quantity sold, target markets, land tenure, land size, education, annual income and the commercialization extent. A questionnaire pretest was conducted to test the validity of the tool before commencing with the collection exercise.

3.6 Data analysis

The primary data collected from respondents was first examined to ensure that it is was completely filled. It was then cleaned, organized and analyzed using SPSS, STATA and Ms EXCEL.

3.6.1Objective one: To characterize the small scale farmers practicing agroforestry and the existing systems practiced in Kwale and Kilifi Counties.

Descriptive statistics like measures of central tendencies such as means and percentages were used to analyze the common agroforestry systems practiced and the socio economic characteristics of small scale farmers in the study area.

3.6.2Objective two: To determine the factors affecting choice of agroforestry fruits market outlets used by small scale farmers in Kwale and Kilifi Counties.

Multivariate Probit regression model

The Multivariate probit regression model was used to analyze the second objective. According to Gumataw *et al*. (2016), the Multinomial Logit Model is appropriate when one is choosing a single alternative from a set of mutually exclusive alternatives. It assumes the choices are independent of each other which means that it does not allow for correlation among the alternatives. However, in this study the market outlets are not mutually exclusive. There exists a possibility of simultaneous market outlets choices in farmers' decision making. Since the agroforestry fruits can be sold in rural, urban and export markets the farmers are forced to choose more than one outlet simultaneously.

The Multivariate regression model simultaneously estimates the influence of explanatory variables on one or more than one dependent variables while allowing for free correlation of the error terms (Belderbos *et al*., 2004). The decision of the farmer to supply produce to market A will affect the

amount of produce supplied to the other market outlets. The dependent variable is represented as 1 (if a market outlet is chosen) or 0 (if not chosen).The farmer selects a market outlet depending upon the profit and level of utility achieved. The market outlet with an expected higher level of utility compared to the others is chosen by the farmer.

The ith farmer is faced with $i = (1,2,....n)$ options of whether to choose or not a market outlet. Letting U_o be the expected utility obtained by the farmer who chooses the N^{th} marketing channel while U_n representing the actual utility the farmer obtains by choosing the N^{th} market outlet.

Where N can be choice of Farm gate customers $(Y1)$, Middlemen $(Y2)$, Rural retail markets $(Y3)$ and Town markets $(Y4)$. The farmer decides to choose the N^{th} marketing channel if

$$Y_{in}^{*} = U_{in}^{*} - U_0 > 0 \qquad (14)$$

The benefit that the farmer obtains from choosing a particular market outlet is a latent variable determined by the observed independent variables (X_i) and the error term (e_i).

$$Y_{in}^{*} = B_{in} X_{in} + e_i \quad (n = YI, Y2, Y3, Y4) \qquad (15)$$

Where Y are the different market outlets, B_{in} is a vector of the parameter to be estimated and n represents a different utility level.

The observed selection outcome for mango fruits market outlet is modelled as follows,

$$y_{in} = \begin{cases} 1 if\ Y_{in}* \rangle 0 \\ 0 \quad otherwise \end{cases} (Y1, Y2, Y3, Y4) \qquad (16)$$

Where,

$Y_{in} = 1$ if the farmer chooses farm gate customers, 0 otherwise

Y_{in} =2if the farmer chooses middle men, 0 otherwise,

Y_{in} =3 if the farmer chooses rural retail markets, 0 otherwise and

Y_{in} =4 if the farmer chooses town markets, 0 otherwise.

Table 5: Description of variables for the determinants of market outlet choice

Variable	Variable description	Units of measurement	Expected sign
Dependent Variable			
MktOutl	Market outlet	1= Participating, 0= Otherwise	
Gender	Sex	1=Male 0=Female	+/-
QtyP	Quantity produced	Currency KES	+/-
Trns C	Transport cost	Currency KES	-
Mktdis	Market distance	In Kilometers	+/-
Cred	Credit borrowing	Dummy 1=Yes, 0=No	+
Exp	Farmer experience	No. of yrs in farming	+/-
Edu	Education	1=No formal education, 2=Primary, 3=Secondary, 4=Tertiary	+
Off-frm	Non-farm income	Currency in KES	+/-
Prc	Market Price of produce	Currency in KES	+/-
NgC	Negotiation costs	Currency in KES	+/-
SrC	Search costs	Currency in KES	+/-
Age	Age	No. of yrs	+/-

3.6.3 Objective three: To determine the factors influencing the extent of agroforestry fruits commercialization and its effect on household incomes in Kwale and Kilifi Counties.

Household Commercialization Index

The Household Commercialization Index (HCI) was used to measure the extent of commercialization at household level. A study conducted in Ethiopia used sales to output and sales to income ratios in measuring determinants of smallholder commercialization (Gebre-Madhin *et al*., 2012). This study used the HCI as it only focused on the agroforestry produce sales thus knowing the exact commercialized ratio of the produce. It is a ratio of the gross value of all agroforestry produce sales per household annually to the gross value of all agroforestry production. It measures the level to which a household sells its produce to the market. The HCI is calculated as;

$$\text{HCI}=\frac{\text{Gross value of agroforestry sales by } ith \text{ household in year } b}{Gross\ value\ of\ all\ agroforestry\ produce\ by\ ith\ household\ in\ year\ b} \quad (17)$$

Where HCI_i represents the level of the *ith* household's commercialization extent.

The index takes values of between 0 and 1. If the index is zero it implies that the household is wholly subsistence oriented. If the index is closer to 1 it implies that the household has a higher degree of commercialization.

The tobit model was used to analyze the determinants of agroforestry commercialization. It was introduced to describe the relationship between a non-negative dependent variable and a set of independent variables (James, 1958). It assumes that the dependent variable has to be above or below some cut level that is left or right censoring. The Tobit model is a censored regression where there is a considered threshold. Some studies have used the Ordinary Least Square method to analyze this objective. However, the OLS gives inconsistent results of the parameters when the variables are censored thus not reflecting the true population parameters. The Tobit was used to overcome the limitations of the OLS. A similar study conducted in Zimbabwe used the Tobit regression to analyze determinants of small holder agricultural commercialization (Lighton *et al*., 2016). It is specified as;

$$y^* = x_i B + \varepsilon_i$$

$$y_i = y_i^* \quad if\ y_i^* > c_i$$

$$y_i = 0 \quad if\ y_i^* \leq c_i \quad (18)$$

Where y_i^* represents the latent dependent variable,

y_i represents the observed dependent variable,

x_i is the vector of the independent variables vector and

ε_i represents the normally distributed error term with a mean of zero and constant variance σ^2

c_i is the commercialization threshold

The values of X_{is} were translated into a probability that ranges from 0 to 1 to allow estimation between the independent variables and the dependent variable when there is left or right censoring of Y. Values of y_i are recorded for the values above the threshold c_i.

$$y_i = \begin{cases} x_i^T B + \varepsilon_i & if \quad y_i > c_i \\ c_i & otherwise \end{cases} \tag{19}$$

For values less than the threshold then c_i is recorded.

$$y_i = \begin{cases} x_i^T B + \varepsilon_i & if \quad x_i^T B + \varepsilon_i < c_i \\ c_i \end{cases} \tag{20}$$

If the threshold value is set at c the log-likelihood function estimation for the parameters u and σ^2 is

$$L\left(\varepsilon, \sigma^2 \mid y_{i,\ldots\ldots} yN\right) = \prod_{y_i^* > c} \phi \frac{1}{\sigma}\left(\frac{y_i - \varepsilon}{\sigma}\right) \prod_{y_i^* \le c} \Phi\left(\frac{c - \varepsilon}{\sigma}\right) \tag{21}$$

Where ϕ the density is function and Φ is the cumulative distribution function of the standard normal. The empirical model will be specified as follows:

$Y = B_0 + B_1 Pric + B_2 Dist + B_3 MktIn + B_4 Edu + B_5 Fs + B_6 Exp + B_7 Crd + B_8 Gen + B_9 Ag + B_{10} LndT + B_{11} Ext + B_{12} Lab + B_{13} GrpM + \varepsilon$ (22)

Table 6: Description of variables that influence the extent commercialization of Agroforestry products

Variable	Description and measurement of variables	Expected sign
Dependent Variable		
HCI	Level of agroforestry produce commercialization	+
Independent Variables		
Pric	Price in KES	+/−
Dist	Distance from the nearest market in Kilometers	+/−
MktIn	Access to market information	+
Edu	Education level of the farmer (no. of yrs).	+
Fsize	Farm size in hectares	+/−
Exp	Period farmer has practiced AF in years	+
Credit	1=Credit borrowing, 0= No credit borrowing	+/−
Gend	Household head 1=Male, 0 = Female	+/−
Age	Age of the farmer in years	−
LndT	Land tenure of the farmer	+/-
Lab	Labour hours	+
GrpM	Group membership	+
Agro Trn	Agroforestry training 1=Received 0= Did not receive	+

3.7 The Cost Benefit Analysis

The Cost Benefit Analysis was used to quantify the costs and benefits of agroforestry in monetary terms. Some studies have used the Gross margin analysis to analyze this objective. However, agroforestry trees not being annual crops the CBA captures the long term returns of the agroforestry enterprise. A study done by Fransisca (2014), used the Cost Benefit Analysis to determine agroforestry economic potential in Kilosa district, Tanzania. The formulas are stipulated as follows.

Net Present Value

Is the difference in the current value of benefits and costs and the future value of benefits and costs. The benefits and the costs of the agroforestry production system are discounted over the lifespan of the practiced enterprise.

$$NPV = \frac{V_t}{(1+i)^t} \tag{23}$$

The NPV is then divided by the costs of the enterprise to obtain the benefit cost ratio.

$$BCR = \frac{\sum \frac{V_t}{(1+i)^t}}{\sum C_t} \tag{24}$$

The BCR is a ratio of the current value of all benefits and costs. It will be used as a proxy for agroforestry profitability.

Where V_t is the net income value of agroforestry products sales in year t.

C_t are the costs in year t,

t is the time frame of the enterprise and

i is the discount rate.

V_t is the net income obtained from agroforestry products sale. C_t include; seedlings, tree maintenance, harvesting and marketing costs. The costs and the income benefits have to be presented in the discounted present values. The discount rate i takes into account the inflation rate for time t. If the enterprise has a BCR of greater than 1 it is profitable and if it is less than 1 it

implies that the costs outweighs the benefits thus making losses. This will then be compared with the BCR of farmers who did engage into agroforestry commercialization.

Internal Rate of Return

This is the discount rate at which the NPV of the future income benefits is equal to the initial investment costs. The NPV is equal to zero at this discount rate. It is calculated as;

$$\text{IRR}= \sum_{t=1}^{T} \frac{V_t - C_t}{(1+i)^t} = 0 \qquad (25)$$

The IRR is thus the maximum interest rate that the agroforestry investment can earn for the resources invested while recovering from the operating and initial investment costs.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-economic attributes of commercial and non-commercialized agroforestry farmers

This chapter presents the descriptive statistics on the socio economic attributes of commercial and subsistence small scale agroforestry farmers. The institutional and marketing factors affecting agroforestry farmers are also explained in this section. The multivariate Probit model results on the factors influencing the choice of various market outlets are explained showing the significant variables for each outlet. The section also includes the Tobit model results on the factors affecting the extent of agroforestry fruits commercialization. The last section of this chapter discusses the cost benefit analysis between farmers who ventured into commercial agroforestry and those who did not to determine the economic viability of the enterprises.

4.1.1 Gender of the respondents

The results in Figure 3 depict that female respondents were more than their male counterparts in the study where 57.6% were female while 42.4% were male. The findings are in line with Chemuku *et al.* (2017), which indicate that majority of the farm work is conducted by women in Kwale and Kilifi counties. Matuga Sub County had the highest number of female respondents (64%) followed by Kilifi North (56%). However, in Kilifi South Sub County the number of male respondents participating in agroforestry was higher at (54%) compared to female participation at (46%). This can be supported by the proximity of Kilifi South to Mombasa town where majority of the women work in the tourism hospitality industry thus leaving the men to work on the farms (Chemuku *et al.*, 2017).

When the results are separated into commercial and subsistence farmers they indicate that more male respondents participated in commercial agroforestry at 52.76% compared to 47.24% of female respondents. The results are similar to Muniu *et al.* (2019), findings which indicate that despite women doing most of the farm labour it is the men who venture into commercializing the produce. This implies that the male agroforestry farmers participate more in selling the produce as compared to female farmers in Kwale and Kilifi Counties. This can be attributed to the fact the male respondents are more involved in the decision making and mostly probably marketing of agroforestry products compared to the female respondents.

