

# Value Chain Analysis Report

FRUIT TREES

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## Executive summary

The agriculture sector directly contributes 26% of the country's Gross Domestic Product (GDP) and provides employment to millions of Kenyans. As a subsector of agriculture, horticulture has the greatest commercial significance. Kenya's large export-oriented horticulture sector profits from the increasing demand abroad. Another driver of sector growth is the rise in demand for fresh produce domestically. To keep up with this trend, relatively high and steady levels of productivity become ever more important.

Yields and income levels in Kenya's rain-fed agricultural sector are seriously affected by climate change, posing a growing challenge to the sector. Small and medium sized enterprises are particularly affected. Rainfall has become unpredictable, with periods of drought increasingly being interspersed with periods of excessive rainfall. Changes in precipitation have direct consequences for plant growth and facilitate the increased presence and outbreaks of pests and diseases.

The global fruit production was about 870 million metric tons in 2018. Asia Pacific was the largest region in the global fruit farming market. Kenya's tropical and temperate climate zones favors the cultivation of a wide range of fruits. Kenyan counties promote the fruit value chain by creating favorable conditions for production. They also engage in entrepreneurial endeavors using value-adding strategies.

The Lake Basin region has the advantageous environmental features of arable land, good soil, and consistent water supply from rain as well as several rivers and lakes. These features have formed the foundation on which residents have relied on for generations. In the past these features were adequate to ensure the food security of the region, however over the past 50 years Kenya's population, and that of the Lake Basin region, has grown to a point where existing farming practices and food supply chains do not meet current food security needs. FAO Kenya is designing a Green Climate Fund proposal titled Transforming Livelihoods through Climate Resilient, Low Carbon, Sustainable Agricultural Value Chains in the Lake Region Economic Bloc, Kenya (CRLCSA). The value chain study will be done in four fruits banana, avocado, passion fruit and citrus fruits.

The research employed a mixed-methods approach comprising qualitative data through varied techniques including literature/desk reviews, key informant interviews, Focus Group Discussions, and interviews.

Fruits were grown before the colonial era (i.e., before 1860), and fruits were brought to Kenya by Arab and Indian traders from Asia, either directly or via southern Africa. Citrus (*Citrus* spp.), fruits (*Mangifera indica* L.), and banana (*Musa acuminata* Colla) may be the earliest introductions, arriving before the sixth century. passion fruit (*Passiflora edulis* Sims) is among the most recent introductions and was imported by Portuguese explorers, missionaries, or colonialists. Avocado (*Persea americana* L.) in the family Lauraceae is a sub-tropical tree native to South Central Mexico. It is believed to have been introduced in Kenya by the Portuguese between 16th and 18th centuries

Demand for the fruit has been on the increase across sectors, including supermarket retail, restaurant catering, and the hotel markets. The demand for fruit in Kenya has exceeded the supply. The international trade in fruits is increasing in scale and variety. Neither processors nor exporters are currently able to satisfy their demand for mango, only 40 and 50 percent of their demand is met. The domestic market for mango is significantly larger than the export market both in volume and value. The development of value addition for bananas in making crisps, flours, and essence has also increased the consumption and demand of bananas, especially for processing companies and individuals. Production does not meet the local demand necessitating the importation of large quantities of citrus fruits and products. The demand for passion fruit is high both in local and regional markets as well as in the export market. There local demand for avocado is growing in Kenya. The rise in demand has been caused by realization of the health benefit as well as increased processing activities.

Kenya exports its products to several markets in Africa, Europe, the Middle East, Asia, and the US. Liberalized economy and globalization of markets means, Kenyan exporters are expected to be more competitive and innovative if they are to effectively exploit the opportunities that world markets present. The EU is Kenya's principal market in horticultural export produce with the UK, Netherlands and France being the main markets. Germany, Switzerland, Belgium, and Sweden are the other important markets in the EU. Exports of fresh passion fruit to Uganda and fresh fruits to Tanzania have also increased significantly over the past three years due to favorable climatic conditions and suitable varieties. There is growing potential for Kenya export horticulture products and fruits specifically both internationally and in other Africa countries.

