

**FACTORS INFLUENCING GRAFTED MANGO (*Mangifera indica* L.)**

**PRODUCTION IN MATINYANI DIVISION, KITUI COUNTY.**

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**Thesis Submitted in Partial Fulfillment of the Requirements for the Degree  
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**JUNE 2015**

## DECLARATION AND APPROVAL

This thesis is my original work and has not been submitted or presented for a Degree in any other University, either in part or as a whole.

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## **DEDICATION**

I dedicate this work to my beloved wife Mrs. Esther Muia Kasee, my daughter Peace Mukai Kasee and my son Samuel Mulinge Kasee, who encouraged me to undertake further studies and supported me financially and spiritually. To my mum Lucia K. Mulinge, who kept on reminding me to work very hard in order to better my future. Lastly, to all my family members and friends.

## **ACKNOWLEDGEMENT**

I sincerely appreciate my supervisors Prof. Reuben M. Muasya, Prof. Thomas E. Akuja and Dr. Jacinta M. Kimiti for their unwavering support, understanding and valuable guidance through all steps of this thesis development. The project was realized through their scholarly advice and guidance.

Special regards and appreciation to mango farmers who willingly provided very useful information making the study a great success.

I also appreciate the Ministry of Agriculture, Livestock and Fisheries in Kitui County, who assisted me to reach mango farmers and also provided me with resourceful information that was critical for the success of this study.

I do also thank South Eastern Kenya University for availing me the precious chance to pursue a Master of Science Degree in Agricultural Resource Management. It was such an eye opener and experience.

## ABSTRACT

Mango (*Mangifera indica L.*) fruit is produced and consumed globally, regionally, and locally. The fruit is a potential source of essential nutrients including potassium, phosphorous, magnesium and is an excellent source of vitamin A and C. Mangoes can also be sold to earn income. However, most smallholder mango farmers in Matinyani Sub-county experience lack of clean planting materials, inadequate production technologies, inadequate mango varieties with long production cycles and poor transport infrastructure. In addition, higher losses are incurred due to surplus experienced during the peak of production seasons. This raise a need therefore, for enhancing agronomic and agro-processing activities on mango fruit in order to obtain products of high value and long-shelf life as a way of mitigating losses, diversifying utilization and markets. Thus, this study was conducted at Matinyani Division of Kitui County to investigate the factors influencing grafted mango production in Matinyani Division. A sample of 120 mango farmers was studied and simple random sampling technique was used to select respondents. Primary data was obtained by use of questionnaires while secondary involved review of relevant literature. Data collected was analyzed using Statistical Package for Social Scientists (SPSS) version 20.0 of year 2009.

The results revealed that in Matinyani Division both local and grafted mangoes were grown. The local mangoes grown included: Ngowe, Dodo and Boribo. Varieties of grafted mangoes grown included: Apple, Kent, and Tommy with majority of the farmers growing Apple mangoes. It was established that, majority of respondents consumed grafted mangoes in form of a dessert with 62% in Matinyani location, 73% in Kalimani location and 74% in Kauma location. None of the respondents consumed grafted mangoes as sliced packed mangoes or dried powder. This indicated that the level of value addition in the Division was low resulting to high mango losses which translated to low income generation. The study also revealed that majority of the respondents sold their grafted mangoes within the locations with Kauma location leading with 67%, followed by Matinyani location at 60% and then, Kalimani location with 55%. None of the respondents sold their grafted mangoes outside the Sub-County which implied lack of adequate market linkages. Finally, the study established that majority of the respondents earned KES 1,000 to KES 5,000 with the highest earning KES 15,000 per annum from sale of local mangoes while, majority earned KES 6,000 to KES 9,000 with highest earning KES 20,000 per annum from sale of grafted mangoes.

The recommendations for this study were: First, farmers should be sensitized to increase grafted mango production compared to local mangoes since grafted mangoes can be processed to products of higher economic value like mango juice. Second, the County Government, NGO's, private sector and other stakeholders need to avail adequate and up to date value addition, marketing and processing technologies to improve shelf- life of mango fruit and enhanced incomes. Third, farmers should organize themselves into self-help groups, farmers associations or co-operative societies in order to have a common collection and marketing of mango produce. This will minimize costs and maximize mango returns due to economies of scale. Finally, farmers should be sensitized to increase grafted mango production and reduce local mango production since the sale of grafted mangoes earned more income.

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## ACRONYMS

<b>ANOVA</b>	Analysis of Variance
<b>CAN</b>	Calcium Ammonium Nitrate
<b>FAO</b>	Food Agricultural Organization
<b>FAOSTAT</b>	Food Agricultural Organization Statistical Databases
<b>FFTC</b>	Food and Fertilizer Technology Centre
<b>GoK</b>	Government of Kenya
<b>HCDA</b>	Horticultural Corporation Development Authority
<b>IFAD</b>	International Fund for Agricultural Development
<b>KARI</b>	Kenya Agricultural Research Institute
<b>KES</b>	Kenya Shillings
<b>LSD</b>	Least Significant Difference
<b>M</b>	Meters
<b>MM</b>	Millimeters
<b>MOA</b>	Ministry of Agriculture
<b>MT</b>	Metric Tonnes
<b>NGO's</b>	Non-Governmental Organizations
<b>Ph</b>	Potential of Hydrogen
<b>SPSS</b>	Statistical Package for Social Scientist
<b>USAID</b>	United States Agency for International Development
<b>USD</b>	United States Dollar

## CHAPTER ONE

### INTRODUCTION

#### 1.0 Background of the Study

Mango (*Mangifera indica L.*) is one of the most important fruits in the tropics and subtropics. It originated from the foothills of the Himalayas of India and Burma where it has been cultivated in that region for at least 4,000 years (FAOSTAT, 2007). The United States is the largest single-country importer of mangoes and has developed the most popular cultivars traded on the international market (FAOSTAT, 2007).

According to HCDA (2009), the horticulture sub-sector is the fastest growing industry in the Agricultural sector. It employs directly and indirectly about 4 million people and smallholder farmers contribute over 60% of the production. The horticulture industry generated KES 73.3 billion in foreign exchange from exported commodities and over KES 65 billion domestically in the year 2008 (HCDA, 2009). Fruit and vegetable sectors are appropriate sectors where smallholder farmers are able to participate due to low demand on land and moderate labour requirements (Andrea, 2012).

Mango is a major fruit in the horticultural industry and it plays an important role in poverty reduction by providing employment to about 2 million people annually (MOA, 2004 – 2014). It is exported to earn foreign exchange while at the same time acting as a source of food and household income for farmers (HCDA, 2007). Mangoes are important sources of provitamin A carotenoids, particularly  $\beta$ -carotene (Rodriguez, 2001) and mostly contribute in alleviating Vitamin A deficiency, whose prevalence is high (MOA,

2007). They are also rich in other non provitamin A carotenoids which have diverse roles and benefits for human health including antioxidant activity, cell communication, immune function enhancement and UV skin protection (Palozza and Krinsky, 1992).

In Kenya, mango fruit has been the third most important in terms of area and total production after bananas and pineapples (HCDA, 2010). The hectares under mango production, production output (Tonnes) and the revenue earned have continued increasing over years (HCDA, 2011). Hectarage increased from 36,304 to 59,260, production from 528,815 MT to 636,585 MT and revenue earned increased from USD 104,616,297 to USD 139,836,268 (HCDA, 2011).

In Kenya, research on mango has been accorded a high priority under the horticulture program (KARI, 2008) which has concentrated on varietal introduction of high yielding varieties (Gathambiri *et al.*, 2006) which have different qualities that are suitable for either fresh consumption or processing. Despite this, Kenya's potential in mango production has not been fully exploited due to constraints such as diseases and insect pests, poor agronomic practices, weak marketing structure and glut during peak seasons (MOA, 2006).

Two types of mango are grown in Kenya, the local and the exotic or improved varieties (FAO, 2005). The latter are usually grafted on local mangoes and are grown for consumption and processing. Most local varieties tend to have high fibre content, commonly referred to as "stringy", and this characteristic makes them unpopular for processing (FAO, 2005). The local mango varieties are usually left to grow naturally

without much crop husbandry. KARI, (2008) introduced widely adopted varieties leading to increase in production levels especially in Eastern, Coast and Central regions.

Mango production is mainly carried out by smallholder farmers who depend largely on brokers, local traders or export agents for market information. This kind of market arrangement is generally unstable and offers them low and unpredictable prices. When the retail and wholesaler prices are high, middlemen try to control the market prices by reducing their market margin and when the prices are low middlemen try to get more benefits by increasing their market margin (Sandika, 2011). Most mangoes produced are consumed within the same production area or sold in local urban markets which result to high wastage due to surplus in the market and perishability of the same (FAO, 2005).

Mango processing in Kenya has not expanded, and only a negligible share of total production is currently processed (FAO, 2005). Currently, there is only one large mango processing firm located in Coast Province Milly Fruit Industries (Gitonga *et al.*, 2009). However, local juice and jam makers import mangoes in the form of concentrates mainly from Mauritius, Egypt and South Africa (Gitonga *et al.*, 2009). There is, therefore, a potential for increasing processing of mangoes into products of high value and long-shelf life as a way to mitigate against losses due to gluts in production while at the same time diversifying utilization and markets (Gathambiri *et al.*, 2006, KARI, 2004). During post harvest handling, at least 40-45% of fruit is lost due to mechanical damage, pests and diseases, excess fruits in the market and immature harvesting (Gathambiri *et al.*, 2006, KARI, 2004)

With about 70% of the labour force being involved in agricultural activities with very low profitability, poverty is still wide spread and more people find their way to the urban areas in search of a better future (Singh, 2002). Furthermore, quality standards for products are very high in particular the European Union, which often makes it more complicated for farmers from developing countries to sell their farm produce (Singh, 2002). Kenya is the leading mango producing country in Africa but still, many mangoes do not make it to the customer, due to perishability, bad quality or poor road infrastructure and inefficient ports (Mungai *et al.*, 2000). The huge amount of fruits that perish could be decreased if mangoes were processed.

## **1.2 Statement of the Problem**

In Kenya, ninety five percent (95%) of mango produced is made up of indigenous varieties which have high fiber content and are of little market value (FAO, 2005). The mangoes are either consumed within the households or sold for fresh consumption (Nakasone and Paul, 1998). Mango exports from Kenya are declining despite the expansion in demand for fresh fruits in Europe and the Near East. This is attributed to high fiber contents, unreliable supplies arising from pest infestation and crop mismanagement, as well as inadequate infrastructure, which raise the costs and the risks of shipping products abroad (FAO, 2005).

According to Serem (2010), mango production and marketing in Kenya has faced numerous problems among them: lack of clean planting materials, poor agronomic practices, poor transport infrastructure, inadequate postharvest handling techniques, price fluctuations in internal and external markets and limited knowledge on marketing which

has led to low levels of mango production and low returns, hence, food insecurity and low income for small farmers has remained high.