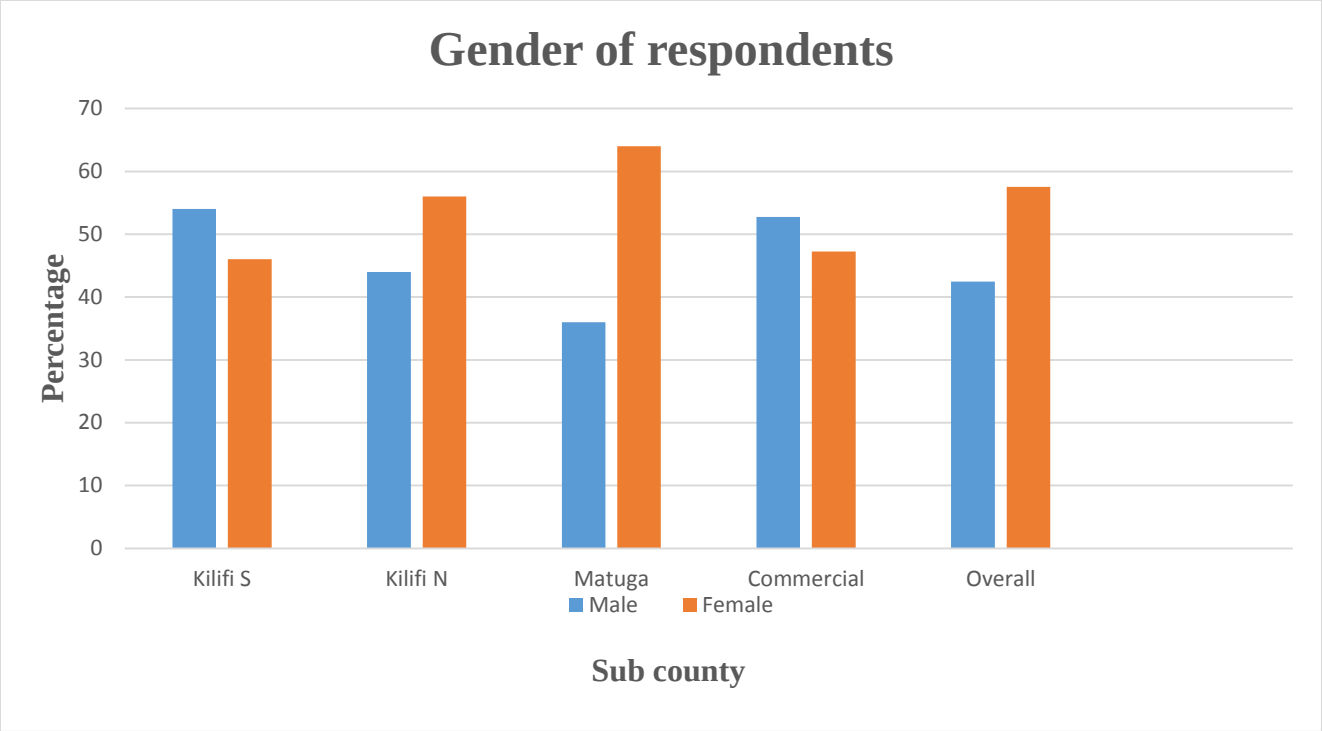

Figure 3: Gender of the respondents

4.1.2 Main decision making of the respondents

The results in figure 4 show that men dominated the main decision making process in making agroforestry decisions in the study area with more than 50% in each Sub county. Generally, 60.5% of the agroforestry decisions from planting to selling were made by men as women had a 39.5% in decision making. The results are in support with Kiptot *et al.* (2011), whose findings indicate that men make the main decisions regarding production and marketing.

The prevalence of men making the main decisions regarding agroforestry farming decisions is widespread in rural Sub Saharan Africa, (FAO, 2010). This happens despite women being the most in carrying out farm labour than men which consequently limits the effectiveness of agroforestry. The results are consistent with Christopher *et al.* (2014), findings which suggest that women are excluded from the main decision making regarding farming in Sub-Saharan Africa. The fact that women participated more in agroforestry within the study area, more emphasis is required in enabling them participate in making independent decisions regarding agroforestry.

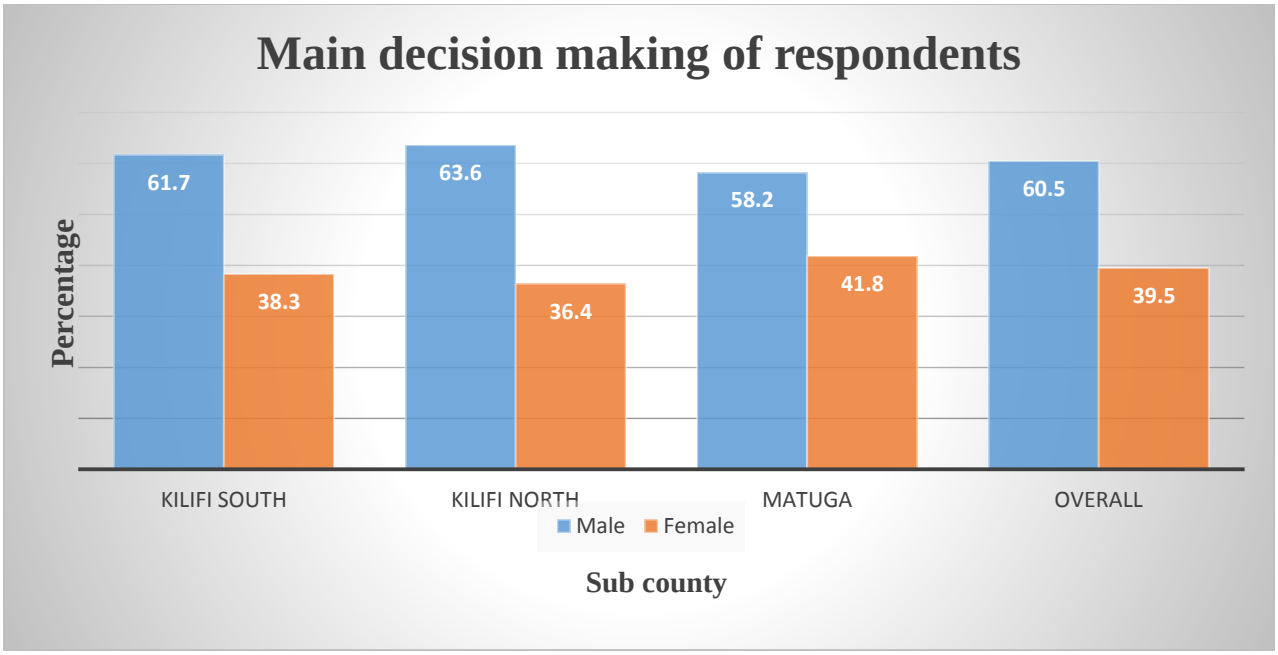

Figure 4: Main decision makers among the respondents

4.1.3 Main occupation of the commercial and subsistence agroforestry farmers

From the results given in Figure 5, almost three quarters of the respondents (66.4%) had no formal employment. The remaining respondents (10.7%) were casual labourers, (15.9%) were business operators, (5.2%) were private company employed and (1.8%) government employed. The findings are consistent with KCIDP, (2018) which indicates that majority of the rural households' dwellers in Kwale and Kilifi Counties lack formal employment opportunities.

When the results are classified into commercial and subsistence respondents they indicate that the unemployed respondents had the lowest number participating in commercial agroforestry (43.9%) as compared to the other levels of employment. The results show that from casual labourers to the government employed respondents had a more than 50% participation in commercialization. This implies that the farmers with formal employment were more able to meet the transaction costs involved in commercialization as compared to the unemployed farmers. The findings are in line with Yegoh and Kimeli (2013), findings which suggests that farmers with formal employment are have a higher likelihood in engaging to commercialization.

The farmers without formal employment mainly depended on farming to sustain their daily basic subsistence needs first before engaging into commercialization of their produce. Generally, the

results show that majority of rural households are unemployed as they mainly depend on farming. The findings are similar to Chemuku *et al.* (2017), whose study reveals that most rural households in Kwale and Kilifi Counties depend mainly on their farms for food and income.

Due to the seasonality nature of agroforestry farming, fruits perishability and lack of proper storage facilities most of the farmers in Kwale and Kilifi Counties engage in other income generating activities, (KALRO, 2014). The fact that the farmers are not engaged throughout the year in mango production, explains why the respondents had to engage in other income generating activities. The prevalence of formal employed respondents engaging more in commercialization can also be attributed to the capability of purchasing the required farm inputs for better production and employ hired labour to work in production and marketing of the produce.

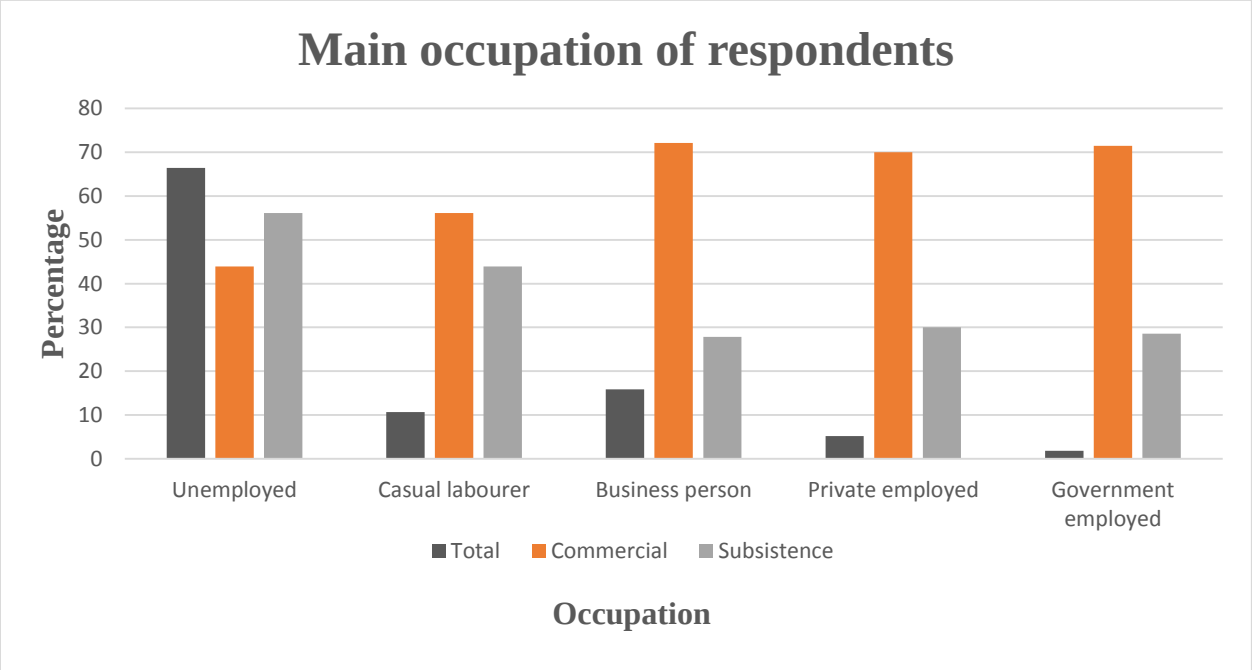

Figure 5: Main occupation of the commercial and subsistence agroforestry farmers

4.1.4 Age, household size and farming experience of commercial and subsistence agroforestry farmers

The results in Table 4 shows that the average age of agroforestry farmers in Kwale and Kilifi Counties is 46 years. This shows that those involved practicing agroforestry were within the economically active age group of between 18 to 65 years. World Bank (2019) defines the age

between 16 to 65 as economically active. Most agroforestry practices are labour intensive. This implies that it requires a labour active age group for tree maintenance and fruit harvesting. Furthermore, the results show that there is no significant difference between the age of farmers with commercial agroforestry systems and the subsistence practicing farmers ($p>0.05$).

With regard to household size the results show that the mean household size among agroforestry farmers in Kwale and Kilifi Counties is 7 members per household. The variation between households is relatively low as shown by the standard deviation. The average household size of 7 per household is considerably higher than the mean national average household size of 4 per household (KNBS, 2019). This implies agroforestry practice requires labour resource endowed households. This shows that most agroforestry practicing families have household sizes larger than the national average household size. This helps in carrying out the various activities involved in agroforestry farming. The findings are consistent with KCIDP (2018), which indicates that most of the households in Kwale and Kilifi Counties have higher family sizes. The results also indicate that there is no significant difference between commercial and subsistence practicing agroforestry household's size.

The overall mean farming experience of the respondents was 14 years. However the mean farming experience between commercial and subsistence farmers was 15 and 12 years respectively. The results also show that there is a significant difference between commercial and subsistence farmers farming experience ($p<0.05$). Number of years practicing agroforestry thus had an influence on farmers participating in commercial agroforestry. This can be attributed to the skills learnt over the years on how to improve productivity for higher market value. Farmers who have more years in practicing a particular farm enterprise are more knowledgeable on efficient production and marketing thus engaging in commercialization of the produce (Hailua *et al.*, 2015).

Table 4: Demographic attributes of commercial and subsistence agroforestry farmers

Variables	Commercial		Subsistence		All respondents			
	Mean	SD	Mean	SD	Mean	SD	t test	p-value
Age	46.27	11.69	46.17	11.88	46.22	11.77	-0.083	0.9336
Household size	7.40	2.52	7.17	2.36	7.29	2.44	-0.907	0.3649
Farming experience	15.19	7.40	12.78	4.98	14.02	6.45	-3.705	0.0002

4.1.5 Education level of the respondents

The results on education level of respondents indicate that 73 percent of respondents had access to formal education where 47 percent had primary education, 18 percent secondary education and 8 percent had access to tertiary level of education. The prevalence of formal education among the respondents indicates that farmers can easily be educated to planting better tree species and how to maintain them to maturity. There is a positive correlation between labour productivity and access to formal education among farm households (Palapala *et al*., 2016). Similar findings are shared by Erick *et al.* (2015), whose study indicate that the education level of a farmer influences the ability to undertake better farming enterprises.

Furthermore, when the respondents are classified into commercial and subsistence the results show that only (18.8%) of the farmers who had no formal education ventured into commercialization. The respondents who attained formal education had a higher percentage of commercialization at all levels of education. Farmers' with tertiary education had (82.8%) commercialization level which indicates that the higher the level of education attained, the higher the commercialization level. This implies that farmers with formal education engaged more in produce commercialization compared to those who had no formal education. Educated farmers have a higher likelihood to engage in agricultural commercialization (Erick *et al.,* 2015).