Fruit production is mainly done by small-scale farmers who grow multiple varieties, use no irrigation, and rarely use any fertilizer. Large and medium-scale fruit farmers can stimulate flowering and use supplementary irrigation. Collection involves farmers, brokers, village assemblers, wholesalers, retailers, and exporters. Village assemblers/brokers are the main links between farmers and the rest of the value chain. They purchase and sell either direct to retailers, wholesalers, processors, or to contracted agents. Wholesalers purchase directly from farmers or through brokers and supply urban markets, where they sell to retailers or agents acting for supermarkets. Retailers are the final link, bringing fruits directly to consumers. Exporters purchase directly from large-scale farmers. Processors rely on brokers and in some cases organized farmer groups for the delivery of fruits. Exporters rely more on their staff to supervise harvesting, sorting, packaging, and transportation. Retailers in rural-urban centers and road sites have little to no infrastructure for storing and/or displaying their products, which tends to further risk the durability and quality of the fruit.

Support services are intended to facilitate the production, marketing, and distribution of agriculture products. Seedling nurseries are registered by HCD and certified by Kenya Plant Health Inspectorate Services (KEPHIS), which is responsible for the certification of domestically produced seeds and providing permits for seed imports. Kenya Agriculture and Livestock Research Organization (KALRO) and different universities study various aspects of fruit production.

Farmers obtain planting materials from uncertified sources, and these have risk on the production. Fertilizer is another major input, it is imported, with both state agencies and the private sector playing a major role. Other farm chemicals (pesticides, herbicides, fungicides) are widely available through stockists and all major leading manufacturers are represented in Kenya. Financial institutions are important players in the agriculture sector through the financing of activities, including farm inputs, trading, and processing. Financial institutions are important players in the agriculture sector through the financing of activities, including farm inputs, trading, and processing. Farmers find the loan application process tedious while others fear the consequences of defaulting as most farmers can only access loans as a group and therefore one farmer defaulting could have consequences for the others. Farmers have also indicated that loans are very risky due to the uncertain nature of rain-fed agriculture. Kenya's horticultural sector is characterized by insufficient extension services, ineffective extension messages, and a poor delivery system.

Kenyan fruits compete in a worldwide market that is subject to strict regulations and standards for social responsibility and safety. Kenya is a signatory to various agreements aimed at enhancing trade amongst member states, and notable amongst these are the regional trade agreements under the East African Community (EAC), the Common Market for East and Southern Africa (COMESA), and trade agreements with the European Union.

Women are concentrated along different nodes of the fruit value chain with men dominating at the production stage and women being active participants at the marketing level. Limited access to land, the unequal power relations within the household reinforced by a low bargaining power in decision-making, barriers to credit, and information access on the prices offered by the different marketing channels as some of the constraints faced by women.

Water is linked to the natural environment in the following ways. Businesses that grow and process fruit must have access to a secure and consistent supply of water of the right quality to ensure the safety of their supply to retailers and customers. Climate change, especially rainfall and temperature have adverse effects on the fruit. Rainfall and extreme temperatures have affected output of mango, passion fruit, avocado and citrus. Although in different ways, drought has an impact on all stages of the fruit value chains (banana, citrus, mango, avocado, and passion fruit). Low germination rates, tough soils, and a rise of pests and diseases are problems in the production stage. Hard soils make planting more time and labor-intensive; limited germination necessitates more irrigation; and water stress makes crops more vulnerable to pests and diseases, yields are low, and the produce is of worse quality. Flood on production setbacks, poor stand establishment, more labor and weed control expenses, rise in insect and disease incidence, and plant rot. Flooding ruins roads, and this harm to the transportation network can also make it more difficult to access markets, storage facilities, and processing equipment, which frequently has knock-on implications for processors, and agricultural stakeholders.