In Kitui County, the ecological zone forms an essential prerequisites for good development of mango tree, however, the potential for crop production is under-utilized with only 77,000 ha and 2,000 ha under food and cash crop production respectively, including mango production (GoK, 2002). Moreover, the County experiences lack of improved mango germplasm technologies, inadequate processing facilities, poorly developed transport infrastructure and unreliable supplies. Hence, production of grafted mangoes for domestic consumption, local and international market is low. Further, the problem has resulted in smallholder farmers relying on local mangoes which are very small in size, highly perishable and have high fibre content (FAO, 2005). Therefore, failure to address these problems will lead to increased poverty and food insecurity in the area and it is against this background that, the study focused to address factors that influence grafted mango production in Matinyani Division with an aim of improving food security and enhancing household income.

### **1.3 General Objective**

The general objective of this study was to investigate factors influencing grafted mango production in Matinyani Division, Kitui County with an aim of improving food security and enhancing farmer's income.



#### **1.4 Specific Objectives**

In order to investigate factors influencing grafted mango production in Matinyani Division Kitui County, the following specific objectives were addressed in the study:

1. To determine varieties of grafted mangoes and the extent to which they are grown in Matinyani Division,
2. To evaluate the adoption of value addition on grafted mango fruits in Matinyani Division,
3. To determine the market linkages for grafted mangoes produced in Matinyani Division,
4. To assess the impact of income from grafted mango on the livelihoods of mango farmers in Matinyani Division.

#### **1.5 Research Questions**

1. Which varieties of grafted mangoes are grown and to what extent are farmers growing them in Matinyani Division?
2. Which value addition practices have the farmers adopted on grafted mango fruits produced in Matinyani Division?
3. Which markets do farmers use to sale grafted mangoes produced in Matinyani Division?
4. How does income from grafted mangoes affect the livelihoods of mango farmers in Matinyani Division?

## **1.6 The Significance of the Study**

The study determined factors influencing grafted mango production in Matinyani Division. The results from this study will be used by County Government and other stakeholders to develop programs and policies that will establish the best mango varieties, adequate and up to date marketing and processing technologies which will minimize costs and maximize returns hence, enhancing farmers' income and improving food security. The results will also be used by Agricultural extension officers and other extension agents to train mango farmers on appropriate agronomic practices, mango value addition and postharvest handling of mango fruit, hence, increasing production of mangoes and minimizing postharvest losses. The study will also help mango farmers to focus mango production as a potential source of income generation and strategize on how to increase the production and attract more consumers leading to increase in market scope for mango produce. Finally, it is hoped that the findings from this study will be used as a basis for further research on factors influencing grafted mango production within and outside Matinyani Division.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.0 Origin of Mangoes

Mango (*Mangifera indica L.*) is a tropical, subtropical and frost-free fruit. It originated from the foothills of the Himalayas of India and Burma and has been cultivated in that region for at least 4,000 years (FAOSTAT, 2007). The United States is the largest single-country importer of mangoes and has developed the most popular cultivars traded on the international market (FAOSTAT, 2007).

In Africa, Nigeria produces the largest amount of mangoes in the continent and occupies the eighth position in the world ranking of mango producing countries as at 2002, producing 730,000 MT annually, Kenya is in the ninth position (FAOSTAT, 2007). In Kenya, the crop is mainly grown in Coast, Rift Valley and Eastern regions. Although the mango tree is not indigenous to Kenya, it has been cultivated in the Coast Province for centuries with traders in ivory and slaves bringing the seed in the country during the 14th century (Griesbach, 2003).

Two types of mangoes are grown in Kenya, the local and the exotic or improved varieties (FAO, 2005). In Eastern region, both local and exotic varieties are grown. The local varieties include: Ngowe, Dodo, Boribo and Batawi while the exotic varieties include: Apple, Kent, Keit, Tommy Atkins, Van Dyke, Haden, Sensation, Sabre, Sabine, Pafin, Maya, Kenston and Gesine (FAO, 2005).

## 2.1 Mango Ecology and Growth Requirements

Mango (*Mangifera indica L.*) is successfully grown on a wide range of soils. Mango trees do well in sandy soils at the coastline as well as on loam, black cotton and even murrum soils at other elevations. The essential pre-requisites for good development of the trees are deep soils (at least 3 m), appropriate rainfall (500-1000 mm), good drainage, suitable altitude (0-1200 m) and preferably a pH of between 5.5 and 7.5 (Griesbach, 2003). The tree itself is not difficult to grow and, once well established, is relatively tolerant to drought, occasional flooding and poor soil conditions (Griesbach, 2003).

Among the various climatic factors, temperature, rainfall and humidity have a greater bearing on mango production. Furthermore, production of high quality mango fruit does not depend on elevation but on prevailing temperatures. The two important considerations for mango cultivation are a dry period at the time of flowering, which in Kenya is mainly during the months of August to October and sufficient heat during the time of fruit ripening. For optimum growth and productivity, a temperature range of between 20-23°C is believed to be ideal for mango fruit appearance, palatability and decay control (Paull and Chen, 2004). Temperatures exceeding 40°C, especially in hot/dry areas, may lead to sunburn of mango fruits and stunting of tree growth (Griesbach, 2003).

According to Griesbach (2003), the amount of rainfall in a given locality is not as important as its intensity and distribution to mango growth. Rainfall of 500-1000 mm

at the right time of the year is sufficient for successful mango cultivation. However, mango can not do well in areas which experience frequent rains or very high humidity during the flowering period. Such conditions are not conducive to good fruit set and increase disease incidence such as powdery mildew (*Podosphaera xanthii*) and anthracnose (*Colletotrichum graminicola*). Anthracnose can be a major problem because it also attacks avocado (*Persea americana*), coffee (*Coffea arabica*) and papaya (*Carica papaya*). Powdery mildew is common under low temperatures accompanied by high humidity.

### **2.1.1 Mango Growth and Management**

Mango is a long-lived perennial fruit tree; its planting distance usually depends to a large extent on the vigour of the cultivar/root stock and the environment. Most orchards (either solely mango or a few trees on small farms) are planted too densely and trees are forced to grow upright and tall. Overcrowding results in the production of fewer fruits which are poorly coloured and infected with diseases. Tall trees also present a harvesting problem and create difficulties during spraying and pruning.

Normally, grafted mangoes are spaced at 8 x 10 m or 10 x 12 m, though at the coast seedlings require 12 x 14 m. Mango trees develop into strong well-shaped trees within the first 4 years and do not require pruning unless there are excessive branches or the shape is unusual. Grafted mangoes tend to flower from the first year, and the formation of fruit on year-old mango trees is nothing exceptional. Early flowering has to be avoided by removing the inflorescences. From third to fourth year, mango trees can be allowed to bear fruits (Gathambiri *et al.*, 2006).

In general, mango tree at full bearing age (7 years and older) needs about 1.5 to 2.5 kg of Calcium Ammonium Nitrate (CAN) (26 % N), 2.25 kg Superphosphate and 0.75-1.5 kg Potassium Chloride per year or the equivalent inputs from manure or compost for small-scale farmers. These quantities can be supplied either at one time or may be split into two doses administered within two-month interval (HCDA, 2007). Gathambiri *et al.*, (2006) also add that orchards should be kept clean, especially under the canopy of the trees where the fertilizer is spread uniformly in a circular belt around the drip line.

### **2.1.2 Mango Fruit Maturation and Harvesting**

Studies on factors that determine the final quality of mango fruit at consumer level have generally focused on maturity at harvest (Jacobi *et al.*, 1995; Lalel *et al.*, 2003) and also on postharvest management (Hoa *et al.*, 2002; Nunes *et al.*, 2007). Griesbach (2003) noted that depending on cultivars and environmental conditions, it takes 90 to 160 days after flowering for Kenyan mango fruits to reach maturity.

Mango fruit maturation occurs in the final stages of fruit growth, resulting in rise in respiration rate and ethylene production (Akamine and Goo, 1973). Since mango fruit is generally harvested green, the onset of the climacteric phase is studied during fruit storage according to the maturity stage at harvest (Lalel *et al.*, 2003). Not all fruits on one tree ripen at the same time and the challenge is to determine precisely the stage at which the fruit is ripe for picking. Mango fruits harvested too early have inferior quality after storage while those picked when too ripe can not be stored for long period of time and

may give rise to problems such as jelly seed. Mango fruit has its best flavour if allowed to ripen on the tree (Griesbach, 2003).

Mango fruits are generally picked when they begin to change colour. That occurs first in a small area or the change covers most of the fruit's surface (Griesbach, 2003). However, one maturity test that can be applied even before the external colour break starts is to examine the colour of the flesh around the seed. When it begins to change from green-white to yellow or orange, it indicates that the fruit is beginning to ripen and may therefore, be picked (Griesbach, 2003). Also the greater the swelling of the shoulders above the stalk attachment, the riper the fruit is likely to be (Griesbach, 2003).

During and after harvesting, the highly perishable fruit must be handled with the greatest care. The fruit is removed from the tree by cutting the fruit stalk about 2 cm from the fruit. This prevents the latex (exuded from the cut stalk) adhering to the skin of the fruit, staining it and rendering it unattractive (Griesbach, 2003). Ladders or long picking poles with a cutter blade attached with canvas bag, held open by a ring, are also used. To avoid physical damage, the picked mangoes should be carefully placed into clean wooden or plastic containers and not gunny bags. If there is a delay in the transfer of the fruits to a store or packing shed, they should be kept in a sheltered place to minimize sunburn, loss of moisture and accumulation of dust. After any sorting, grading, washing, fungicidal treatment and perhaps waxing, the fruits are ready for packing, preferably into shallow single-layered trays of 4-5 kg each (Griesbach, 2003). Since mangos are harvested during the summer months, the fruit temperature may be as high as 35°C and more. This has a detrimental effect on the shelf life of the fruit. It is, therefore, advisable to move the

packed fruits into cold storage as quickly as possible to help them lose this inherent heat (Gathambiri *et al.*, 2006).

## **2.2 Varieties of Grafted Mangoes**

In the international market, fresh mango is one of the main traded products. It takes a fifth place on total fruit crop production globally (Tharanathan *et al.*, 2006), accounting for over one-third of the worldwide production of tropical fruits (Maneepun and Yunchalad, 2004). Mangoes are grown in almost all continents (Galán, 2004). At least 87 countries were involved in mango production by the year 2000 (Tharanathan *et al.*, 2006). Around 25 million tons of mangoes were grown in 2000 (Galán, 2004) of which three-quarters were in Asian countries. India is by far the world's leading mango producer contributing about half of the global mango production, however, it exports very small amount of this amount. Mexico, Pakistan and the Philippines are the most important exporters for fresh mangoes with 41%, 7.6% and 7.8% respectively of the global supply (Galán, 2004).