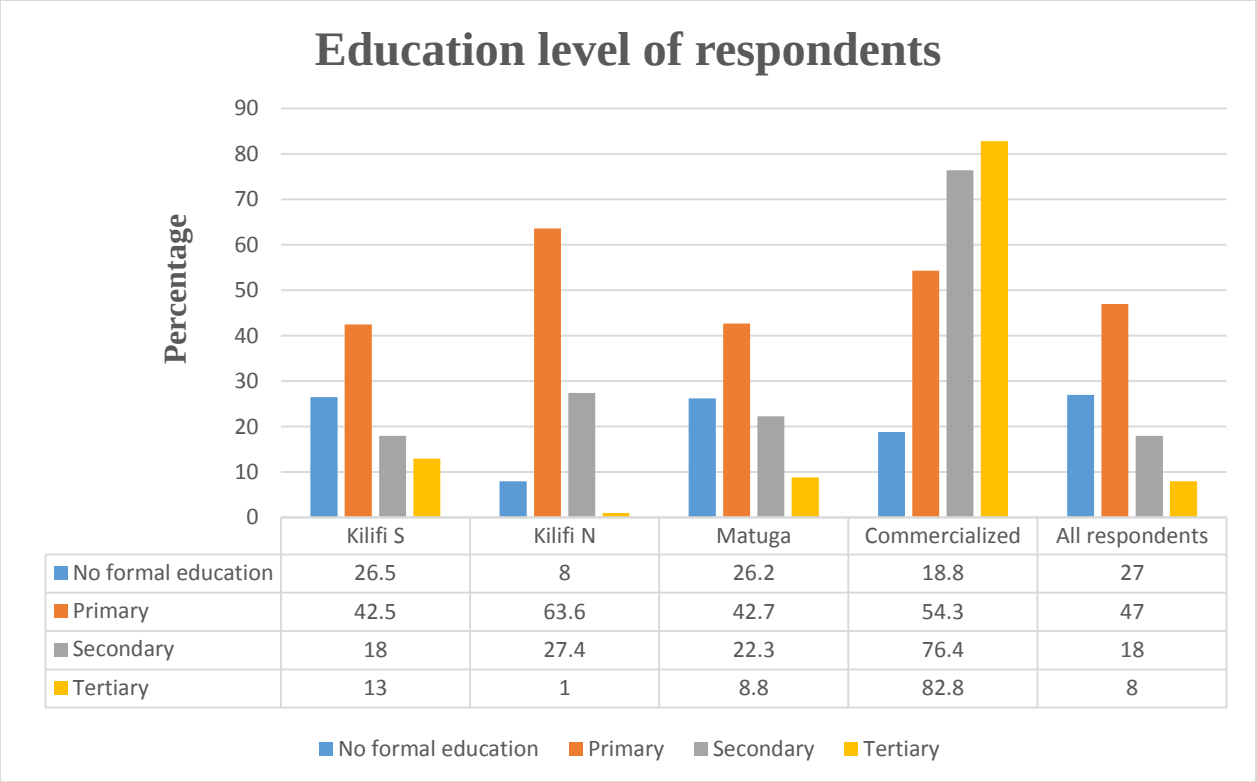

Figure 6: Education level of agroforestry small scale farmers

4.1.6 Land ownership of the respondents

Results shown in Figure 7 indicate that 66% of the respondents were cultivating on their own land, 26% cultivated on communal land while 8% leased land for farming. When the respondents are classified into commercial and subsistence farmers the results show that farmers with commercial agroforestry systems had a higher percentage with self-owned land at 60% while the subsistence farmers had the highest percentage in owning communal and leased land at 64% and 65% respectively. The finding implies that the higher the self-ownership of land by a farmer the higher the chances of engaging into commercialization. The results are consistent with FAO (2015) findings which suggest that farmers with title to their lands tend to invest more in commercial farming as compared to peasant farmers. This shows that farmers with their own land have the freedom to grow long term agroforestry trees as compared to the farmers who do not have self-ownership to land. The farmers without full land ownership are not sure of owning the trees planted in the long run thus contented with planting short season food crops. This is in line with

Christopher *et al.* (2014), whose findings indicate that self-ownership to land has a positive relationship to planting of more long term trees on one's farm land.

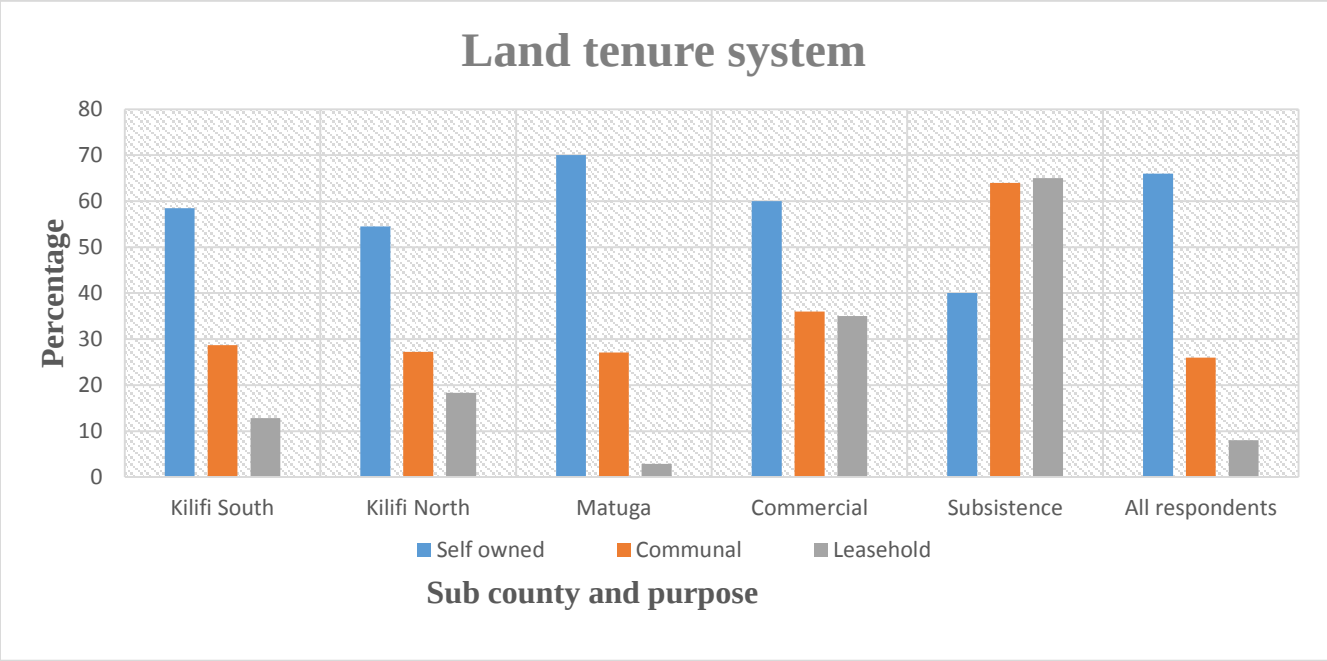

Figure 7: Land ownership of the respondents

4.1.7 Average household farm size

The study shows that the mean farm size of agroforestry farmers in Kwale and Kilifi Counties is 2.7 acres. Small scale farms are those which are less than 4 hectares (FAO, 2017). However, average land size for the intercropped mango agroforestry trees is 0.56 acres. This shows that majority of the farmers in Kwale and Kilifi Counties only allocate a quarter of their farm lands for agroforestry trees farming. The findings are consistent with Davis *et al.* (2017), which indicates that majority of the small scale farmers in Coastal Kenya have not fully adopted mango farming as a commercial enterprise.

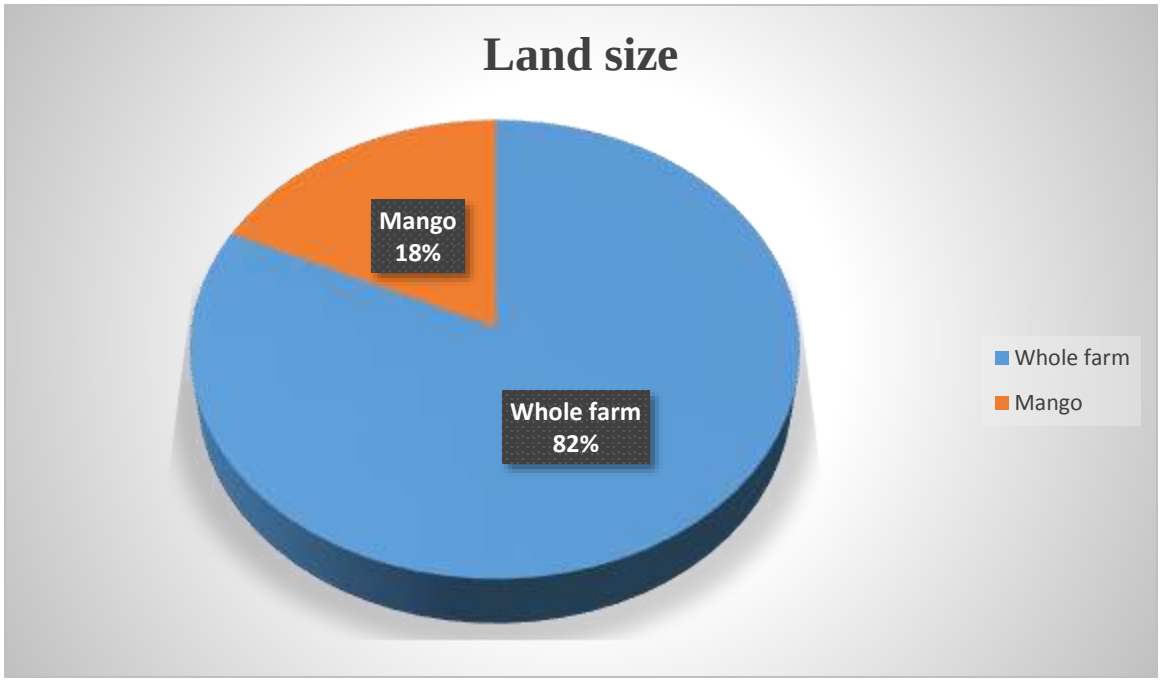

Figure 8: Average farm size of small scale agroforestry farmers

4.1.8 Form of labour used by respondents

The results in Table 5 indicate that over three quarters of the respondents used family labour (84.6%) while only (2.9%) used hired labour and (12.5%) used both for maintenance and harvesting of agroforestry produce. The prevalence of the small scale agroforestry farmers using family labour can be attributed to the large household sizes in Kwale and Kilifi Counties. Muniu and Mwashumbe (2019) findings indicate that majority of the households in Kwale and Kilifi Counties use family on their farms as a result of a large number of family members. When the respondents are classified into commercial and subsistence the results show that subsistence farmers were the majority in using family labour (53.5%) compared to farmers with commercial agroforestry systems (46.5%). However, farmers with commercial agroforestry sytems had a higher percentage (90.9%) at using hired labour compared to subsistence farmers (9.1%). This implies that the farmers engaged in commercial farming found it necessary and had the capability to hire labour for production. According to Himlal (2016), commercial farmers are willing to incur input and production costs for improved quantity and quality of output.

Table 5: Form of labour used by agroforestry farmers

Labor source	Kilf S	Kilf N	Matga	Comm	Subs	All respondents (%)
Family	76.5	72.7	86.4	46.5	53.5	84.6
Hired	7.4	9	1.7	90.9	9.1	2.9
Both	16.1	18.3	11.9	75	25	12.5
Total						**100**

4.2 Agroforestry system practiced in the study area

The results in Figure 9 below indicate that averagely 98% of the respondents in Kwale and Kilfi counties practiced mixed gardening agroforestry system while only 2% practiced alley cropping. This shows that the small scale farmers in Kwale and Kilifi counties still use the traditional mixed gardening agroforestry method with only a few practicing alley cropping agroforestry system. The findings are in line with Chemuku *et al.* (2017), whose study reveal that majority of the Coastal rural farmers practice the indigenous farming methods.

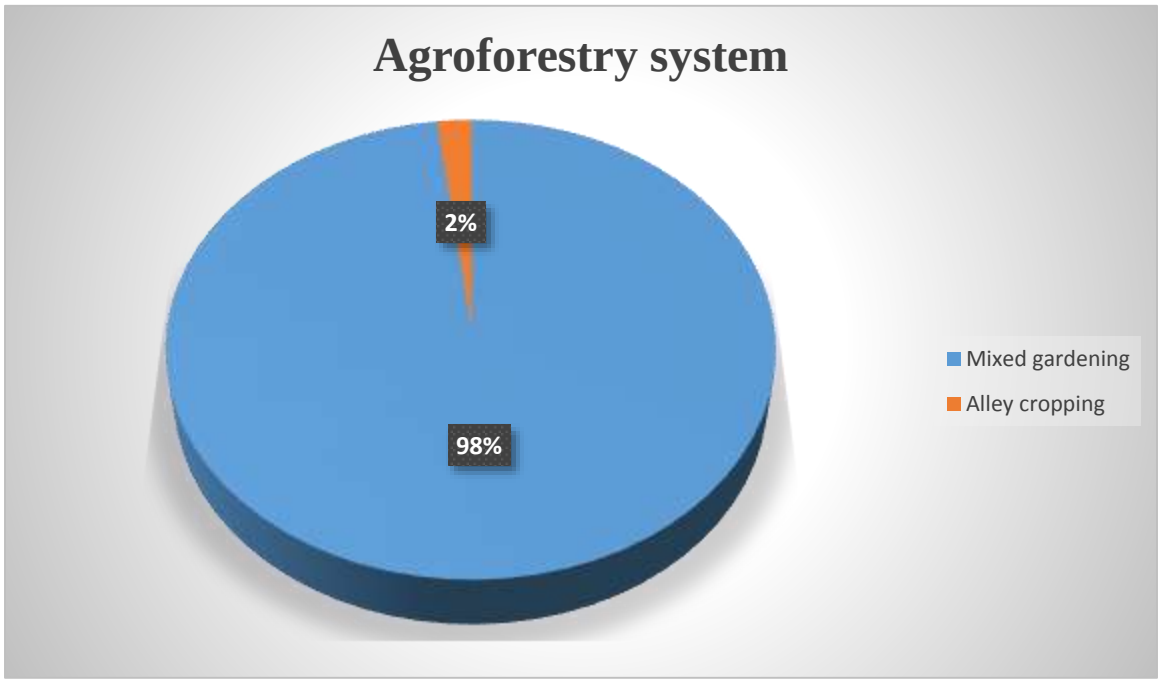

Figure 9: Agroforestry system practiced by agroforestry farmers

4.2.1 Types of mango varieties planted

From the results depicted in Figure 10, 58% of mango farmers in Kwale and Kilifi Counties plant the indigenous Ngowe mango variety, 22% of the respondents had the Boribo mango variety and 16% planted the Dodo variety. The findings indicate that only 4% of the agroforestry small scale farmers had the apple mango variety. This is in line with William *et al.* (2015), study which indicates that most of the farmers in Kwale and Kilifi Counties have not yet fully adopted the exotic mango varieties like in Eastern Kenya. The exotic mango varieties have favourable characteristics like early maturity and large volume size of mangoes (HCDA, 2011). The results also indicate that the exotic apple mango variety was (100%) owned by farmers practicing commercial agroforestry as no single subsistence farmer had possession of the Apple mango variety. This implies that the farmers with commercial agroforestry systems had the ability to afford planting the variety and awareness of the exotic apple mango profitability as compared to the subsistence farmers.

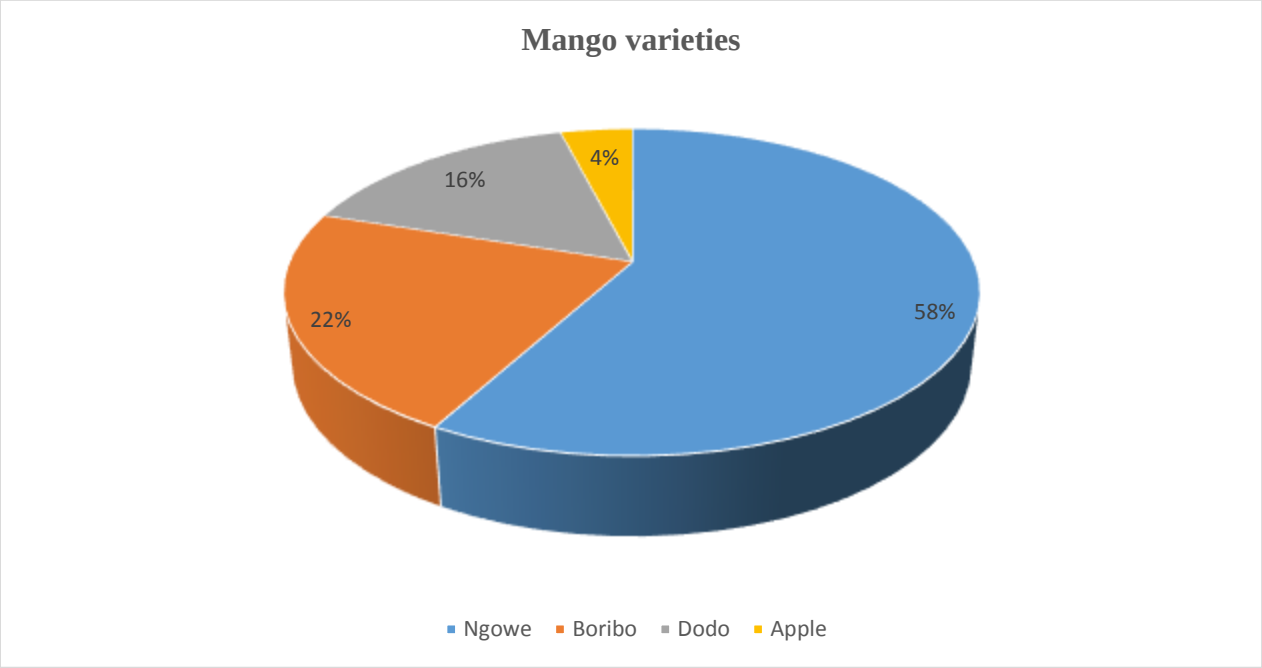

Figure 10: Mango tree varieties grown by small scale farmers

4.3 Institutional attributes of commercial and subsistence agroforestry farmers

The main credit sources, farmer self-help group membership, agroforestry training, market information and main means of transport are discussed under this section.

4.3.1 Main source of credit

The results in Table 6 shows that more than half of the respondents (63.8%) did not borrow credit facilities. KCDIP (2018) indicate that majority of the small scale farmers in Kwale and Kilifi Counties do not benefit from credit facilitation. The highest source of credit was from women groups at (25.7%) followed by micro finance institutions (5%), farmer groups (4.2%) and banks (1.3%).The respondents who did not borrow credit facilities had a lower percentage of farmers participating in commercial agroforestry at 42.8%. Respondents who borrowed credit facilities had more than half participation in commercial agroforestry at all sources of credit. This implies that credit facilities enhanced the participation of farmers into commercial agroforestry. This is in line with Yegoh and Kimeli (2013), study who found that credit facilities increases the probability of farmers to venture into commercial farming.

Table 6: Main credit borrowing sources of small scale agroforestry farmers

Credit source	Kilf S	Kilf N	Mtga	Comm	Subs	All respondents (%)
No credit access	68	72.7	58.2	42.8	57.2	63.8
Banks	2.1	1.5	1.9	80	20	1.3
Farmer groups	4.2	2.2	1	56.3	43.7	4.2
Micro finance institutions	5.3	4.2	5.8	84.2	15.8	5
Women groups	20.4	19.4	33.1	64.6	35.4	25.7
Total						**100**

4.3.2 Farmer self-help group membership

The findings on farmer self-help group participation show that majority of the respondents (85.4%) did not participate in farmer groups as only (14.6%) of agroforestry farmers were engaged in group membership. This indicates that in Kwale and Kilifi Counties the agroforestry farmers are hugely

segregated from each other thus having no any market bargaining power. According to Innocent (2016), findings farmers are more advantaged when they are in groups. It is easier for them to enter into contractual arrangements with buyers because they can sell in bulk rather than selling individually. The commercial oriented farmers had a higher participation in group membership (66%) compared to the subsistence farmers (34%). This implies that the commercial oriented farmers acknowledged the need to engage in farmer self-help groups due to the various benefits associated with collective action.

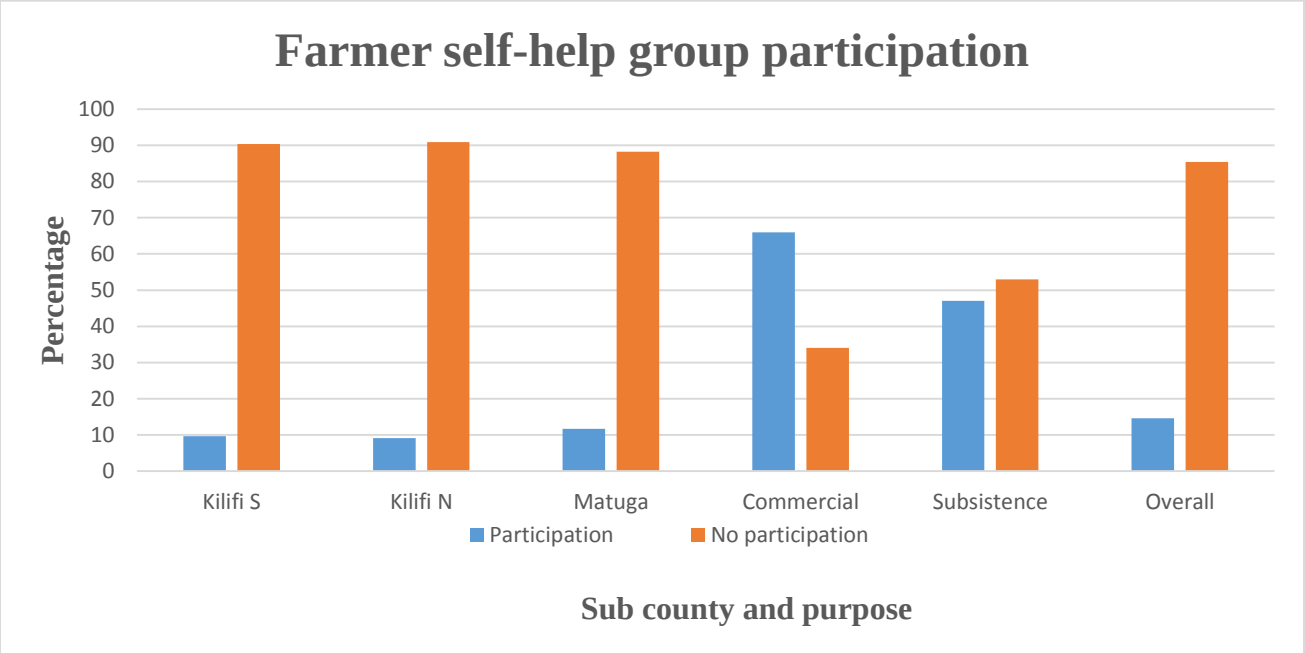

Figure 11: Self-help group membership participation of small scale agroforestry farmers

4.3.2.1 Benefits of participating in mango farmers self-help groups

The results in Figure 12 indicate that 90% of mango farmers did not receive any farmer group benefits because majority were not members of any farmer self-help group. Of the members participating in farmer self-help groups, 8% benefited by access to technical information while 2% received financial assistance to boost their farming enterprises.

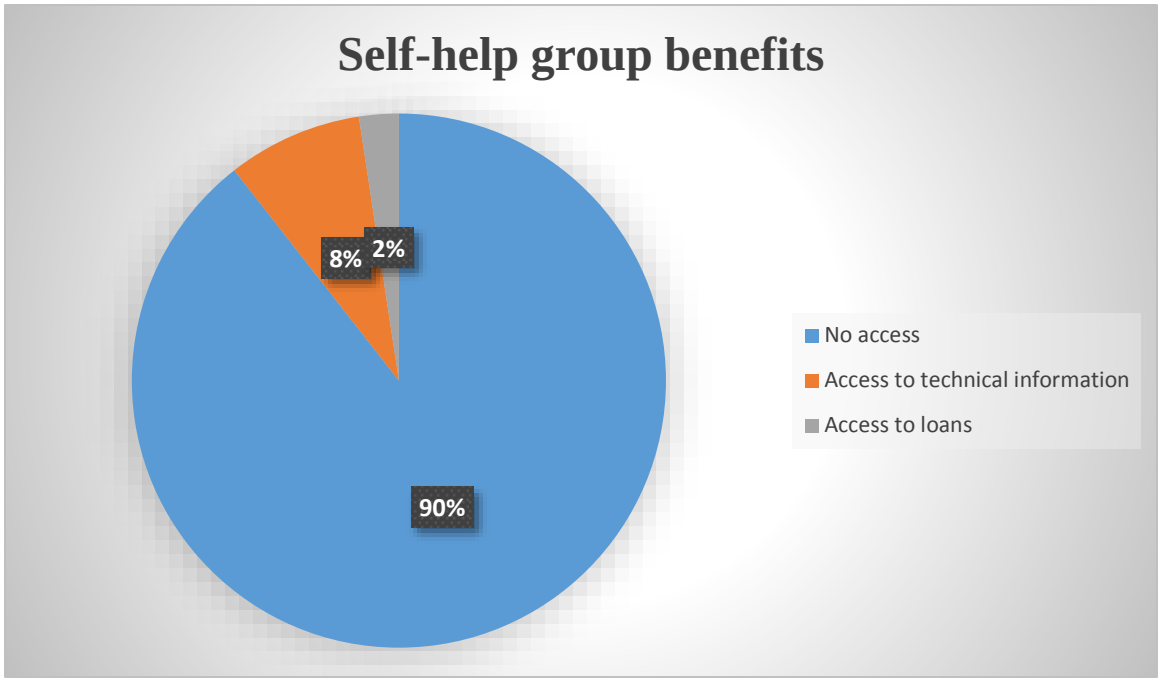

Figure 12: Mango farmers' self-help group benefits

4.3.3 Agroforestry production and marketing training

Majority of the agroforestry farmers did not receive agroforestry training (56.5%) as only (43.5%) received agroforestry training. The results indicate that the commercial oriented farmers had a higher percentage (67%) in attaining agroforestry training compared to (33%) of subsistence farmers. Agricultural training equips the farmer with the necessary technical knowhow on better farming practices and basic knowledge on various market access procedures (Ngenoh *et al.*, 2019). This thus explains the higher percentage of commercialization among farmers who received agroforestry training as they had better produce in terms of quantity and quality compared to the farmers who did not receive any agricultural training.