In Kenya, many varieties of mangoes have been introduced in Eastern region. Survey results (Gitonga *et al.*, 2008) revealed that Tommy Atkins is the most popular being planted by 49.4% farmers followed by Kent 18.2%, Haden 14.3%, local variety 7.8%, Apple 3.9% and Van dyke 2.6%. These results were contrary to survey results by (FAO, 2005) on mango varieties in major producing areas in Kenya which revealed that 95% of mango produced is made up of indigenous varieties. That indicates an increase in grafted mango production over a 3 year period (2005 to 2008). Further, the average number of trees species per farmer was 31 trees with an average age of 9 years. A similar



study by Gathambiri *et al.*, (2006) on variety of mangoes also revealed that farmers preferred Tommy and Kent as good for processing.

Source of planting materials varied from farmer to farmer. Majority of the farmers sourced their planting materials from neighbors (37.7%), and own farms (10.4%). Others sourced planting materials from groups that had mango nurseries, as well as from KARI and Ministry of Agriculture (MOA).

### **2.3 Mango Cultivation and Processing in Kenya**

Mango production in Kenya is concentrated in the Coastal, Central and Eastern regions (FAO, 2005). Significant production also takes place in the Western parts of the country, in Nyanza and in the low lying areas of Rift valley such as Marakwet. Both small and large scale mango production is practiced in Kenya for both locally and export markets. In addition, significant mango quantities are processed into juices and fruit concentrates in an attempt to add value. However, mango exports from Kenya are declining despite the expansion in demand for fresh fruits in Europe and the Near East. This is because of unreliable market supplies, arising from pest infestation and crop mismanagement, as well as inadequate infrastructure, which raise the costs and the risks of shipping products abroad (FAO, 2009).

Mango production is faced by serious challenges like seasonal over-production, inadequate post-harvest handling techniques and facilities that lead to significant losses (up-to 40%), limited access to information on technology in value addition, inadequate clean and quality planting materials, limited access to information on technology in

husbandry practices, pests such as mango weevil and fruit fly. Mango is a highly perishable seasonal fruit and large quantities are lost during the peak season as a result of poor postharvest handling.

Based on data from MOA (2007), Mango processing in Kenya has not expanded, and only a negligible share of total production is currently processed. Only one large-size mango processing firm based in Mombasa County processes mangoes. Other local juice and jam makers import mangoes in the form of concentrates mainly from Mauritius, Egypt and South Africa (Gitonga *et al.*, 2009). In principle, therefore, there is potential for increasing processing of grafted mangoes. Local production, however, is of low quality (FAO, 2005), as 95% of mangoes produced in Kenya are indigenous varieties which have high fibre content.

Constraints hindering the development of the mango supply chain can be categorized into four basic stages in the supply chain (FAO, 2005); the farm level, the marketing stage, the processing stage and the export stage. At the farm-level, key constraints faced by farmers include lack of clean planting materials, inappropriate management technology, the length of the production cycle and inadequate post-harvest handling facilities. At the marketing stage, major constraints include poorly developed transport infrastructure, such as bad road conditions that serve production areas which further contribute to post-harvest losses and low mango quality leading to low selling prices. At processing level, the main constraints include insufficient plant capacity and organization of supplies. Finally, at the export stage, there is unreliable supplies and

inferior mango quality which can not meet the international market standards. These challenges could be addressed through value addition.

#### **2.4 Market Linkages for Mangoes**

Marketing grafted mangoes involves pricing, promoting, and distributing mangoes from the farm to consumers. During the process of distribution and marketing of mangoes, substantial losses are incurred which range from 1 to 50%, depending upon the country (FFTC, 2004). Serem, (2010), pointed that poor transport infrastructure, especially the rural and trunk roads constitute significant challenge to Agriculture in Africa. Not only are there few roads, but transport costs in Africa are among the highest in the World, reaching as much as 77% of the value of exports (Serem, 2010).

In tropical and sub-tropical countries, the warm, humid climate adds more stress and accelerates the decay of tropical mangoes. Brecht *et al.*, 2010 noted that, mangoes are susceptible to many physical, physiological and pathological defects which include anthracnose, jelly seed and sunburns. All these post-harvest problems reduce the prices and competitiveness of mango produce.

According to Kehlenbeck, (2010), the market for fresh fruit currently constitutes the biggest market for mangoes accounting for almost 90% (165,000 MT) in 2010. Within this market, the urban market is the biggest and most lucrative accounting for 75% of the total marketed production (14,200 MT) valued at KES 5.3 billion annually. Apart from fresh fruit market, there is also processing of fresh fruits for extraction of

juice. International market for mango fruits from Kenya account for 10% total value of marketed mangoes estimated at KES 800 million in 2011 (HCDA, 2011).

Priorities within the post-harvest sector of developing countries have evolved from a primarily technical focus geared towards the reduction of mango losses to a more holistic approach designed to link on-farm activities to processing, marketing, and distribution (Mrema and Rolle, 2002). In this scenario, new organizational structures for mango marketing, such as cooperative marketing, contract farming and supermarket are considered better ways to reduce post-harvest losses. However, such market arrangements either have transaction costs or are biased towards large farmers (Mrema and Rolle, 2002).

Marketing process for mangoes need to be undertaken as efficiently as possible, with lowest cost and minimum losses occurring so that it will be more competitive, hence facilitating economic growth and maximizing benefits to mango farmers (Adimado and Baah, 2002). The relationships among mango farmers, wholesalers, and retailers play an important role in the marketing of mango produce. Such linkage creates a mutual trust among different functionaries in the marketing system, but may also cause a dependency relationship between parties and make it difficult for newcomers to enter the marketing process since they may be often based on village proximity (area based) or on family relationships developed over many years (Karl and Leinemann, 1996).

In rural markets, trade is characterized by direct sales of small quantities of produce by producers to village traders and by retail sales to rural consumers. The rural

markets normally form part of a local trade network and are usually arranged on a periodic basis, on specific weekdays (FAO, 2005). They are commonly organized at a central place in a village or Sub-County centre or beside a village's access road. In some instances, County and Sub-County level markets also serve this function, as well as providing an assembly function (by combining produce in larger quantities for onward sale to outside buyers) (Maneepun and Yunchalad, 2004).

Terminal wholesale and semi-wholesale markets are located within or near major cities. If an urban population exceeds 0.5 million some form of wholesale facility is likely to develop (Adimado and Baah, 2002). These centers may be supplied by purchasing/assembly centers in the rural areas or directly from farms, particularly those in peri-urban areas. The supply is either from agents, traders or by the farmers themselves. Within wholesale markets, traders often handle transactions and only large producers deliver their own produce directly. Thus, the produce after its arrival in an urban area often passes through a number of intermediaries, including retailers before it reaches consumers.

In many countries small retail shops, often termed "corner" shops and roadside stands provide produce close to consumers' homes (Adimado and Baah, 2002). Alternatively, with very low-density urban areas mobile shops or stalls may supply consumers (Maneepun and Yunchalad, 2004). These retailers usually purchase their produce from wholesale markets, although in some cities there are many small hawkers, operating from bicycles or small carts, which provide retailers with small quantities of produce or sell directly to consumers. In Kathmandu, for example, hawkers account for

more than 25% of the produce out flow from the wholesale markets (Tharanathan *et al.*, 2006).

Kameri, (2012) established that, training and research is one of the major requirements for profitable enterprise and recommended that research on marketing should be intensified and the findings made available to farmers. Farmers' success and sustainability are determined by extent of their equitable participation in markets accompanied by their higher level of training on marketing (Serem, 2010).

## **2.5 Impact of Income from Grafted Mango Production in the Livelihoods of Mango Farmers**

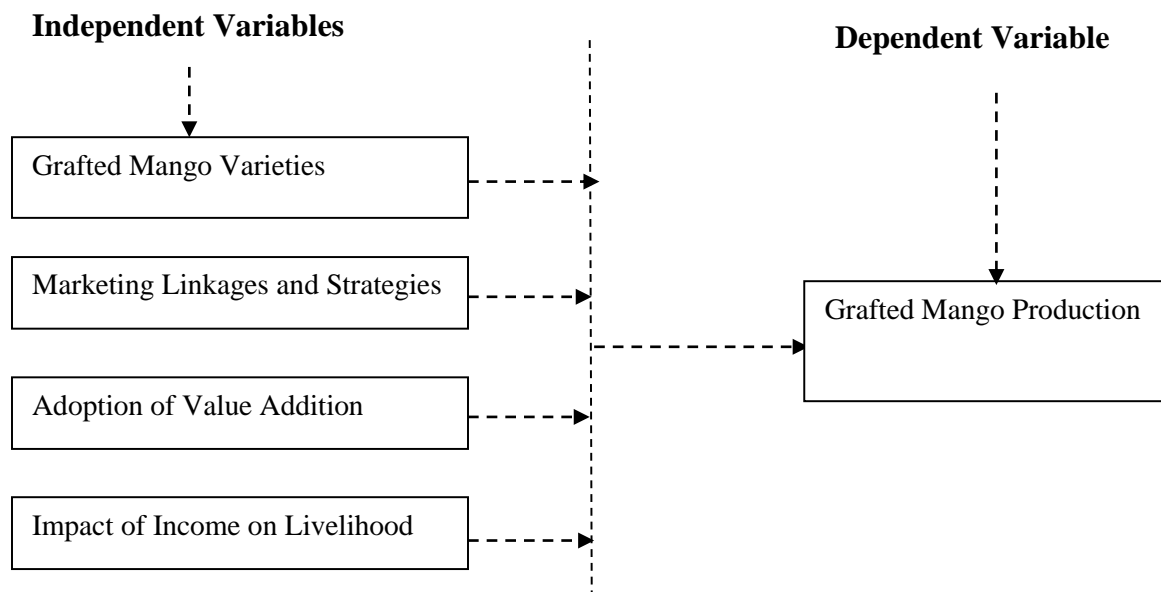
Mangoes are grown worldwide (Galán, 2004). At least 87 countries were involved in mango production by the year 2000 (Tharanathan *et al.*, 2006). Mangoes have attractive appearance and very pleasant taste and are, therefore, claimed to be the most important fruits in the tropics. It has been touted as 'king of all fruits' (Griesbach, 2003). Mangoes are important horticultural fruits both for domestic and export markets with considerable potential of foreign exchange and employment (Muriithi *et al.*, 2004). There are great diversity of mango fruit types which permits considerable manipulation for various purposes and markets: juice, chutney, pickles, jam/jelly, fresh fruit, canned and/or dried fruit etc. Given the multiple products, it is, therefore, a potential source of foreign exchange for a developing country; it can be eaten fresh or processed to make fruit drinks constituting an important source of energy, combating nutritional disorders (Litz, 1997). It is also a source of employment for a considerable seasonal labour force (Griesbach,

2003). Mango compares favourably in food value with both temperate and tropical fruits. Indeed the fruit contains almost all the known vitamins and many essential minerals.

Mango plays an integral part in rural household lives not only by being rich in nutrients but also serving as a common good that is consumed casually. In Kenya, mango production is consumed locally contributing to food security. In rural areas, mango serves principally as complementary food during the dry season when staple crops are not produced and food reserves have dwindled. The calorific value of mango is mostly derived from the sugars. It is as high as that of grapes and even higher than that of apple, pears or peaches. The protein content is generally little higher than that of other fruits except the avocado. Mango is also a fairly good source of thiamine and niacin and contains some calcium and iron (Griesbach, 2003).