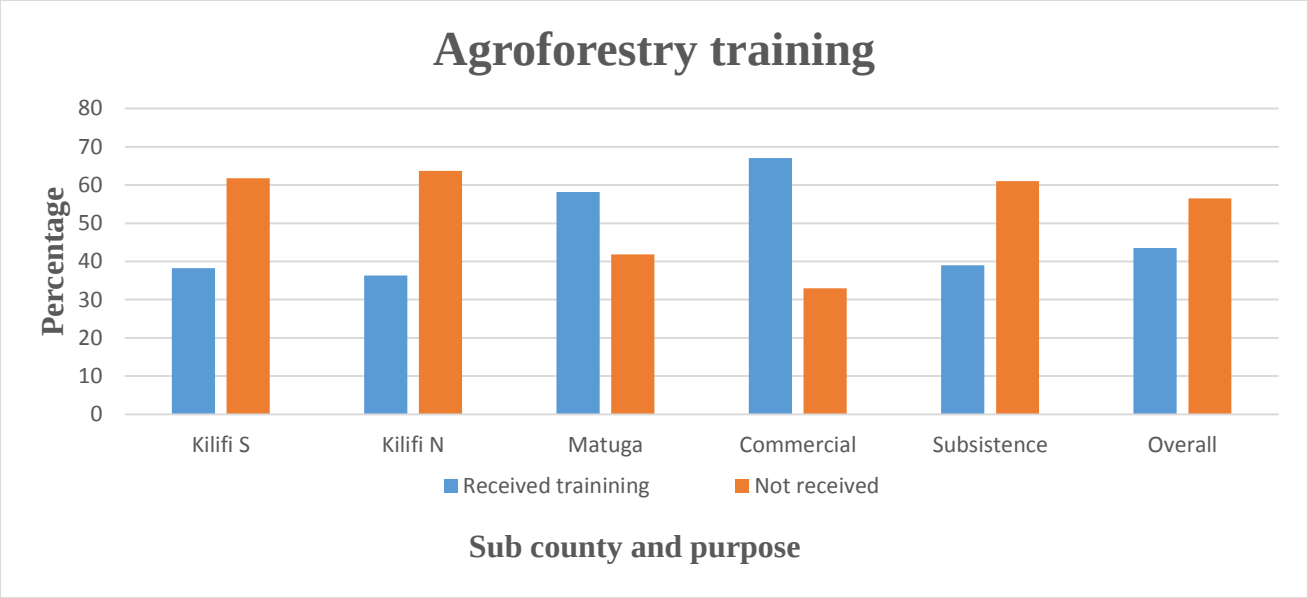

Figure 13: Production and marketing training of small scale agroforestry farmers

4.3.3.1 Agroforestry training sources

From the results in Figure 14 they indicate that government extension officers were the most prevalent in offering extension services to agroforestry farmers. This can be attributed to the fact that government extension officers offer extension services at a cheaper fee rate compared to private organizations. The close proximity of the Kenya Agricultural and Livestock Research Institutes at Matuga and Mtwapa in Kwale and Kilifi Counties respectively also explains the prevalence of government extension officers' access to farmers. The findings are in line with Chinwe *et al.* (2009), whose findings suggest that government extension officers are tasked with offering agroforestry training services to small scale farmers in the operating region.

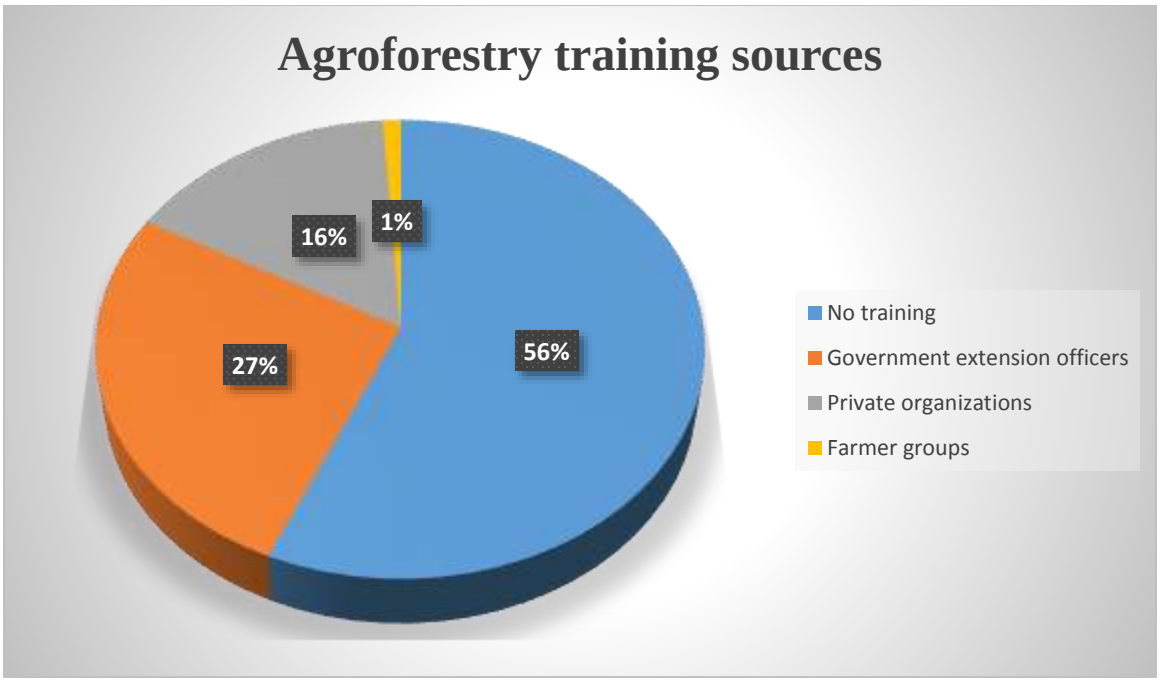

Figure 14: Agroforestry training sources

4.3.4 Agroforestry market information sources

The results in Table 7 show that more than a quarter (33.07%) of the respondents did not have access to market information. This implies that most of the agroforestry farmers in Kwale and Kilifi Counties did not invest much in market information search. Majority of the respondents obtained information from neighbouring farmers (28.65%), extension officers (13.02%) and radios (10.42%). Due to ease of access and less costliness, neighbours were the prevalent form of information access. Farmers also acknowledged that extension officers and radios were important in relaying market information. When the results are classified into commercial and subsistence they indicate that of those farmers who did not have information access, 83.46% were subsistence while only 16.54% were commercial farmers. Among the information sources from which respondents obtained their information, commercial farmers had more than half in each information source compared to subsistence farmers. This implies that the commercial oriented farmers had more access to market information compared to the subsistence farmers. The results are in line with Innocent (2016), who found that information access positively affects farmers' participation in the market.

Table 7: Main market information sources

Source of information	Commercial	Subsistence	All respondents (%)
No formal information access	16.54	83.46	33.07
Neighbouring farmers	54.55	45.45	28.65
Farmer groups	73.1	26.9	6.77
Extension officers	78	22	13.02
Private organizations	66.66	33.34	7.81
Radio	77.5	22.5	10.42
Internet	100	0	0.26
Total			**100**

4.3.5 Means of transport used by mango farmers

The transport means used to access the main market destinations reveals that motor cycles were widely used (81%) followed by pick-ups (11%), human transport (7%) and trucks (1%). Due to the flexibility and affordability of motor cycles it was the most effective mode of transport used in Kwale and Kilifi Counties. The farmers who sold their produce at farm gate found it more convenient to use human labour in ferrying the produce due to its cheaper cost. Majority of the rural small scale farmers who sell at farm gate in Coastal Kenya use family labour (Chemuku *et al.,* 2017).

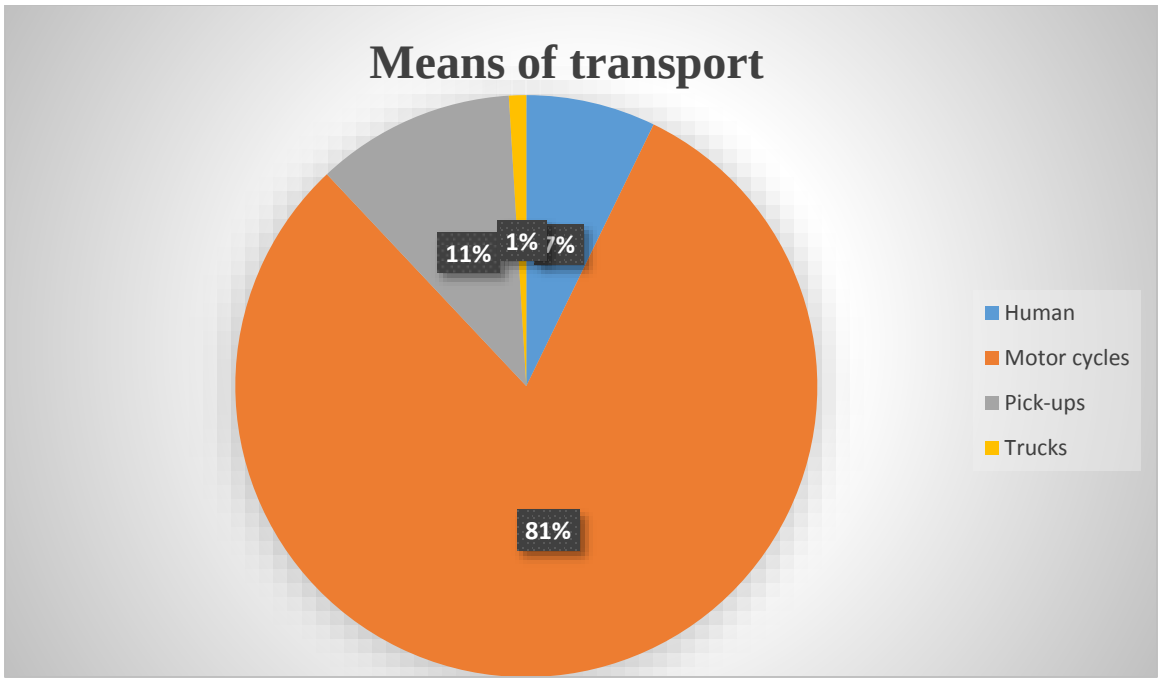

Figure 15: Mango farmers' main means of transport

4.4 Market outlets

The main market outlets used by small scale agroforestry farmers and the distance to the chosen outlets are discussed under this section.

4.4.1Mango farmers' main market outlets

As indicated in Figure 16 majority of mango farmers sold their produce to middle men (62.5%). This indicates that mango business in the study area is dominated by middle men who act as intermediaries between the farmers and the market. The preference of selling to middle men can be attributed to the need of immediate cash by farmers so as to cater for their daily basic needs. The middle men also relieve the farmers from the transaction costs involved in the produce marketing. However, the middle men usually obtain higher profits compared to the farmers due to their knowledge and experience of produce marketing. Similar findings are supported by Mesay (2017), whose results indicate that middlemen are the ones who enjoy larger profits in the mango business compared to the farmers in Sub Saharan Africa. When the results are divided into commercial and subsistence they indicate that subsistence farmers dominated the farm gate and middle men market outlets at 93.8% and 50.8% respectively. To the contrary, commercial farmers

dominated the local retail and town markets respectively at 63.6% and 100% respectively. This implies that the mango commercial farmers were more market oriented as they integrated higher along the value chain compared to the subsistence farmers. The higher the farmers integrate along the value chain, the higher the profits they obtain (Innocent, 2016).

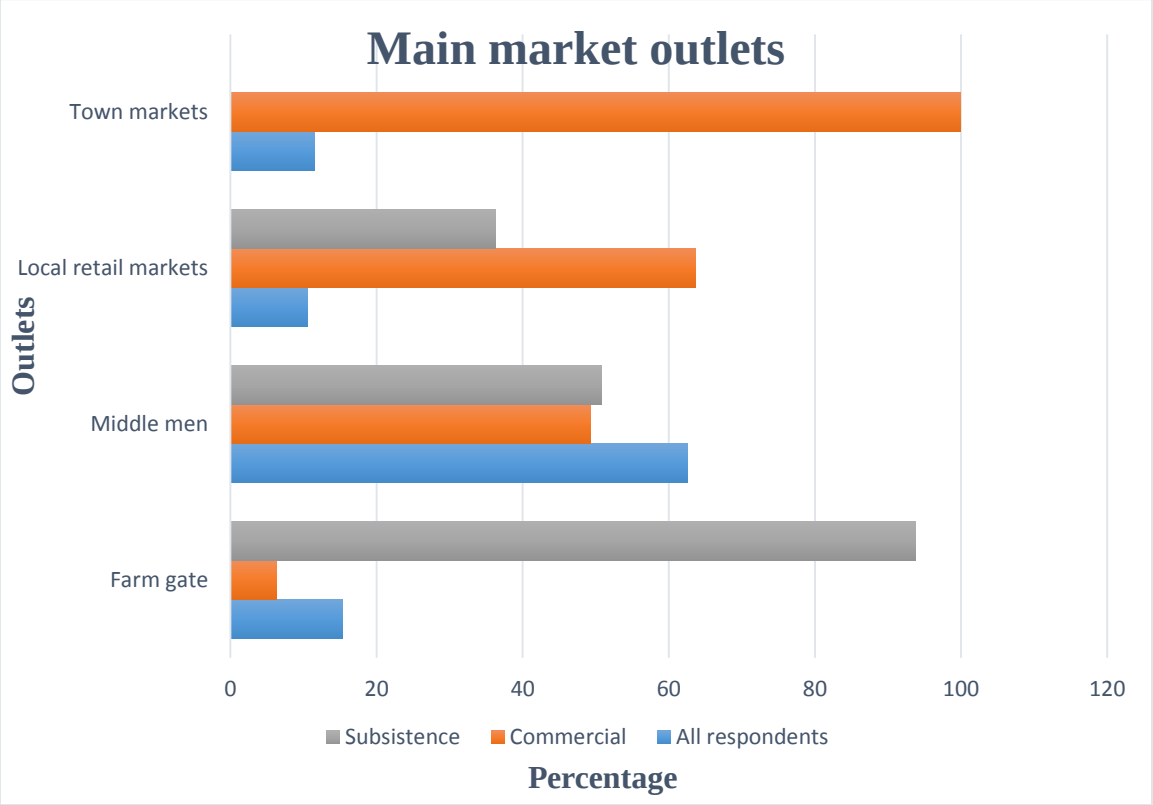

Figure 16: Mango farmers' main market outlets

4.4.2 Average distance to main market outlets

The average distance to the main market outlets by mango farmers was 12.51 kilometers. The minimum market distance was 0 while the maximum distance was 70 kilometers. The standard deviation indicates that there was a high distance variance between the market outlets as some farmers incurred no travel cost by selling at farm gate while others sold at town markets. The further the market outlet implied that the transport cost increased. This can be explained by a higher percentage of mango farmers selling their produce to middle men as 62.5% of farmers sold their produce to middlemen thus subsequently transferring the transportation cost. The findings are

congruent with Mesay (2017), whose results indicate that small scale farmers cannot access high value markets due to high transport costs.