## **2.6 Conceptual Framework**

Mugenda and Mugenda (2003) define a conceptual framework as a graphical or diagrammatic representation of the relationship between the variables. This study's conceptual framework is based on four independent variables presumed to influence Grafted Mango Production which includes; determination of grafted mango varieties grown, marketing linkages and strategies used, the adoption of value addition, and the impact of income from grafted mangoes on the livelihood. The dependent variable is grafted mango production.



**Figure 2.1 Conceptual Framework**



## CHAPTER THREE

### RESEARCH METHODOLOGY

#### 3.0 Study Site

The study was carried out in three locations of Matinyani Division, Matinyani Sub-County in Kitui County. The locations included: Matinyani, Kalimani and Kauma. Matinyani Sub-County comprise of two other Divisions namely: Kwa- Mutonga and Kathivo. The two Divisions are vast and drier compared to Matinyani Division hence, little grafted mango farming is practiced in these Divisions. Matinyani Sub-County in Kitui County, is located between Longitudes  $37^{\circ}45'$  and  $39^{\circ}0'$  East and Latitude  $0^{\circ}3.7'$  and  $3^{\circ}0'$  South with the Sub-County rated among those with the highest population due to high land potential (GoK, 2005). The altitude ranges between 400 m and 1800 m above sea level. Rainfall occurs in two rainy seasons with two peaks in April- May (long rains) and November- December (short rains). The rest of the year is hot and dry. Rainfall ranges from 500mm to 1050mm with 40% reliability (GoK, 2005).

Approximately 90% of Kitui's population is rural-based with human activities such as clearing of land for agriculture, settlements, charcoal burning and cutting of indigenous trees for curving. The population is largely rural-based with only 10% residing in the urban areas. The potential for crop production is under-utilized and 77,000 ha and 2,000 ha are under food and cash crop production, including mango production (GoK, 2002).

### **3.1 Research Design**

The study adopted a descriptive research design. In order for the study to elicit useful information, a survey study was used as a valuable tool for assessing grafted mango farmers opinions and trends in Matinyani Division. Further, questionnaires were used as a tool for collecting information under the survey study. The purpose of the survey was to study the relationships that exist, practices that prevail, beliefs and attitudes held, processes that are going on, effects being felt or trends that are developing among the grafted mango farmers, this was a suitable way of assessing grafted mango farmers opinions without influencing them in Matinyani Division. The survey was also suitable for obtaining information from a large sample of 120 grafted mango farmers from a population of 600 grafted mango farmers in Matinyani Division and also well suited for gathering data that described the composition of the sample. Finally, the survey was cost-effective and led to easy access of information among grafted mango farmers in Matinyani Division.

### **3.2 Sampling Techniques and Sample Size**

Simple random sampling technique was used in selecting the respondents in each location. This sampling technique was used to provide an independent and equal opportunity of selecting each grafted mango farmer in the entire population. The technique also allowed the researcher to apply inferential statistics to generalize the results about the population. In every location, 20% of the grafted mango farmers were selected because according to Gay (1992), a sample of at least 10% of the population is enough.

### **3.3 Research Instruments**

Data was collected using questionnaires as the main instrument. Mugenda and Mugenda (2003) observed that, the use of questionnaires is a popular method for data collection in most disciplines because of the relative ease and cost-effectiveness with which they are constructed and administered to a large population. Questionnaires were also used because they were effective to administer to respondents scattered over a large area and convenient for collecting information from a large sample of 120 grafted mango farmers in Matinyani Division within a short period of time.

### **3.4 Data Collection Procedures and Analysis Techniques**

Ministry of Agriculture, Livestock and Fisheries Kitui County was used as an entry point to mango farmers in Matinyani Division. A schedule of visits to meet the mango farmers was prepared in consultation with frontline extension workers in Matinyani Division, County administration and village heads.

Sampled grafted mango farmers were each issued with a detailed questionnaire containing both open and closed ended questions to solicit information required for the study. This was done to offer a greater assurance of anonymity, reduce opportunity for bias and errors and enhance objectivity on the required information. Secondary data was obtained from the Ministry of Agriculture, Livestock and Fisheries records on mango farming, internet and other written publications.

Data collected from the field was examined through sorting, editing and coding. Coded data was then analyzed using SPSS software version 20.0 of year 2009 and

presented in frequencies and percentages as distribution tables, graphs and figures. The qualitative aspects were discussed in the study.

## CHAPTER FOUR

### RESULTS

#### 4.1 Varieties of Grafted Mangoes Grown in Matinyani Division, Kitui County

Results from the study revealed that varieties of local mangoes grown in Matinyani Division included Ngowe, Dodo and Boribo (Table 4.1). Majority of the mango farmers were growing Ngowe. However, in Kauma Location there was significantly higher ( $P<0.05$ ) Dodo mango production at 7% as compared to Matinyani and Kalimani locations at 2% and 2.5% respectively (Table 4.1).

**Table 4.1: Varieties of Local Mangoes Grown in Three Locations of Matinyani Division, Kitui County**

Location	Ngowe	Dodo	Boribo	Standard Deviation
Matinyani	96 <sup>a</sup>	2 <sup>a</sup>	2 <sup>a</sup>	3.26 <sup>b</sup>
Kalimani	95 <sup>a</sup>	2.5 <sup>a</sup>	2.5 <sup>a</sup>	3.9 <sup>a</sup>
Kauma	90 <sup>a</sup>	7 <sup>b</sup>	3 <sup>a</sup>	3.99 <sup>a</sup>
<b>LSD (<math>P=0.05</math>)</b>	14	9	7	

\* Means same letters within a column are not significantly different at 5% level of significance.

On grafted mango varieties, the study revealed that the varieties of grafted mangoes grown in Matinyani Division included Apple, Tommy and Kent (Table 4.2). Majority of the grafted mango farmers in Matinyani Division were growing Apple mangoes. However, in Kauma location there was significantly higher ( $P<0.05$ ) Tommy mango

production at 4% as compared to Matinyani and Kauma locations at 1.8% and 2.0% respectively (Table 4.2).

**Table 4.2: Varieties of Grafted Mangoes Grown in Three Locations of Matinyani Division, Kitui County**

<b>Locations</b>	<b>Apple</b>	<b>Tommy</b>	<b>Kent</b>	<b>Standard Deviation</b>
Matinyani	96 <sup>a</sup>	1.8 <sup>a</sup>	2.2 <sup>a</sup>	2.04 <sup>b</sup>
Kalimani	95 <sup>a</sup>	2.0 <sup>a</sup>	3.0 <sup>a</sup>	4.02 <sup>a</sup>
Kauma	93 <sup>a</sup>	4 <sup>b</sup>	3 <sup>a</sup>	4.3 <sup>a</sup>
<b>LSD (<i>P</i>=0.05)</b>	10	9	7	

\* Means same letters within a column are not significantly different at 5% level of significance.

#### **4.2 Adoption of Value Addition on Grafted Mangoes in Matinyani Division, Kitui County**

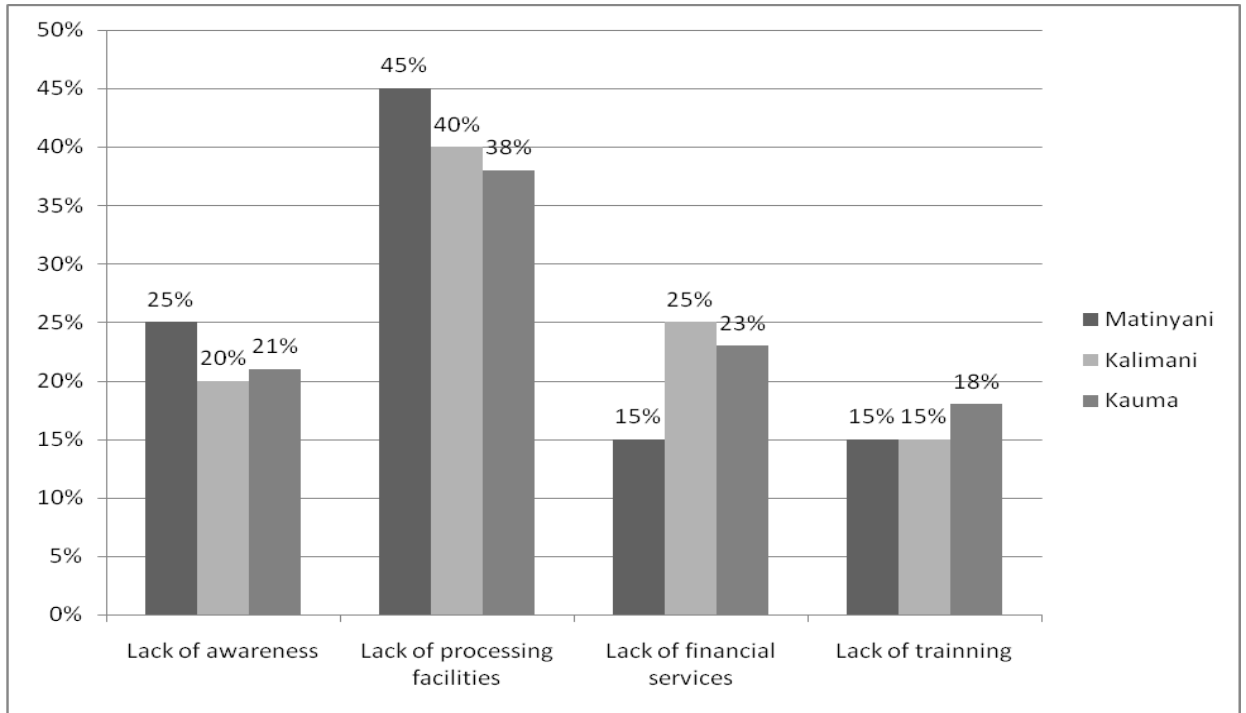
This study revealed that in Matinyani Division, mangoes are consumed as raw, dessert, or in juice form. In Kalimani and Kauma locations, there was a significantly higher ( $P < 0.05$ ) mango consumption in form of dessert compared to Matinyani location (Table 4.3). However, Matinyani location led in mango juice consumption (24%) which was significantly higher than Kalimani and Kauma locations at 15% and 13% respectively (Table 4.3).

**Table 4.3: Forms in which Grafted Mangoes are Consumed in the Three Locations of Matinyani Division, Kitui County**

<b>Location</b>	<b>Raw</b>	<b>Juice</b>	<b>Dessert</b>	<b>Standard Deviation</b>
Matinyani	14 <sup>a</sup>	24 <sup>b</sup>	62 <sup>b</sup>	7.017 <sup>a</sup>
Kalimani	12 <sup>a</sup>	15 <sup>a</sup>	73 <sup>a</sup>	7.35 <sup>a</sup>
Kauma	13 <sup>a</sup>	13 <sup>a</sup>	74 <sup>a</sup>	7.0 <sup>a</sup>
<b>LSD (<i>P</i>=0.05)</b>	7	10	7	

\* Means same letters within a column are not significantly different at 5% level of significance.

The study revealed that, challenges facing value addition opportunities on grafted mangoes in Matinyani Division included: Lack of awareness on how to add value to the mango fruit, lack of processing and storage facilities, inadequate accessibility to financial services and lack of training and necessary value addition technology (Figure 4.1).



**Figure 4.1: Challenges Facing Value Addition on Grafted Mangoes in the Three Locations of Matinyani Division, Kitui County**

**Table 4.4: Transformation Data on Challenges Facing Value Addition**

Statement	SA	A	D	SD
Lack of awareness on how to add value to the mango fruit is the main challenge in the Division.	58%	32%	8%	2%
The government is not doing enough to avail training and necessary value addition technology	59%	28%	5%	8%
Farmers are not organized into self-help groups to help them pursue value addition and benefit from its commercial advantages	21%	22%	42%	15%
The ripe mango fruit is cumbersome to manage and hence a lot is left to waste	43%	23%	12%	22%
The reasons behind a farmers engagement in Mango	53%	38%	5%	4%

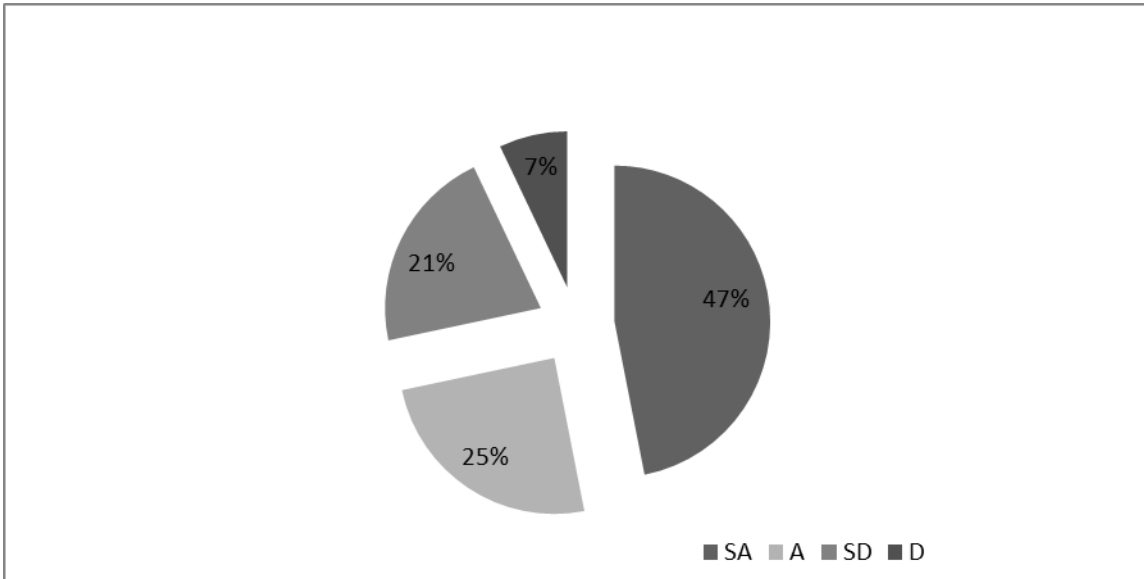


farming determines whether they will embark on value addition of the fruit or not.

Lack of financial facilities and opportunities hinder the practice of value addition as it is resource intensive

Lack of processing facilities is a major challenge in mango growing.

<b>Mean Responses</b>	<b>47%</b>	<b>25%</b>	<b>21%</b>	<b>7%</b>
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**Figure 4.2: Farmers Opinion on Challenges Facing them on Value Addition**

The results in figure 4.2 show that majority of the respondents (47%) strongly agreed with the results in Table 4.3 which revealed that the major challenges facing mango farmers are; Lack of awareness on how to add value to the mango fruit, lack of processing and storage facilities, inadequate accessibility to financial services and lack of training and necessary value addition technology.

### 4.3 Market Linkages for Grafted Mangoes in Three Locations of Matinyani Division, Kitui County

Results obtained in this study showed that, majority of farmers sold their grafted mangoes within 1 – 3 months in a year with Kalimani location leading in sell of mangoes at 71%, followed by Kauma location at 69% and then, Matinyani location with 68% (Table 4.4). Only small number of farmers sold their grafted mangoes within 7 – 9 months with a 2% representation across all the locations.

**Table 4.5: Months in a Year Grafted Mangoes are Sold in Three Locations of Matinyani Division, Kitui County**

<b>Location</b>	<b>1 -3</b>	<b>4 - 6</b>	<b>7 - 9</b>	<b>Standard Deviation</b>
Matinyani	68 <sup>a</sup>	30 <sup>a</sup>	2 <sup>a</sup>	15.2 <sup>a</sup>
Kalimani	71 <sup>a</sup>	27 <sup>a</sup>	2 <sup>a</sup>	14.3 <sup>a</sup>
Kauma	69 <sup>a</sup>	29 <sup>a</sup>	2 <sup>a</sup>	14.86 <sup>a</sup>
<b>LSD (<math>P=0.05</math>)</b>	14	5	6	

\* Means same letters within a column are not significantly different at 5% level of significance

On the other hand, Kalimani location was leading in the local mangoes sold within 1 – 3 months in a year with 91% followed by Matinyani location 90% and then, Kauma location with 85% (Table 4.5). There was a significant difference ( $P<0.05$ ) in the local mangoes sold within 4 – 6 months with Kauma location leading at 10% compared

to Matinyani and Kalimani locations with 9% and 7% respectively (Table 4.5). Also, there was a significant difference ( $P<0.05$ ) in the local mangoes sold within 7 – 9 months with Kauma location leading with 5% followed by Kalimani and Matinyani locations at 2% and 1% respectively (Table 4.5).

**Table 4.6: Months in a Year Local Mangoes are Sold in Three Locations of Matinyani Division, Kitui County.**

<b>Location</b>	<b>1- 3</b>	<b>4 - 6</b>	<b>7 - 9</b>	<b>Standard Deviation</b>
Matinyani	90 <sup>a</sup>	9 <sup>a</sup>	1 <sup>a</sup>	13.24 <sup>a</sup>
Kalimani	91 <sup>a</sup>	7 <sup>b</sup>	2 <sup>a</sup>	14.38 <sup>a</sup>
Kauma	85 <sup>a</sup>	10 <sup>a</sup>	5 <sup>b</sup>	13.72 <sup>a</sup>
<b>LSD (<math>P=0.05</math>)</b>	11	6	5	

\* Means same letters within a column are not significantly different at 5% level of significance

This study also established that, the market for grafted mangoes in Matinyani Division includes: within the village, within location and outside the location (Table 4.6). In Kauma location significantly higher ( $P<0.05$ ) percentage of mangoes were sold within the location (67%) compared to Matinyani and Kalimani locations which had 60% and 55% respectively (Table 4.6). However, Kalimani location significantly ( $P<0.05$ ) led in selling grafted mangoes within the village (40%) while Matinyani location significantly ( $P<0.05$ ) led in selling grafted mango outside the location (12%).

**Table 4.7: Market Linkages for Grafted Mangoes in Three Locations of Matinyani Division, Kitui County**

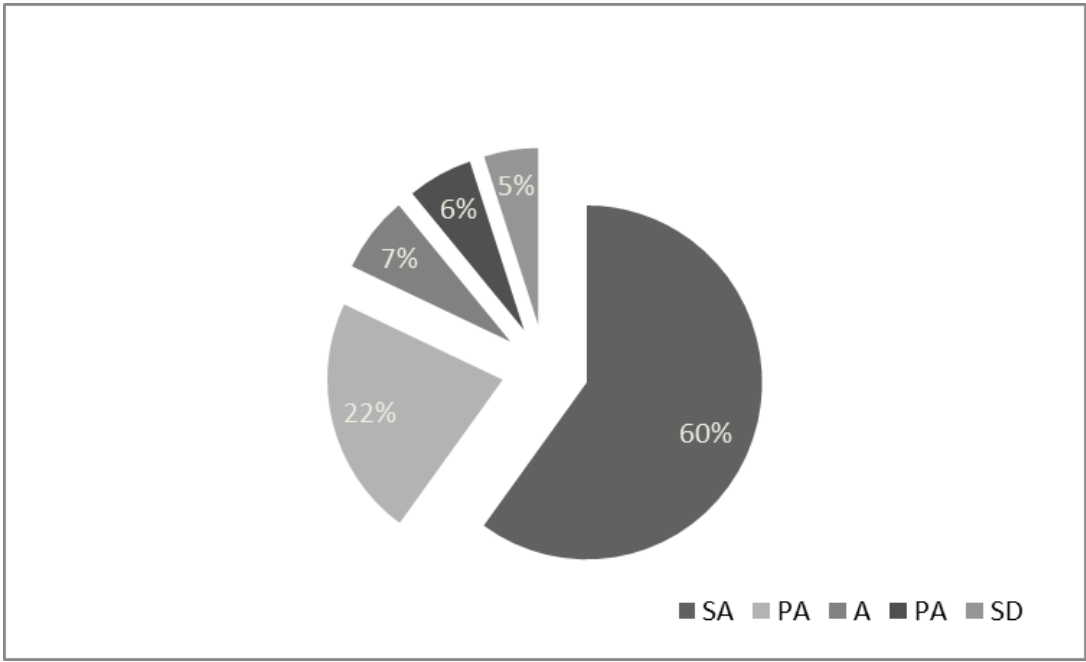
<b>Location</b>	<b>Within the Village</b>	<b>Within Location</b>	<b>Outside Location</b>	<b>Standard Deviation</b>
Matinyani	28 <sup>a</sup>	60 <sup>a</sup>	12 <sup>b</sup>	16.98 <sup>b</sup>
Kalimani	40 <sup>b</sup>	55 <sup>a</sup>	5 <sup>a</sup>	17.222 <sup>a</sup>
Kauma	27 <sup>a</sup>	67 <sup>b</sup>	6 <sup>a</sup>	17.235 <sup>a</sup>
<b>LSD (P=0.05)</b>	7	15	10	

\* Means same letters within a column are not significantly different at 5% level of Significance

**Table 4.8: Transformation Data for Marketing Linkages**

<b>Problem/Pressure/Situation</b>	<b>1 = Strongly Agree</b>				
	<b>2 = Partially Agree</b>				
	<b>3 = Agree</b>				
	<b>4 = Partially Disagree</b>				
	<b>5 = Strongly Disagree with statement.</b>				
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
There is no enough market for mangoes during harvesting season.	65%	23%	7%	3%	2%
Local Markets are not enough for mango growers.	58%	38%	2%	1%	1%
The farm gate selling to brokers is the main market	59%	25%	9%	4%	3%

There is wastage of mangoes in the local markets	54%	26%	15%	3%	2%
No access to the main supermarkets	75%	20%	5%	0%	0%
Poor marketing is the major cause of wastage and spoilage	57%	26%	10%	5%	2%
Transport to the markets is a major challenge	23%	10%	15%	40%	27%
There is no access to the export markets	87%	10%	2%	1%	0%
The quality of mangoes grown by most of the farmers does not meet international standards.	68%	26%	3%	2%	1%
<b>Mean Responses</b>	<b>60%</b>	<b>22%</b>	<b>7%</b>	<b>6%</b>	<b>5%</b>



**Figure 4.3: Market Linkages**

Figure 4.3 shows that, majority of the respondents strongly agreed that there was marketing problems for grafted mangoes in Matinyani Division. However, the fact that there is no access to the export markets (87%) and no access to the main supermarkets (75%) was significantly high.