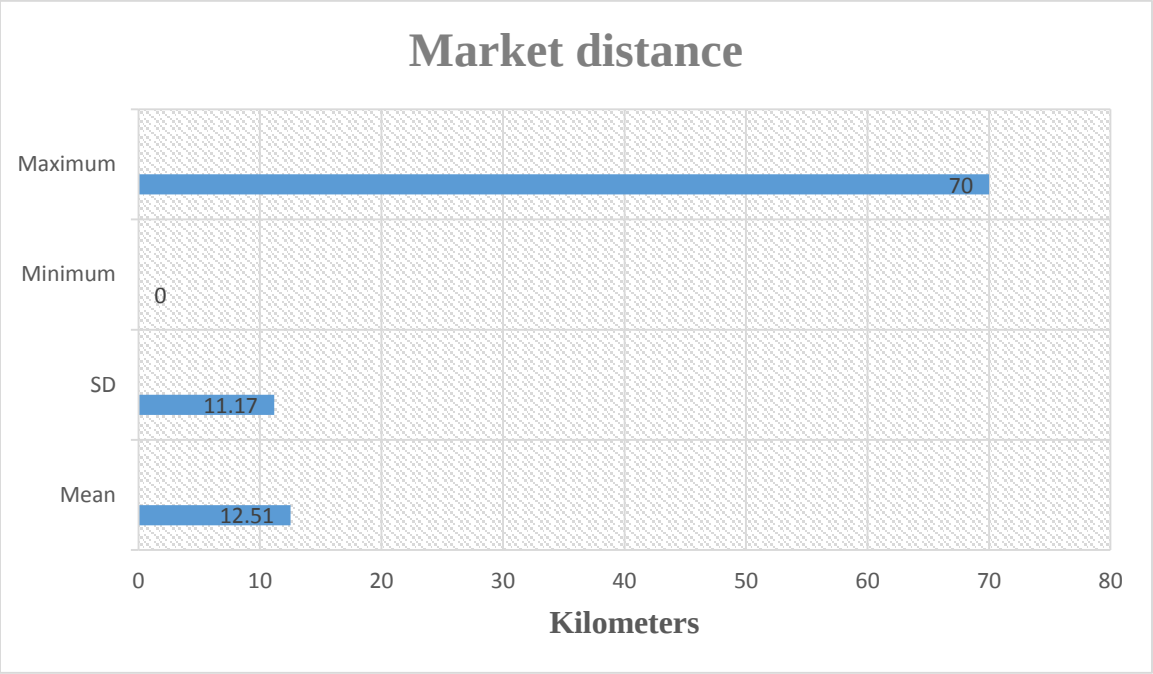

Figure 17: Distance to the main market outlets for mango produce

4.5 Preliminary tests for model appropriateness

In order to authenticate the validity of the econometric models used, multicollinearity and heteroskedasticity tests were conducted.

Multicollinearity

Multicollinearity occurs when more than one independent variables are related to each other. This means that one variable can be linearly estimated from the other variables. The presence of multicollinearity often leads to the occurrence of inflated standard errors thus making some predictor variables to be statistical insignificant (Tonidandel *et al.,* 2011). The Variable Inflation Factor (VIF) was conducted on the explanatory variables used in the model to detect the presence of multicollinearity. A VIF of less than 10 indicates the absence of multicollinearity among the explanatory variables of the estimated model (Jim, 2017). According to the results presented in Table 10 below, the VIF mean is less than 5 and the VIF results for all the variables are less than 10 thus showing the absence of multicollinearity. The test thus approved the use of the data for analysis.

Table 8: Variance Inflation Factor for predictor variables

Variable	VIF	1/VIF
Cost of transport	2.71	0.368
Distance to market outlet	2.21	0.452
Negotiation cost	2.07	0.483
Age	1.97	0.507
Agroforestry experience	1.87	0.533
Mango price	1.75	0.570
Mango land size	1.66	0.603
Access to credit	1.61	0.620
Agroforestry training	1.58	0.631
Off farm income	1.51	0.662
Search cost	1.48	0.674
Mango quantity sold	1.45	0.688
Gender	1.44	0.695
Household size	1.35	0.741
Farmer group participation	1.33	0.750
Labour hours worked	1.27	0.788
Whole farm size	1.19	0.837
Education level	2.04	0.490
Land tenure system	1.15	0.867
Mean VIF	**1.67**	

Test for Heteroskedasticity

Breusch-Pagan/ Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: fitted values of Local retail market

Chi2 (1) = 0.99

Prob > chi2 = 0.3632

The Breusch-Pagan test was conducted to check for heteroskedasticity using the command *estat hettest*. The results show a p value of 0.3632 thus indicating the absence of heteroskedasticty. According to Henning *et al.* (2014), a p value of more than 0.1 indicates that the test is insignificant thus implying that the errors are homoscedastic which means they are randomly dispersed throughout the range of the independent variable hence the absence of heteroskedasticity.

4.5.1 The factors affecting choice of mango market outlets used by small scale farmers in Kwale and Kilifi Counties

To determine the factors affecting the choice of market outlets among small scale farmers the multivariate probit model was employed. The multivariate probit model is an extension of the probit model as it is used to simultaneously estimate several correlated binary outcomes (Belderbos *et al*., 2004). The model takes into account the correlation in the error terms by jointly modelling the effects of the independent variables on each of the market outlet. The study found four outlets for the mango produce that is farm gate customers, middle men, local retail and town markets. The farmers thus sold their produce among these outlets in various proportions. If the inter-relationships involved in selling among the various outlets are not taken into consideration it may result to biased estimates of the factors influencing choice of agroforestry products market outlets (Amos *et al.,* 2017). The multivariate probit model was thus used to account for the interdependent relationships of the market outlets. The results are shown in table 19.

The likelihood test ratio (Rho-values), of $rho_{21} = rho_{31} = rho_{41} = rho_{32} = rho_{42} = rho_{43} = 0$ are statistically significant at 1%. The error terms of the multivariate probit model thus jointly follow

a normal distribution with a zero conditional mean. The model is thus fit for use as it shows that the farmer' decision to sell to the various market outlets is interdependent.

Table 9: Multivariate probit regression results on the factors influencing the choice of mango market outlets

Explanatory variable	Farm gate		Middle men		Local retail		Town market	
	Coef	RSE	Coef	RSE	Coef	RSE	Coef	RSE
Gender	.38*	.24	-.17	.28	-.05	.24	-.69	.46
Distance to market outlet	.005	.01	.005	.02	-.02	.01	.06**	.02
Agroforestry experience	-.003	.02	.002	.02	.01	.02	.004	.02
Education level	-.33**	.16	-.08	.16	-.10	.14	.76***	.28
Off farm income	.00004	.00003	-.0003	.00003	.00001	.00003	-.0002**	.00008
Negotiation cost	-.0004	.0002	.001***	.0004	.0001	.0002	-.0008**	.0002
Search cost	.0009	.001	.001	.001	.00007	.001	.001	.001
Mango price	-.03***	.007	-.04***	.008	.04***	.008	.05***	.009
Cost of transport	.0004	.0003	-.002**	.0005	-.0008**	.0003	.0004	.0003
Quantity produced	.00007	.0002	.0006**	.0002	.00003	.0002	.00002	.0003
Borrowing of credit	-.67**	.24	.21	.28	.12	.22	.40	.43
Age	-.02*	.01	-.002	.01	.002	.01	.04**	.02
Constant	2.72	.52	1.56	.60	-2.32	.55	-5.9	1.1
No. of observations								208
Log likelihood								-315.92
Wald chi2 (48)								222.30
Prob> chi2								0.0008***
Likelihood ratio test							rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0	

Note: Variable marked with* are significant at 10%, ** at 5%, *** at 1%

Table 11 gives the results of the factors affecting the choice of mango market outlets. The model had four dependent variables (Market outlets) and twelve explanatory variables. It had a p- value <0.05 which confirms that the model was fit and adequate for use. The results show that gender, education level, price, access to credit and age were significant at influencing farmers' choice of the farm gate market outlet. Negotiation costs, price, cost of transport and mango quantity sold were found to be significant when selling to middle men. For the local retail market outlet only price and cost of transport were found to be significant at 1% and 5% respectively. Lastly, at the town market outlet the significant explanatory variables were distance to market outlet, education level, off farm income, negotiation cost, price and age.

Gender of the farmer had a positive significant relationship ($p<0.1$) in selling at farm gate only but insignificant in the other outlets. Holding all other factors constant being a male farmer increased the chances of selling at farm gate by 38%. The result implies that male farmers were more likely to sell their mangoes at farm gate rather than carrying the produce to the market. This is line with FAO (2010), whose study reveals that female farmers dominate the fruit retail markets. This is further supported by the prevalence of women groups as the main source of credit in the region which consequently helped them to venture into better market outlets other than farm gate. Despite the fact that men are the main decision makers regarding produce commercialization, the women usually do most of the labour involved in the process including taking produce to the market. The findings are in line with Kiptot *et al.* (2011), whose findings reveal that women carry out most of the farm and market labour though they don't have the final decision on the returns obtained from marketing of the produce.

Increase in distance to the market is hypothesized to reduce fruit commercialization. However, increase in distance to the market outlet had a significant ($p<0.05$) positive effect on selling to town markets. The finding implies that the further away the distance from the farm, the higher the returns from produce sale. This can be supported by the high demand of fruits in Coastal towns which consequently necessitates the increase in mangoes supplied. The fact that Coastal towns are populated with customers having a higher purchasing power than the rural markets, mango producers are willing to incur the costs involved in accessing the outlet. This is in line with Njuguna *et al.* (2012), whose study indicates that due to the warm and hot climate in the Coastal

Kenya towns, demand for mango produce by locals and visiting tourists is always high throughout the year.

The education level of respondents had a negative and positive effect on the choice of farm gate and town markets at 5% and 1% levels of significance respectively. This implies that an increase in the level of education of the respondent reduced the probability of selling at farm gate by 33 percent but increased the likelihood of the producer selling to town markets by 76 percent. The findings indicate that educated mango producers were much more aware of the profitability of selling at higher returns market outlets (town markets). The finding is in line with Erick *et al.* (2015), who found that higher education level increases the probability of farmers integrate into high value chain markets. Education increases the basic knowledge of handling commercial transactions. This thus gives the educated farmers an advantage in gaining more returns from their farm enterprises by venturing into more profitable market outlets.

Increase in off farm income is expected to increase the level of produce commercialization. However, increase in off farm income had a negative significant ($p<0.05$) impact on selling to town markets by 0.02 percent. The results indicate that an increase in off farm income reduced the probability of farmers selling their produce to the market. The rationale behind this can be that farmers who had other sources of income didn't see the need of selling their produce at the expense of their own consumption. The transaction costs involved in selling produce to the town markets may also have inhibited their access to town markets. The finding is in line with Palapala *et al.* (2016), who found that farm producers who have other sources of income do not depend much on agricultural returns. The other reason could be that the farmers involved in other income generating activities do not have enough time to solely focus on farming. The fact that they are engaged in off farm activities, implies that farming is not their primary source of income thus less emphasis is placed on it. This is in line with ASDSP (2017), findings that due to the small-scale nature of farming in Kwale and Kilifi counties, most households look for other means of living in the form of formal and informal employment. The seasonal nature of mango production also necessitates the need to search for other alternative income sources during the production off seasons.

Negotiation cost had a positive and negative impact on selling to middlemen and town markets at 1% and 5% level of significance respectively. Increase in negotiation costs increased the probability of selling to middle men by 0.1%.The possible explanation could be that the farmers were willing to sell to middle men even at higher negotiation costs because they offered immediate cash for buying farm produce. This leaves farmers who are in desperate need of cash in hand with no option but rather sell their produce to middle men. This finding is in line with Mesay (2017), whose findings indicate that middle men usually exploit farmers as they offer low prices but reap higher prices by linking producers to the market. On the other hand as expected, at the town market outlet negotiation cost had a negative impact on choosing the outlet implying that a one shilling increase in negotiation costs reduced the probability of selling to town markets by 0.08%. Due to the taxes involved in selling fruits to town markets, farmers try to avoid those costs by transferring them to middle men. The results are in line with IFPRI (2017), findings that high transaction costs limit agroforestry farmers into selling at high value market outlets.

Mango price had a negative significant ($p<0.01$) influence on selection of the farm gate and middle men market outlets at 3 and 4 percent respectively. This implies that a one shilling increase in mango prices reduced the probability of selling to farm gate customers and middle men by 3 and 4 percent respectively. The possible rationale behind this finding could be that these two outlets offer lower prices to farmers thus an increase in market price of mangoes means that producers opted for higher price offering outlets. The findings are in line with Korir *et al*. (2013), whose results show that price is one of the primary factors influencing farmers' decision to sell their fruits. The mango price however, had a positive significant ($p< 0.01$) effect on the choice of local retail and town markets at 4 and 5 percent respectively. A one shilling unit increase in mango price increased the probability of farmers selling their produce at local retail and town markets by 4 and 5 percent respectively. The rationale behind this finding is that the local retail and town markets offer better produce prices compared to the farm gate and middle men. The finding supports Korir *et al*. (2013), results which indicate that the higher the produce price offered by a market outlet the higher the likelihood of producers targeting the respective market.