#### **4.4 The Impact of Income from Grafted Mango Production on the Livelihoods of Mango Farmers in Matinyani Division, Kitui County**

Income from sale of grafted mangoes in Matinyani Division per annum ranged from KES 1, 000 to KES 20,000. Among farmers who earned KES 6,000 – KES 9,000, Matinyani location led with 59% responses, followed by Kauma location with 57% and then Kalimani location with 47% (Table 4.7).

**Table 4.9: Income Received per Year from Sale of Grafted Mangoes in Three Locations of Matinyani Division, Kitui County**

<b>Location</b>	<b>1,000-5,000</b>	<b>6,000-9,000</b>	<b>10,000-15,000</b>	<b>16,000-20,000</b>	<b>Std error</b>
Matinyani	12.5 <sup>a</sup>	59 <sup>b</sup>	20.5 <sup>b</sup>	8 <sup>a</sup>	2 <sup>a</sup>
Kalimani	8.3 <sup>a</sup>	47 <sup>a</sup>	29.7 <sup>b</sup>	15 <sup>b</sup>	3 <sup>b</sup>
Kauma	29 <sup>b</sup>	57 <sup>b</sup>	11 <sup>a</sup>	3 <sup>a</sup>	3.7 <sup>b</sup>
<b>LSD (P=0.05)</b>	13	10	25	23	

\* Means same letters within a column are not significantly different at 5% level of significance

Among farmers earning KES 10,000- KES 15,000 Kalimani location was leading with 29.7%, followed by Matinyani location with 20.5% and then Kauma location with 11%. There was a significant difference ( $P<0.05$ ) between the locations earning income of KES 16,000 – KES 20,000 with Kalimani location attaining 15% while Matinyani and Kauma locations had 8% and 3% respectively. However, Kauma location led on the farmers who earned KES 1,000 – KES 5,000 from the sale of grafted mangoes at 29%.

The study also revealed that majority of the respondents earned KES 1,000 – KES 5,000 from the sale of local mangoes (Table 4.8). However, Matinyani and Kalimani locations were earning significantly ( $P<0.05$ ) higher income than Kauma location.

**Table 5.0: Income Earned (KES) per Year from Sale of Local Mangoes in Three Locations of Matinyani Division, Kitui County**

Location	1,000-5,000	6,000-9,000	10,000-15,000	16,000-20,000	Std error
Matinyani	65 <sup>a</sup>	30 <sup>a</sup>	5 <sup>a</sup>	0 <sup>a</sup>	1.8 <sup>a</sup>
Kalimani	70 <sup>a</sup>	28 <sup>b</sup>	2 <sup>a</sup>	0 <sup>a</sup>	2.5 <sup>b</sup>
Kauma	72 <sup>a</sup>	25 <sup>b</sup>	3 <sup>a</sup>	0 <sup>a</sup>	3.0 <sup>b</sup>
<b>LSD (<math>P=0.05</math>)</b>	10	7	20	13	

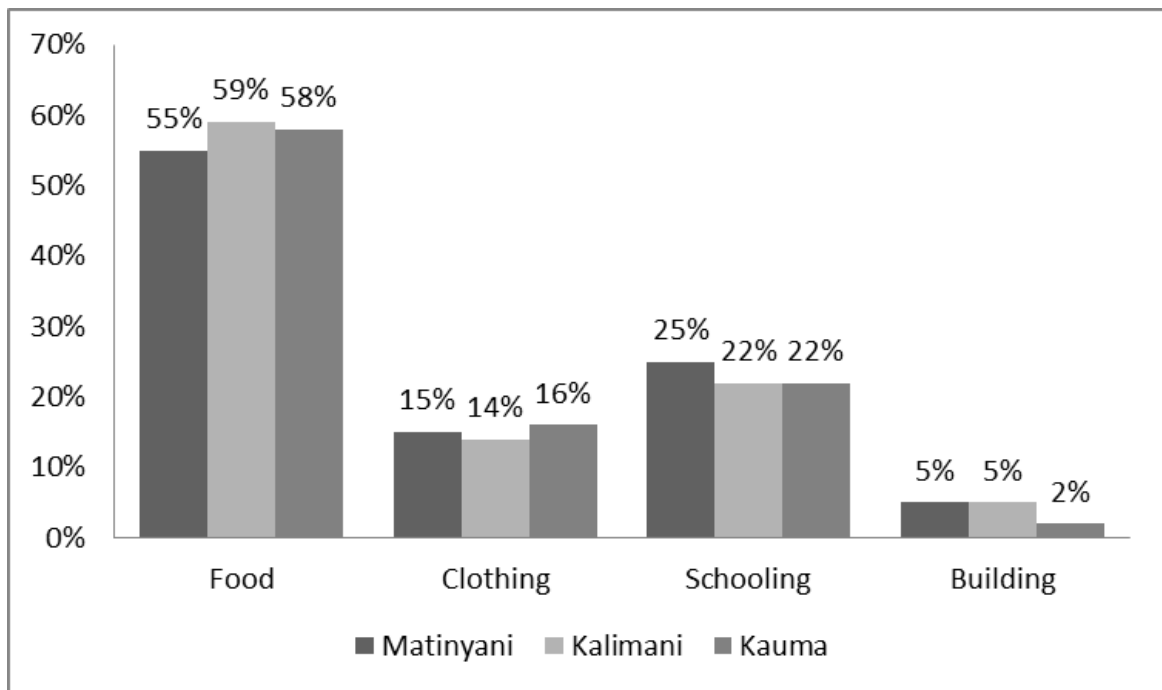
\* Means same letters within a column are not significantly different at 5% level of significance

Income from the sale of grafted mangoes was used for buying food stuffs, clothing, paying school fees and building (Table 4.9).

**Table 5.1: Income Utilization by Farmers from Sale of Grafted Mangoes in Three Locations of Matinyani Division, Kitui County**

Location	Food	Clothing	Schooling	Building
Matinyani	55 <sup>a</sup>	15 <sup>a</sup>	25 <sup>a</sup>	5 <sup>a</sup>
Kalimani	59 <sup>a</sup>	14 <sup>a</sup>	22 <sup>a</sup>	5 <sup>a</sup>
Kauma	58 <sup>a</sup>	16 <sup>a</sup>	22 <sup>a</sup>	2 <sup>b</sup>
<b>Total</b>	172	45	69	12

\* Means same letters within a column are not significantly different at 5% level of significance



**Figure 4.4: Expenditure of Income from Grafted Mangoes in Three Locations of Matinyani Division, Kitui County**



## CHAPTER FIVE

### DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 DISCUSSIONS

##### 5.1.1 Varieties of Grafted Mangoes Grown in Matinyani Division, Kitui County.

Cultivation of Ngowe variety was preferred since it was easier for the Ngowe trees to grow naturally at moderate size making it convenient to prune the tree and harvest the fruits. Cultivation of Dodo and Boribo varieties in Matinyani Division was less preferred compared to Ngowe variety because the trees grew into large trees making it difficult to prune and harvest the mango fruit. Further, Ngowe fruit is relatively large in size, more attractive and attains maturity earlier as compared to Dodo and Boribo varieties. Due to its big size, the Ngowe mango sold faster than Dodo and Boribo varieties. Griesbach (2003) observed Ngowe mango as the most easily recognized local mango fruit due to its size. Ngowe fruit develops to an attractive yellow to orange colour when ripe with deep yellow flesh that is of excellent quality, virtually free from fibre and carries no turpentine taste as opposed to Dodo and Boribo local varieties.

Majority of the grafted mango farmers in Matinyani Division were growing Apple mangoes (Table 4.2). The reason attributed to this was that, Matinyani Division is characterized by sandy soils as well as loam, black cotton and murram soil. These soils are essential pre-requisites for good development of Apple mangoes. Griesbach (2003) observed that, Apple trees were not difficult to grow and, once well established, were relatively tolerant to drought and poor soil condition. Grafted mango farmers in Matinyani Division practiced mixed farming and Apple mango trees were observed to

grow into a moderate size allowing better use of underground space for planting other agricultural crops compared to Kent mango trees. Griesbach (2003) reported that, Kent mango trees grow into vigorous large trees forming rounded canopy which essentially hinder growth of other agricultural crops.

Apple mango fruits were tolerant to pests and disease infection due to the moderate size of the Apple trees which made it possible for farmers to spray chemicals, prune the Apple trees, maintain hygiene underground and reduce bruising during harvesting hence increasing the physical appearance and shelf-life of Apple mango fruit. Okoth *et al.*, (2013), reported that, Apple mango fruit has the most preferred flesh colour, flavor, taste, texture and overall acceptability therefore, suitable for fresh consumption and processing.

The study showed Kauma location had the highest number of farmers producing Tommy mango varieties compared to Kalimani and Matinyani locations, such trend was attributed to Kauma location being located near Musengo where there is a mango processing plant which gives Tommy mango variety a first priority in grafted mango processing. Griesbach (2003) reported that, Tommy mango variety has become important for commercial purpose due to the attractiveness of the fruit with excellent shipping and shelf-life qualities.

### **5.1.2 Adoption of Value Addition on Grafted Mangoes in Matinyani Division, Kitui County.**

Raw mangoes were categorized into two; those ripe and those unripe. The ripe and unripe raw mangoes were consumed as a whole fruit just as they were harvested from the farm without any form of value addition. The ripe raw mangoes were eaten without peeling the outer skin while the raw unripe mangoes in some instances were taken with salt as spice since they were sour in taste with tart flavour.

Those consumed as dessert, had an aspect of value addition. Mango dessert was made by peeling ripe mangoes, removing the seed and cutting the fleshy part into desired pieces which could be consumed alone or mixed with other fruits like pawpaw, avocados and bananas. The mango juice was made by peeling ripe mangoes; removing the seed and cutting the fleshy part into small pieces which were put in a blender, in some instances water and sugar was added, then it was blend until it was smooth. The blended mixture was then run through a sieve where the leftover pulp and mango fibers were thrown away. The fruit obtained was served as a mango juice. At certain instances, the mango juice was made up of a mixture of ripe bananas, avocados or pawpaw's.