Transport cost had a significant ($p<0.05$) negative effect on choosing the middle men and local retail market outlets selection by 0.2 and 0.08 percent respectively. This implies that a shilling increase in transport cost reduced the probability of selling produce to middle men and local retail markets by 0.2 and 0.08 percent respectively. The rationale behind this finding is that the middle men will always factor in the cost of transport incurred to ferry produce to the market at the expense of farmers. The finding is in line with Mesay (2017), who found that middle men always strive to maximize their returns by deducting all the transaction costs from the producers selling price. This means that the farmers have to carry the burden of transport cost increase by receiving even lower prices from the middle men. Thus, an increase in the cost of transport consequently reduced the probability of farmers selling to middle men. Furthermore, an increase in transport cost reduced the likelihood of farmers selling to local retail markets. This implies that the mango price offered at the local retail markets could not cover the increase in cost of transport. This thus necessitated the producers' reduction in using the outlet. The findings are in line with Chemuku *et al.* (2017), results which shows that inability to afford transport costs limits agroforestry farmers from accessing potential markets in Kwale and Kilifi Counties.

The mango quantity produced had a positive and significant ($p<0.05$) effect on choosing the middle men market outlet. The results show that an increase in quantity of mangoes produced increased the likelihood of farmers selling their fruits to middle men by 0.06 percent. The possible reason behind this is that middle men prefer to buy in bulk so as to distribute the produce to different market destinations. In most cases middle men have a mastery of the agricultural value chain and it is no different with the mango value chain at Kwale and Kilifi Counties. This finding is similar to HCDA (2011), which indicates that middle men understand the market mechanisms better than the producers thus able to maximize their returns.

Availability of credit facilities is hypothesized to increase the level of mango produce commercialization. However, credit access to farmers shows that it had a significant ($p<0.05$) but negative effect on choosing the farm gate market outlet. This implies that a one shilling increase in credit received reduced the probability of producers selling at farm gate by 67%. The fact that credit access enables farmers to purchase the necessary inputs thus being able to produce better yields. With better yields, farmers eventually opted for high value market outlets rather than selling at farm gate prices. The credit further enhanced their capacity to cater for harvesting, packing and

transport costs required in selling to other market outlets apart from farm gate. The finding is similar to Kirimi *et al.* (2013), who found that access to credit enables agroforestry farmers in attaining better yields thus being able to sell to high value markets for better returns.

Age had a negative and positive impact on selling to farm gate and town markets at 1 percent and 5 percent level of significance respectively. The results show that an increase in age by one year reduced the probability of the farmer to choose the farm gate market outlet by 2 percent but increased the likelihood of choosing town market outlet by 4 percent. The implication of the finding is that as the age of the producer increases his/her experience consequently increases. With more experience the producers have a clear understanding of the most profitable market outlets. Therefore as the age of the farmers' increased, the probability of selling their produce to high end markets consequently increased. The findings are in line with Hailua *et al.* (2015), who found out that the more experienced the producer is the higher the chances of integrating into more profitable market outlets.

4.5.2 Factors influencing the extent of mango agroforestry produce commercialization

Table 10: Tobit regression results on the factors influencing the extent of mango produce commercialization

Explanatory variable	Coefficient	RSE	p> |t|
Agroforestry experience	.001	0.002	0.59
Age	-.02***	0.009	0.011
Number of years in school	.006*	0.004	0.093
Hours worked	.001*	0.0006	0.082
Land tenure system	.02	0.02	0.42
Whole farm land size	-.01	0.02	0.50
Mango land size	.18***	0.05	0.001
Farmer group participation	.14***	0.05	0.010
Borrowing of credit	.06*	0.04	0.089
Distance to market outlet	.004***	0.001	0.002
Constant	.60	0.22	0.007
No. of observations			208
LR chi^2 (12)			60.61
Prob> chi2			0.0000
Log likelihood			-37.332
Pseudo R2			0.465
Lower limit			0.25
Upper limit			1

Note: Variable marked with* are significant 10%, ** at 5%, *** at 1%

The tobit regression model was run and the results are presented in table 20 where the relationship between the dependent and independent variables is shown. The commercialization index of small scale agroforestry farmers was used as the dependent variable. The limit of commercialization was set at 25 percent (lower limit) thus any respondent who sold a volume of mangoes above 25 percent was considered commercial and those who sold below the level were considered subsistence. The independent variables fitted in the model were age, number of years in school, labour hours worked, land size, farmer group participation, borrowing of credit, market distance and agroforestry training. The chi square statistic value of the model was 60.61 and it had a p-value<0.05. This thus indicates the model was fit to be used.

The results in Table 13 show that age had a significant ($p< 0.05$) but negative relationship on the level of mango produce commercialization. A one year increase in the farmers' age reduced commercialization by 2 percent. This can be attributed to the bulkiness of mango produce which requires active labour to harvest, clean, sort, pack and transport to the market. This implies that older farmers were less likely to participate in selling their mangoes compared to younger farmers. Therefore, as the farmer ages the less likely to have more energy to effectively participate in the market. This finding is consistent with Erick *et al.* (2015), whose results indicated that the mango markets are dominated by the middle aged traders due to its laborious nature.

The number of years in school was used as a proxy for education. The study found out that the education level had a positive significant ($p<0.1$) influence on the level of commercialization. A one year increase in the level of education increased the commercialization level by 0.6 percent. The education level of farmers is hypothesized to influence produce commercialization. Households which have a higher level of education have a higher probability to engage in market participation (Omiti *et al.,* 2012). Due to the technicalities involved in handling market transactions commercialization favoured the educated farmers. The basic exchange of goods and services between two parties requires some level of understanding which is made easier by education. The findings are in line with Palapala *et al.* (2016), who found out that an increase in education level increases the probability of the farmer to participate in produce commercialization.

The number of hours worked had a positive significant ($p<0.1$) influence on the mango produce commercialization. All factors constant, a one hour increase in the labour hours invested in farming increased commercialization by one percent. This implies that with more hours worked in the farm

the more the mangoes produced thus consequently increasing the quantity of produce sold at the market. The possible reason behind this can be because more time is allocated to the enterprise then more energy and effort is applied to the farm enterprise. This thus eventually increases the quantity and quality of produce hence fostering commercialization. The finding corresponds to Ruth *et al.* (2017), study who found out that the more time allocated to a farm enterprise, increases its quantity commercialized.

The land size under mango acreage had a positive significant ($p<0.1$) relationship with the commercialization level. Holding all other factors constant, a one acre increase in land size increased the quantity commercialized by 18 percent. This implies that the more land allocated for mango farming increased the commercialization level of the farmer. The findings are in line with Christopher *et al.* (2014), who suggest that farmers with bigger land sizes are more likely to engage in commercial farming compared to farmers with smaller land sizes. Due to the small scale nature of farmers in Kwale and Kilifi Counties majority of the farmers allocate their farm land to food crops production. However, the farmers who allocated more land to mango farming earned higher returns compared to those who didn't. This implies that farmers with more land allocated to mango farming resulted to more commercial orientation of the farmer thus resulting to more profitability. The results are in line with HCDA (2011), which show that mangoes are the highest income earners among the tropical fruits in Coastal Kenya.

The results also indicate that farmer group participation had a positive significant ($p<0.01$) influence on the commercialization level. Participation of the farmer in a group increased the commercialization level by 14 percent. This implies that farmer groups increased the probability of farmers participating in commercial agroforestry. The result is in line with Innocent (2016), who found out farmer groups increases the propensity to commercialize by farmers. The increase in produce commercialization can be attributed to the technical and marketing assistance provided within farmer groups. Farmer groups also have the advantage of consolidating farmers produce to sell in bulk (Heike, 2016). This thus gives farmer groups an advantage in negotiating for better market prices compared to individual farmers. Therefore, this is another reason as to why farmer groups increased the probability to commercialize their produce because better market prices are always attractive to farmers.

Borrowing of credit had a positive significant ($p<0.01$) effect on the mango commercialization level. The results suggest that a one shilling access to credit by farmers increased the commercialization level by 6 percent. This is because credit facilities enhances the farmers' capacity to invest into better mango production, harvesting and marketing strategies. The finding is congruent with Yegoh and Kimeli (2013), whose results reveal that credit facilities enables small scale farmers to integrate into produce commercialization. This implies that the mango farmers who obtained credit in Kwale and Kilifi Counties sold most their produce compared to the farmers who did not receive credit.

A longer distance to the market is expected to lower the level of commercialization (Innocent, 2016). However, the results reveal that an increase in distance to the market had a positive significant ($p<0.01$) effect on the level of mango produce commercialization. A one kilometer increase in distance increased the commercialization level by 0.4 percent. The reason behind this is could be that distant markets offered better produce prices compared to the farm gate prices. The finding is in line with Kirimi *et al.* (2013), whose results indicate that the Coastal town markets offer lucrative prices for fruit produce due to the high demand from domestic and international tourist hotels. The lucrative prices thus covers the transport costs incurred by farmers to fetch the produce into the markets.

4.5.3 Cost Benefit Analysis of Agroforestry

The Cost Benefit Analysis of commercial and non-commercialized farmers was conducted to determine the viability of agroforestry among small scale farmers in Kwale and Kilifi Counties. The benefits in terms of income revenues from agroforestry produce sales and the costs in terms of the expenses incurred in production and transaction costs incurred on the produce were used in calculating the Net Present Value, Internal Rate of Return and the Cost Benefit ratio. The hypothesis is that farmers who undertake commercial agroforestry attain higher returns of benefits compared to those who practiced subsistence agroforestry.

The interest rate used to determine the net present value of agroforestry projects was 14% per annum while the time taken for mango trees to mature is approximately five years (World Bank, 2015). The study thus assumed that the first yields of the mango trees is harvested after five years.

The study used the total costs incurred from maintenance up to the transaction costs involved in taking the produce to the final consumer.

Table 11: Net Present Value, the Benefit Cost Ratio and IRR of agroforestry farmers

NPV		**BCR**		**IRR (%)**	
Commercial	Subsistence	Commercial	Subsistence	Commercial	Subsistence
2136.2	346.7	2.7	0.6	17	60

The results in Table 14 show that the net present value of commercial and subsistence farmers was positive thus implying that the agroforestry enterprises are economical viable in Kwale and Kilifi Counties. The finding is in line with Nair *et al.* (2012), whose results indicate that agroforestry has the potential to improve the economic livelihoods of small scale farmers. This is further enhanced by the favourable climatic conditions for tropical fruit growing and the high demand markets in Kwale and Kilifi counties coastal towns. However, the commercial oriented farmers had a higher net present value of KES 2136.2 compared to KES 346.7 per acre of subsistence farmers. This thus shows that the commercial oriented farmers had more present worth benefits stream compared to the subsistence farmers. This can be attributed to the high demand of fruits in the Coastal towns propagated by the booming hotel industry which requires a continuous supply of fresh fruits.

The results show that the internal rate of return (maximum interest rate) of commercial farmers was 17% while the internal rate of return for non-commercialized farmers was 60%. A higher discount rate implies greater uncertainty, thus a lower present value of the future cash flow (Fransisca, 2014). The finding thus implies that commercial oriented farmers had a higher present value of future cash flows compared to subsistence farmers.

The BCR ratio was used as a measure of the agroforestry enterprises profitability. The results indicate that the commercial oriented mango agroforestry farmers had a BCR of 2.7 while the subsistence farmers had a BCR of 0.6. The commercial agroforestry enterprises had a BCR of more than 1 thus profitable while the subsistence farmers had a BCR of less than 1 thus making losses. This implies that for the subsistence farmers, the costs incurred outweighed the benefits accrued which consequently resulted to negative profit margins. The finding is consistent with Hailua *et al.* (2015), whose results reveal that integration of small scale farmers into commercial markets increases their farm returns thus boosting their household incomes.

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The main objective of the study is to contribute towards improved livelihood of farm families through commercial agroforestry in Kwale and Kilifi counties. Primary data was collected from 208 respondents using the systematic sampling approach. The data was used for analysis in providing the descriptive statistics and econometric results. The descriptive statistics analyzed the socio economic characteristics of agroforestry small scale farmers and the existing systems practiced. The Multivariate Probit model was used to analyze the determinants of market outlets choice by agroforestry small scale farmers. For the farmers sampled, 15% sold at farm gate, 63% sold to middle men, 11% sold to local retailers while 11% sold to town markets. Finally, the Cost Benefit Analysis technique was used in determining the profitability and economic viability of commercializing agroforestry systems to small scale farmers. Farmers who ventured into commercialization had a BCR of 2.7 thus profitable while subsistence farmers had a BCR of 0.6 which implies they incurred more costs than benefits hence incurring losses.

5.2 Conclusions

The descriptive statistics show that majority of the agroforestry farmers are female compared to male farmers. The results also indicate that majority of the farmers are unemployed while the most practiced agroforestry system is mixed farming. The findings indicate that farmers with commercial agroforestry systems have more years of farming experience, higher education level and receive more income from their produce sales than the subsistence farmers. The institutional attributes of agroforestry farmers is also described where the farmers with commercial agroforestry systems have more access to credit, a higher participation in farmer self-help groups and receive more agroforestry training compared to the subsistence farmers.