The study revealed that, majority of grafted mango farmers in Kauma and Kalimani locations consumed grafted mangoes as desserts compared to Matinyani location. This was attributed to lack of awareness on value addition on mango fruit and also lack of processing and storage facilities in the locations. Serem (2010) pointed that, lack of education on value addition as one of the factors challenging the marketing of mangoes in Kenya. Lack of enough training may result to seasonal over-production,

inadequate post-harvest handling techniques and limited access to information on technology in value addition (Serem, 2010)

The study also showed grafted mango farmers in Matinyani location consumed grafted mangoes inform of juice as compared to Kalimani and Kauma locations (Table 4.3). This trend was attributed to the fact that, a decade ago there used to be mango solar driers in Matinyani multi-purpose where some mango farmers within Matinyani location were trained on value addition but the project ceased to exist. Few grafted mango farmers who benefited during that time used such knowledge in producing mango juice.

Lack of processing facilities was the major challenge in value addition of grafted mangoes with Matinyani Division having majority of the respondents (45%) facing this challenge (Figure 4.1). This was attributed to a mango processing plant that was recently located at Musengo which is nearer to Kauma location as opposed to Matinyani and Kalimani locations. According to FAO (2005), value addition in mango fruit involves processing of mangoes by making it into various products such as pickles, preserves, desserts, chutneys, mango juice, mango concentrate, mango jam, mango jelly and mango syrup/ canned mango. In Matinyani division, the only value addition that was adopted was making mangoes into dessert and mango juice. That showed there was still a great need in Matinyani Division for more value addition in mango fruit. This agrees with FAO (2009), which stated that mango production is faced by serious challenges like seasonal over-production, inadequate post-harvest handling techniques, limited access to information on technology in value addition, inadequate clean and quality planting material and limited access to information on technology in husbandry practices.

According to Gulati *et al.*, (2005), the development of food processing sector assumes significant importance due to the growth of high-value products. The seasonality and perishability of high-value products demand that these products be processed as swiftly as possible as storage for a long period is not possible and processing can avoid wastage and shrinkage. Thus, the emerging trend of demand-driven growth in high-value agriculture has to be accompanied side-by-side by the development of the food processing sector.

### **5.1.3 Market Linkages for Grafted Mangoes in Three Locations of Matinyani Division, Kitui County.**

The results showed a trend where higher percentage of local mango farmers sold their local mangoes within 4 – 6 months at Kauma and Matinyani locations compared to Kalimani location, such trend was attributed to poor development of roads in Kauma location and some parts of Matinyani location leading to high costs associated with transportation. Torbjorn and Bharat (2012) noted that, good road accessibility significantly reduces farm gate prices of manufactured goods and increase farm gate prices of agricultural goods. Improvement of transport services results in reduction of transport cost and/or travel time which in turn lead to increased production (IFAD, 2001)

Local mangoes, on the other hand sold at lower price compared to grafted mangoes. According to FAO (2005), local mango varieties tend to have high fibre content, commonly referred to as “stringy”, and this characteristic makes them unpopular

for fresh consumption. Kalimani location is served by the tarmac road Kitui – Thika road which facilitates efficient mode of transport and the level of production is slightly lower compared to Matinyani and Kalimani locations.

The results in Table 4.6 show that, more mangoes were sold within the location with Kauma location leading with 67% responses followed by Matinyani location with 60% and then Kalimani location with 55%. It was, however, noted that very few mangoes were sold outside the location with Matinyani location leading with 12% responses.

The reason for these results was because in Matinyani Division there was direct sale of small quantities of grafted mangoes to village traders and to rural consumers. Also the rural markets normally form part of a local trade network usually arranged on a periodic basis, on specific weekdays popularly known as market days. These are commonly organized at a central place in a village or location centre or beside a village's access road. In such market days, mango farmers take their mango produce directly to consumers who buy at negotiated and/or set prices. The key determinant factor in such market days are the quantity of grafted mangoes supplied which determine the pricing of grafted mangoes. The more the grafted mangoes are available in such markets, the lower the prices and the fewer grafted mangoes are available the higher the prices. Basically the market operates under the forces of demand and supply process.

In Kauma location, 67% sold their grafted mangoes within the location as compared to Matinyani and Kalimani locations. This study established that, mango farmers from Kauma location harvested their mangoes and organized for transportation to

a collection centre which was based within the location where they sold their produce. In turn, the collecting center was supplying grafted mangoes to a processing plant neighboring Kauma location at Musengo. Such markets follow a trend where such processing plants have their own agents who directly interact with farmers and form a collection centre within the location where farmers supply their mango produce and such agents pay the farmers and organize to transport such produce to the processing plant. The mango farmers at Kauma location were not organized into groups which could help them collect, transport and sale their grafted mango together at minimal costs and access bigger markets. Adimado and Baah (2002), reported that marketing process for mangoes need to be undertaken as efficiently as possible, with lowest cost and minimum losses occurring so that it will be more competitive, hence facilitating economic growth and maximizing benefits to mango farmer.

Matinyani location led in selling grafted mangoes outside the location at 12%, the market arrangement here was slightly different as compared to marketing within the village and marketing within the location. This study established that, grafted mango farmers in Matinyani location had formed a relationship with traders outside the location who in turn transported grafted mangoes to various market destinations including wholesalers. Such marketing arrangement had created some mutual trust between the farmers and buyers with key determining factors being the accessibility and quantity of grafted mangoes which determined the pricing. Karl and Leinemann (1996), challenged this market arrangement arguing that, it develops a mutual trust among different functionaries in a marketing system, and therefore, cause a dependency relationship

between parties and makes it difficult for newcomers to enter the marketing process since they may be often based on village proximity (area based) or on family relationships developed over many years.

#### **5.1.4 The Impact of Income from Grafted Mango Production on the Livelihoods in Matinyani Division, Kitui County.**

According to Chambers and Conway (1992), livelihoods comprise people, their capabilities, means of earning a living, including food, income and assets. Pricing of mango fruits is one of the most important factors that determine the economic status of mango farmers (USAID, 2005). According to Steve (2010), mango fruits prices can be raised if farmers can focus on mango concentrate for juice production, consumption on fresh fruits and dried fruit products. There should be a shift from mere “marketing” to “supply chain management” in order to realize more prices (Sarada, 2013).

The study showed that, majority of grafted mango farmers in Matinyani and Kauma location earned KES 6,000 – KES 9,000 attributed to Matinyani location recording higher levels of mango juice production and Kauma location being situated next to Musengo mango processing plant. Kalimani location had highest percentage of grafted mango farmers earning KES 16,000 to KES 20,000 due to a tarmac road passing near the location enabling mango farmers to access markets with ease. The cost of transport contributes significantly to the price paid by the consumers (FAO, 1989) hence, determining the net income.



The study also revealed that majority of the respondents earned KES 1,000 – KES 5,000 from the sale of local mangoes with Matinyani and Kalimani locations earning significantly ( $P<0.05$ ) higher income than Kauma location. This was attributed to the main road passing through Matinyani and Kalimani locations which enables farmers to access the market with ease unlike Kauma location.

According to the study majority of the mango farmers in Matinyani Division spend their income on food in all the locations. This was attributed to mango farmers growing little food crops hence, selling mangoes to buy food. Also the rainfall reliability was 40% in the Division which was unfavorable for food and cash crops production (GoK, 2005). Other uses of income from mangoes included, payment of school fees, clothing and building respectively. Tharanathan *et al.*, (2006) reported that, if grafted mangoes were grown in a large scale they would improve the livelihood of the farmers to a great extent. This is attributed to international trade where the demand for mango fruit has risen significantly by the end of the twentieth century (Galán, 2004). Hence, earning higher income that could improve the livelihood of the farmers further.

## **5.2 CONCLUSIONS**

This study established that:-

- Mangoes grown in Matinyani Division include both local and grafted types. The local mangoes grown include: Ngowe, Dodo and Boribo while grafted mango varieties were: Apple, Kent, and Tommy with majority growing Apple mangoes.

Besides the mango farming, farmers were also growing other food crops. Such mixed farming affected negatively the quantity of grafted mangoes produced.

- The study further established that, majority of respondents consumed grafted mangoes in form of dessert, a few inform of mango juice and none of the respondents consumed grafted mangoes as sliced packed mangoes or dried powder. That showed the levels of value addition were low resulting in low income.
- Most of the respondents sold their grafted mangoes within the location with none of them selling outside the Sub-County. That implied lack of enough market linkages for grafted mangoes.
- Most of the respondents sold their grafted mangoes and their local mangoes respectively within 1 to 3 months in a year. This shows either the mangoes are not grown at large scale or there is lack of sufficient storage facilities. If these were addressed then food security and income can be enhanced.
- The respondents were not earning more than KES 20,000 in a year from the sale of grafted mangoes. The earnings per annum can be improved if grafted mango farming is taken as a potential source of income by farmers in Matinyani Division.

### **5.3 RECOMMENDATIONS**

Based on the findings from this study, it is recommended that: First, farmers should be sensitized to increase grafted mango production compared to local mangoes since grafted mangoes can be processed to products of higher economic value like mango

juice. Second, the County Government, NGO's, private sector and other stakeholders need to avail adequate training on value addition and processing technologies to mango farmers in order to improve shelf- life of mango fruit and enhance income generation. Third, farmers should organize themselves into self-help groups, farmers associations or co-operative societies in order to have a common collection and marketing of mango produce. This will minimize costs and maximize mango returns. Finally, farmers should be sensitized to increase grafted mango production and reduce local mango production since sale of grafted mangoes earns more income.

#### **5.4 SUGGESTED AREAS FOR FURTHER RESEARCH**

This study investigated the factors influencing grafted mango production in Matinyani Division, Kitui County. Further research can be done on:-

- (i) Factors influencing value addition on marketing of grafted mangoes.
- (ii) The influence of County Government involvement in production of mangoes.
- (iii) Factors influencing the market linkages for grafted mangoes.
- (iv) Economics of grafted mango production

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## **APPENDIX I: SURVEY QUESTIONNAIRE**

### **INSTRUCTIONS**

This questionnaire is intended to help establish factors influencing grafted Mango production in Matinyani Division. Kindly complete the questionnaire by honestly indicating your response by either writing or putting a tick [☐] where applicable. Your identity will be treated with a lot of confidentiality:

### **SECTION A: RESPONDENTS INFORMATION**

Questionnaire No.

Name of respondent

Date of interview

*Date*

*Month*

*Year*

Sub-County

Division

Location

Sub- Location

Village

**Table 1.** Personal and family information: Fill where appropriate.

<b>I D</b>	<b>Age (Group)</b>	<b>Marital status</b>	<b>Sex</b>	<b>Relationship to house hold members</b>	<b>Highest educatio n Level</b>	<b>Famil y size</b>	<b>Main occupatio n</b>	<b>Land owners hip</b>
	1-≤20 yrs	1- Single	1- Male	1- Head	1-None	1- <4	1- Farming/	1-Land owner
	2- 21- 30	2- Married	2- Femal e	2- Wife/Husban d	2- Primary	2- 4 to7	Livestock keeping	2- Landless
	3- 31- 40	3- Widowe d		3- Son/Daughter	3- Secondar y	3- 8 to 11	2-Business	3-Any other
	4- 41- 50	4- Divorce d		4- Mother/father	4- Universit y	4- >11	3- Employed	
	5- 51- 60	5- Separate d		5-Other	5-Other		4- Other	
	6-≥61 yrs						5-None	
<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
<b>1</b>								
<b>2</b>								
<b>3</b>								
<b>4</b>								
<b>5</b>								
<b>6</b>								

**SECTION B: MANGO PLANTING AND GROWING**

9. (a) What is the total size of your land? \_\_\_\_\_ (acres)

9. (b) What is your main economic activity?