The multivariate probit model was used to determine the factors affecting the choice of agroforestry produce market outlets used by mango producing small scale farmers. Education level, price, credit access and age have a negative influence on the selection of the farm gate outlet as only gender has a positive influence on choosing the outlet. Price, cost of transport and credit access has a negative influence on selection of middle men by small scale farmers while only negotiation cost has a positive influence on choosing of middlemen. Increase in mango price has

a positive significant influence on selection of the local retail market outlet while an increase in the cost of transport has a negative significant influence on choosing of the outlet by small scale farmers. Increase in distance, education level, price and age have a significant positive influence on the selection of the town market outlet while an increase in off farm income and negotiation cost results to a significant negative influence in choosing of the outlet by small scale agroforestry farmers. The farmers who sell their produce to town markets earn higher price returns as compared to the farmers who sell at the local markets and middlemen. Majority of the farmers with commercial systems sell their fruits to town markets which offer better prices compared to the subsistence farmers who sell their produce to middle men and farm gate outlets. Based on the results, commercialization of the agroforestry systems enables farm families integrate into high value market outlets which increases their returns.

Factors influencing the extent of agroforestry fruits commercialization were analyzed using the tobit regression model. The education level, labour hours worked, mango land size, farmer group participation, credit borrowing and distance to market outlet have a positive influence on mango agroforestry farmers' commercialization while age has a negative effect on the commercialization level. The Cost Benefit Analysis is used to determine the economic viability of the agroforestry enterprises to determine whether they are profitable or not. The agroforestry farmers who participate in fruits produce commercialization attain a net profit from their farm enterprises compared to the subsistence farmers whose costs outweighed their benefits. This indicates that commercial agroforestry positively impacts the incomes of small scale farmers thus consequently improving their living standards. It is therefore worth for small scale farmers to invest into agroforestry commercialization since the farmers who venture into it enjoy more benefits than the costs incurred.

5.3 Recommendations

According to the results, the study recommends that small scale farmers in Kwale and Kilifi Counties should adopt the new exotic mango varieties as they have more benefits in terms of growth time span, volume of the mangoes and a higher market worth. Agroforestry small scale farmers in the study area are encouraged to embrace education because the results reveal that the higher the education level attained, the higher the income attained from agroforestry practicing. Furthermore, the small scale farmers are encouraged to participate in farmer self-help groups as

they increased the farmers bargaining power in marketing their produce at better prices and provides them with the necessary farming inputs required.

The agroforestry farmers should engage into high value market outlets mainly the town markets as they offer better prices to farmers produce. Despite the longer distance and transaction costs involved in accessing the town markets, the prices offered by the outlet are high enough to cover the costs incurred which should motivate more small scale farmers to target the outlet. High transaction costs is one of the reasons why small scale farmers sold their produce to middle men. The agroforestry farmers thus need to be protected from exploitative middle men who take advantage of the farmers' desperate need of cash thus buying the produce at lower prices. The National and County governments within the study area have to set a law which indicates the minimum commodity buying prices for mangoes so as to cushion the small scale farmers from exploitation.

The agroforestry small scale farmers are encouraged to embrace commercialization of their produce as the income benefits outweigh the costs which eventually boosts household incomes. For commercialization to be effective the relevant stakeholders have to come up with policies like contract farming which will help the small scale farmers to produce with a purpose. The markets should be clearly defined such that farmers know exactly how to produce so as to meet the specifications of their target customers. Therefore, it is very fundamental for agroforestry farmers in Kwale and Kilifi Counties engage into commercialization as a way of improving their respective household incomes and economic growth of the region.

5.4 Further research

The study focused on the mango fruits commercialization in Kwale and Kilifi Counties. Due to the fact trees have multiple uses there is room for other researches on the potential of other tree commodities in Coastal Kenya for products like timber, wood, medicine and gum. This is necessitated by the increasing demand of building materials and the fact that majority of the households use fuel wood for energy purposes. The study focused on the income of agroforestry farmers as a measure of profitability. Another study need to be conducted on the influence of transaction costs on the income of agroforestry farmers. Furthermore, there is a need for a study be conducted if commercial agroforestry improves the living standards of households in terms of human and economic development. The study focused on the farmers with commercial systems

and subsistence farmers irrespective of the tree variety planted hence a need for research to be conducted on the benefits and costs involved between the indigenous and exotic mango trees.

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APPENDICES

APPENDIX A: Farmer/Household Questionnaire

Dear Respondent,

My name is Abel Mbega Mwembe, a student at Egerton University undertaking a Masters degree in Agribusiness Management. For the fulfillment of the course, I am required to undertake a research project in my area of study which will aid the local people. My research topic is on the **Effect of agroforestry fruits commercialization on the incomes of small scale farmers in Kwale and Kilifi Counties, Kenya.** You have been selected as one of the respondents in my research project. Your sincere responses will help in achieving this goal. The information given will be treated with utmost confidentiality.

Date of data collection…….County…….

Questionnaire No.……... Sub county…….

Respondent's Name ……Location…….

Enumerator's Name……..... Sub location……

SECTION A: Agroforestry farmers' socio-economic characteristics

1.0 Household socio-demographic information

1.1 Do you practice agroforestry? 1= YES 2= NO

1.2 Is it for, 1= Subsistence 2= Commercial

1.3 Other than agroforestry (tree planting) do you practice crop farming? 1=YES 2= NO

1.4 Who makes the main decisions on agroforestry in the household?

1= Husband 2= Wife 3= Children between 14 – 30 years.

1.5 For how long have you been practicing agroforestry (Years)……..

1.6 Age of the respondent in complete years……

1.7 Gender of the respondent. (Male=1, Female=0)

1.8 What is the education level of the respondent? ……

0=None 1=primary level, 2= secondary level 3=Certificate 4= Diploma 5=Degree holder 6=Postgraduate

No. of years spent in school…… (0-23 years)

1.9 What is the number of household members?.....

2.0 Of the household members how many are able to work on the farm?

Children below 13 years	Male between 14-65 years	Female between 14-65 years	Above 65 years

2.1 Main occupation of the respondent

1= Agroforestry farmer

2= Casual labourer, How much do you earn per month in KES?.....

3= Business person, How much do you earn per month in KES?.....

4= Private employed, how much do you earn per month in KES?.....

5= Government employed, how much do you earn per month in KES?.....

6= Others (Specify)……

2.2 What are your main sources of labour? (Hours worked per month)

1= Family 2= Hired 3= (In proportion)……..

2.3 What is the land tenure system of the household?

1= Self owned land 2= Communal 3= Leasehold

2.4 What is the size of land owned by the household in Acres?.....

2.5 Which agroforestry system do you practice among these?

1=Alley cropping 2=Mixed cropping 3= Others (Specify)

……

SECTION B: Institutional characteristics

2.0 Institutional characteristics household information

2.1 Are you a member of any agroforestry farmer group…….? 1=Yes 2= No [ ]

2.2 What are the benefits of the group?

1= Access to farm technical information

2= Access to loans

3= Marketing agroforestry produce

3= Others (Specify)……..

2.3 Have you received agroforestry trainings in the last two years? 1=Yes 2= No

2.4 Who offered the training?

1= Government extension officers 2= Non-governmental organizations 3= Others (Specify)……

2.5 How many times did you attend the trainings in the past two years..……?

2.6 Have you benefited from credit facilities? 1= Yes 2= No

2.7 Where did you borrow credit from?

1= Banks 2= Farmer groups 3= Micro finance institutions 4= Women groups 5= Cooperatives 6= Others (Specify)……

SECTION C: Marketing information of agroforestry fruits

3.0 Information on the agroforestry products commercialization extent, market outlets and effect on farm household incomes

3.1 Did you earn carbon credit from the trees planted in the last one year? 1= YES 2= NO

3.2 If Yes how much did you earn in 2018 and 2019 per Acre in KES?.....

3.3 What was the source of the carbon credit payment?.....

1= Government agencies 2= Non-governmental organizations 3= Kenya Wildlife Service 4= Others (Specify)

3.4 Do you get market information on where to profitably sell your products (Search cost)? 1= Yes 2= No

3.5 If Yes where do you obtain market information?

1= Neighbouring farmers 2= Farmer groups 3= Government Extension officers 4= Government parastatals (KFS) 5= Private organizations 6= Radio 7= Television 8= Newspapers 9= Internet

3.6 What was the cost of accessing information from the **main** sources in KES in the last one year?

Source of Information	Search Cost(KES)
Neighbouring farmers	
Farmer groups	
Government Extension officers	
Non-governmental organizations	
Radio	
Television	
Newspapers	
Internet	

SECTION D: Information on mango trees

4.0 Mango fruit trees

4.1 What is the size of the land put under Mango trees in Acres? .....(Tree pop×Spacing)

4.2 Currently how many trees are planted on the farm?

Mango trees……..

4.3 Which types of mango trees do you plant in your farm?

1= Ngowe 2= Boribo 3= Dodo 4= Others

4.4 How long does a mango tree take to start producing in years?

1= Ngowe variety……. 2= Boribo variety…… 3= Dodo……

4.5 How many times do you harvest mango fruits in a year?

4.6 What is the quantity of mangoes produced per Acre in the last one year/ Kg?.....

1= Ngowe variety……. 2=Boribo variety…… 3= Dodo……

4.7 What is the quantity of mangoes sold per Acre in KES?

Mango variety	Quantity Sold/Kg	Price/Unit in KES	Total Price
Ngowe			
Boribo			

4.8 Which market outlet do you sell your **mango fruits**?.....

1= Farm gate 2= Middle men 3= Local retail markets 4= Town markets 4= Processors 5= Exporters

4.9 Which percentage proportion did you sell to and the price offered by the **main** market outlet in 2018 and 2019?

	Farm gate	Middle men	Local retail markets	Town markets	Processors	Exporters
Percentage proportion						
Price offered						

5.0 What was the cost of the following in a mango tree in KES per tree until it matured? (Will calculate for the Acre). 1= Seedling 2= Land preparation 3= Planting 4= Maintenance 5= Harvesting

Mango tree type	Seedling	Land preparation	Planting	Maintenance	Harvesting	Total Cost
Ngowe						
Dwarf						
Others(Specify)						

5.1 On average how much did you incur to maintain a mango tree in the past one year (2018) in KES?

Ngowe…….. Boribo……Dodo…….

5.2 What is the approximate distance in Km from the farm to the **main** market outlets?

Local retail markets	Town markets	Processors	Exporters

5.3 Which **common** means of transport is used to access the **main** market outlets?

1= Human 2= Motor cycles 3= Push carts 4= Pick-ups 5= Trucks

Local retail markets	Town markets	Processors	Exporters

5.4 How much does it cost to transport to the main market outlet per trip in KES?

Means of transport	Local retail markets	Town markets	Processors	Exporters
1=Human				
2=Motorcycles				
3=Push carts				
4=Pick up				
5=Truck				

5.5 What is the negotiation cost in KES incurred for carrying out transactions in the **main** market outlet?

Market outlet	Local retail markets	Middle men	Semi processors	Processors	Exporters
Cost					

APPENDIX B: Tobit regression analysis

Tobit regression — Number of obs = 208
Uncensored = 132
Limits: lower = 0.25 — Left-censored = 76
upper = 1 — Right-censored = 0

LR chi2(12) = 64.98
Prob > chi2 = 0.0000
Log likelihood = -37.332787 — Pseudo R2 = 0.4653

Comm_index	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Agrofo_experience	.0013304	.0024923	0.53	0.594	-.0035848	.0062456
AGE	-.0231505	.0090287	-2.56	0.011	-.0409564	-.0053446
No_yrs_in_sch	.0066571	.0039384	1.69	0.093	-.0011101	.0144243
HOURS_WORKED	.0010906	.0006233	1.75	0.082	-.0001387	.0023198
LAND_TEN_SYST	.0198946	.0245307	0.81	0.418	-.0284834	.0682726
LAND_SIZE	-.0118319	.0176414	-0.67	0.503	-.0466233	.0229595
LANDSIZE_MANGO	.1821188	.0524585	3.47	0.001	.0786631	.2855744
FARMER_GRP	.1362901	.052589	2.59	0.010	.0325771	.240003
ACC_CRED_FACILITIES	.0639966	.0374299	1.71	0.089	-.0098205	.1378137
DIST_MKT_OUTLT	.0044446	.0014506	3.06	0.002	.0015839	.0073053
AGROFO_TRAINING	-.0799731	.0381519	-2.10	0.037	-.155214	-.0047322
_cons	.6001253	.2183691	2.75	0.007	.1694705	1.03078
var(e.Comm_index)	.0433822	.0057393			.0334195	.0563148

APPENDIX C: Abstract of the paper published from the work

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FOOD SCIENCE & TECHNOLOGY | RESEARCH ARTICLE

Factors affecting market outlet choice of agroforestry based mango producers in Kwale and Kilifi counties, Kenya: The application of the Multivariate Probit model

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Abstract: Access to profitable market outlets for agroforestry mango producers is a major concern in Kwale and Kilifi counties. This paper is set to determine the factors affecting the choice of market outlets among agroforestry mango producers. The study analyzed the market outlets chosen by producers to find out which were the most prevalent chosen. The multivariate probit model was used to determine the factors that affect the choice of market outlets among the agroforestry mango producers. Data were collected using exploratory research through the systematic sampling approach. This resulted in an ultimate selection of 208 respondents, half of which participated in commercial farming and the other half practiced subsistence agroforestry. The results show that of the sampled respondents, 15% sold at farm gate, 63% sold to middlemen, 11% sold to local retailers and 11% sold to town markets. The Multivariate Probit model results indicate that education level (5%), price (1%), access to credit (5%) and age (10%) had a negative significant influence on the producers' choice of farm gate market outlet as only gender had a positive influence at 10% significance level. Negotiation costs and

APPENDIX D: Research permit

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