Crop production       Livestock rearing       Business        
Employed

Others \_\_\_\_\_ (Specify)

10. (a) Do you have mango trees in your farm?

Yes       No

10. (b) If yes, which mango types do you grow?

Local       Grafted       Both

11. (a) How many trees of local mangoes do you have?

1-5       6-10       11 – 15       16 – 20       > 20

11. (b) Which varieties of local mangoes do you plant?

Ngowe       Dodo       Boribo       Batawi

Others \_\_\_\_\_ (Specify)

11. (c) How many trees of each variety?      Number of trees

Ngowe      \_\_\_\_\_

Dodo      \_\_\_\_\_

Boribo      \_\_\_\_\_

Batawi      \_\_\_\_\_

Others \_\_\_\_\_ (Specify)

12. (a) How many grafted mango trees do you have?

1-5       6-10       11 – 15       16 – 20       > 20

12. (b) Which varieties of grafted mangoes do you have?

Apple       Tommy       Kent       Van dyke       Keit

Others \_\_\_\_\_ (Specify)

12. (c) How many trees do you have of each type of grafted mango?

Mango type      Number of trees

Apple      \_\_\_\_\_

Tommy      \_\_\_\_\_

Kent      \_\_\_\_\_

Van dyke      \_\_\_\_\_

Keit      \_\_\_\_\_

Others \_\_\_\_\_ (Specify)

13. What is the source of your grafted mangoes?

- Buy grafted seedlings
- Buy scions and graft existing trees
- Buy scions and graft mango seedlings
- Use own scions to graft mature mango trees
- Use own scions to graft mango seedlings

Others \_\_\_\_\_ (Specify)

14. In your view, why do residents grow grafted mangoes in your area?

- For sale locally
- For sale to processors
- For export
- For domestic consumption

Others \_\_\_\_\_ (specify)

15. Which is your most favourite method of controlling mango diseases?

- Chemical
- Biological
- Cultural methods

Other \_\_\_\_\_ (specify)

**SECTION C: ADOPTION AND VALUE ADDITION ON MANGOES**

16. The following statements describe challenges to value addition in grafted mangoes;

Indicate by ticking the extent to which they are agreeable to you.

A- Agree

D- Disagree

SA –Strongly Agree.

SD – Strongly Disagree.

Statement	SA	A	D	SD
Lack of awareness on how to add value to the mango fruit is the main challenge in the Division.				
The government is not doing enough to avail training and necessary value addition technology				
Farmers are not organized into self-help groups to help them pursue value addition and benefit from its				

commercial advantages				
The ripe mango fruit is cumbersome to manage and hence a lot is left to waste				
The reasons behind a farmers engagement in Mango farming determines whether they will embark on value addition of the fruit or not.				
Lack of financial facilities and opportunities hinder the practice of value addition as it is resource intensive				
Lack of processing facilities is a major challenge in mango growing?				

17. In which forms do the locals consume mangoes in Matinyani Division?

- i) Raw mangoes                      YES [ ]    NO [ ]
- ii) Mango juice                      YES [ ]    NO [ ]
- iii) Sliced packed mangoes    YES [ ]    NO [ ]
- iv) Dessert                            YES [ ]    NO [ ]
- v) Dried powder                    YES [ ]    NO [ ]
- vi) Any other\_\_\_\_\_ (Specify)

18. How do you store your mangoes?

\_\_\_\_\_ (Specify)

**SECTION D: MARKETING CHALLENGES IN MANGO GROWING.**

19. The following problems have been suggested as affecting grafted mango growing in Matinyani Division. Please indicate the level to which you agree with them.

Problem/Pressure/Situation	<b>1 = strongly agree</b> <b>2 = Partially Agree</b> <b>3 = Agree</b> <b>4 = Partially disagree</b> <b>5 = strongly disagree with statement.</b>				
	1	2	3	4	5
There is no enough market for mangoes during harvesting season?					
Local Markets are not enough for mango growers					
The farm gate selling to brokers is the main market					
There is wastage of mangoes in the local markets					
No access to the main supermarkets					
Poor marketing is the major cause of wastage and spoilage					
Transport to the markets is a major challenge					
There is no access to the export markets					
The quality of mangoes grown by most of the farmers does not meet international standards?					

20.(a)Where do you sell your grafted mangoes?

- |                            |         |        |
|----------------------------|---------|--------|
| (a) Within the location    | YES [ ] | NO [ ] |
| (b) Outside the location   | YES [ ] | NO [ ] |
| (c) Within the Sub-County  | YES [ ] | NO [ ] |
| (d) Outside the Sub-County | YES [ ] | NO [ ] |
| (e) Within the village     | YES [ ] | NO [ ] |

- (f) They are locally bought by outsiders YES [ ] NO [ ]  
 (g) They are bought by brokers YES [ ] NO [ ]  
 (h) Other----- (Specify)

20.(b)Where do you sell your local mangoes?

- (a) Within the location YES [ ] NO [ ]  
 (b) Outside the location YES [ ] NO [ ]  
 (c) Within the Sub-County YES [ ] NO [ ]  
 (d) Outside the Sub-County YES [ ] NO [ ]  
 (e) Within the village YES [ ] NO [ ]  
 (f) They are locally bought by outsiders YES [ ] NO [ ]  
 (g) They are bought by brokers YES [ ] NO [ ]  
 (h) Other----- (Specify)

21. (a) How many sacks of 90kg of grafted mangoes do you produce per year?

- (i)  1-5 (ii)  6-10 (iii)  11 – 15 (iv)  16 – 20 (v)  > 20

21. (b) How many sacks of 90kg of local mangoes do you produce per year?

- (i)  1-5 (ii)  6-10 (iii)  11 – 15 (iv)  16 – 20 (v)  > 20

22. What do you think should be done to assist farmers in marketing their Mango produce?\_\_\_\_\_

**SECTION ONE: IMPACT OF MANGO PRODUCTION ON LIVELIHOODS**

23 (a) How many months in a year do you sell your grafted mangoes?

- (i)  1-3 (ii)  4-6 (iii)  7 – 9 (iv)  10 -12

(b) How many months in a year do you consume your grafted mangoes?

- (i)  1-3 (ii)  4-6 (iii)  7 – 9 (iv)  10 -12

24 (a) (i) How many months in a year do you sell your local mangoes?

- (i)  1-3 (ii)  4-6 (iii)  7 – 9 (iv)  10 -12

(ii) How many months do harvested food crops last you?



- (i)  1-3      (ii)  4-6      (iii)  7-9      (iv)  10-12

(b) How many months in a year do you consume your local mangoes?

- (i)  1-3      (ii)  4-6      (iii)  7-9      (iv)  10-12

(c) How much income in shillings do you get from the sale of grafted mangoes in a year?

- (i) 1,000 – 5,000        
(ii) 6,000 – 9,000        
(iii) 10,000 – 15,000        
(iv) 16,000 – 20,000        
(v) >20,000

(d) (i) How much income in shillings do you get from the sale of local mangoes in a year?

- (i) 1,000 – 5,000        
(ii) 6,000 – 9,000        
(iii) 10,000 – 15,000        
(iv) 16,000 – 20,000        
(v) >20,000

(ii) How much income in shillings do you get from the sale of food crops per year?

- (i) 1,000 – 5,000        
(ii) 6,000 – 9,000        
(iii) 10,000 – 15,000        
(iv) 16,000 -20,000        
(v) >20,000

25 How do you use the income generated from sale of mangoes?

- (i) Buying food        
(ii) Paying school fees        
(iii) Daily expenses

(iv) Paying debts

(v) Any other----- (specify)

26. (a) Does sales of mangoes bring more income than sale of food crops?

(i) Yes  (ii) No

(b) If yes, how do they compare? -----

**Thank you**

**APPENDIX II: ANOVA on Varieties of Local Mangoes Grown in Matinyani  
Division, Kitui County**

		Sum of Squares	df	Mean Square	F	Sig.
Ngowe	Between Groups	20.667	2	10.333	2.3.	0.000
	Within Groups	.000	0	.		
	Total	20.667	2			
Boribo	Between Groups	.500	2	.250	5.6.	0.000.
	Within Groups	.000	0	.		
	Total	.500	2			
Dodo	Between Groups	15.167	2	7.583	4.3.	0.000
	Within Groups	.000	0	.		
	Total	15.167	2			

**APPENDIX III: ANOVA on Varieties of Grafted Mangoes Grown in Matinyani  
Division, Kitui County**

		Sum of Squares	df	Mean Square	F	Sig.
Apple	Between Groups	12.667	2	6.333	3.11.	0.000.
	Within Groups	.000	0	.		
	Total	12.667	2			
Tommy	Between Groups	2.960	2	1.480	6.21.	0.000.
	Within Groups	.000	0	.		
	Total	2.960	2			
Kent	Between Groups	.427	2	.213	4.8.	0.000
	Within Groups	.000	0	.		
	Total	.427	2			

**APPENDIX IV: ANOVA on Value Addition for Grafted Mangoes in Matinyani Division, Kitui County**

		Sum of Squares	df	Mean Square	F	Sig.
Raw mangoes	Between Groups	1.500	1	1.500	3.000	.333
	Within Groups	.500	1	.500		
	Total	2.000	2			
Joice	Between Groups	28.167	1	28.167	.695	.557
	Within Groups	40.500	1	40.500		
	Total	68.667	2			
Dessert	Between Groups	16.667	1	16.667	.231	.715
	Within Groups	72.000	1	72.000		
	Total	88.667	2			

**APPENDIX V: ANOVA on Market Linkages for Grafted Mangoes Produced in Matinyani Division, Kitui County**

		Sum of Squares	df	Mean Square	F	Sig.
Within village	Between Groups	20.167	1	20.167	.239	.711
	Within Groups	84.500	1	84.500		
	Total	104.667	2			
Within location	Between Groups	.667	1	.667	.009	.939
	Within Groups	72.000	1	72.000		
	Total	72.667	2			
Outside location	Between Groups	28.167	1	28.167	56.333	.084
	Within Groups	.500	1	.500		
	Total	28.667	2			

**APPENDIX VI: ANOVA on Consumption Period for Grafted Mangoes in Matinyani Division, Kitui County**

		Sum of Squares	df	Mean Square	F	Sig.
1-3 months	Between Groups	10.667	1	10.667	1.333	.454
	Within Groups	8.000	1	8.000		
	Total	18.667	2			
4-6 months	Between Groups	4.167	1	4.167	8.333	.212
	Within Groups	.500	1	.500		
	Total	4.667	2			
7-9 months	Between Groups	.667	1	.667	.083	.821
	Within Groups	8.000	1	8.000		
	Total	8.667	2			