Sustainability regarding biodiversity and ecology in the fruit industry focuses on issues like habitat protection, balancing production with conservation efforts, protecting native vegetation and wildlife, pest control, and managing soil. Industries that embrace continued natural biodiversity in the regions where they raise their crops show that they are forward-thinking in their approaches and indicate that they have a long-term view of the success of their industry. Fruits value chain conserve biodiversity and ecosystem in the following ways; creating natural buffer zones approximately 5 meters in width lining all borders of orchards, including fence lines and waterways, that connect native vegetation patches inside and outside the orchard, use integrated pest management to control pests, using biological agents, native species, and chemical solutions to specifically target pests and preservation of native pollinators (like bees) by conserving their habitat within and outside fruits orchards

The horticulture sector employs about 10 million people directly and indirectly predominantly women and youth. About 6 million people are directly involved in production, processing, and marketing, while about 3.5 million people benefit through other related activities along the value chain. For instance, clearing agents, government institutions (pest control board), and other entrepreneurs. Fruits contribute to food security. Apart from their rich nutrient, mineral, and vitamin content, fruits are now known to lower blood pressure; reduce the risk of heart disease, stroke, and probably some cancers; and help to lower the risk of eye and digestive system problems

Given the perishable nature of the fruits, the state of rural infrastructure has an impact on the fruit business. Rural feeder roads need urgent repairs and upkeep because they are essential for the gathering of production. There is lack of collection and sorting facilities in the main fruit-producing areas as one of the key logistical challenges that add to marketing costs

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**List of Abbreviations and Acronyms**

AAK -Agrochemicals Association of Kenya  
ACT -African citrus triozid FTNOAK-The Fruit Tree Operators Association of Kenya  
AFFP- African fruit fly program  
BGAK- Banana Growers Association of Kenya  
EU-European Union  
FCM -false codling moth  
FDG- Focus group discussion  
FPEAK- Fresh Produce Exporters Associated of Kenya  
GOK-Government of Kenya  
HCD-Horticultural Crop Development Authority  
HEBI- Horticultural Ethical Business Initiative  
ICIPE-The international Centre for Insect Physiology and Ecology  
IPM- Integrated Pest Management  
KALRO- Kenya Agricultural and Livestock Research Organization  
KCSAP- Kenya Climate Smart Agriculture Project  
KEPHIS-Kenya Plant Health Inspectorate Services  
KTDA -Kenya Tea Development Agency  
MOA-ministry of Agriculture  
MT- metric ton  
NCCRS -National Climate Change Response Strategy  
NCPB -National Cereals and Produce Board  
NFSCC -National Food Safety Coordination Committee  
NGO- Non-governmental Organization  
SDG-Sustainable development  
TC- Tissue culture  
UK- United Kingdom  
USAID-United States Agency for International Development  
VC-value chain



## 1 Introduction

### 1.1 Background and objectives of the value chain analysis

#### 1.1.1 Global, National, and County overview of the value chain

According to the data from UN Food and Agricultural Organization (FAO), the global fruit production was about 870 million metric tons in 2018. Asia Pacific was the largest region in the global fruit farming market, accounting for 49% of the market in 2018. Western Europe was the second largest region accounting for 13% of the global fruit production. China was the largest fruit producing country in 2018, contributing about 240.8 million metric tons to the world fruit production. India, Brazil, and The United States are also some of the top fruit producers in the world<sup>1</sup>.

The fruit value chain plays an important role in providing fresh and nutritious food to consumers around the world, especially in growing towns and cities. In the context of global ambitions to meet the targets of the United Nations Decade of Action on Nutrition 2016–2025 and 2030 Agenda for Sustainable Development, there is an urgent need to advance investment in the potential of the fruits value chain to improve livelihoods, nutrition, food security, and diet quality. Increased global fruit consumption requires greater supply, at the national level, given that less than 9 percent of global fruit production is traded internationally. The fruit sector also carries potential benefits for employment and empowerment, particularly among women and youth, whose participation is key for effective development<sup>2</sup>.

Fruit production is becoming very important in Kenya for domestic consumption and export. Kenya's tropical and temperate climate zones favor the cultivation of a wide range of fruits. In the coastal lowlands, farmers grow mangos, citrus fruits, and bananas. In the middle altitudes, crops include bananas, mango, passion, avocado and citrus<sup>3</sup>. The fruit value chain in Kenya includes a climate that allows for year-round cultivation, fertile soils, and a competitive labor force with good education and technical background. Kenya counties are promoting the fruit value chain by providing a supportive environment for production. They also undertake entrepreneurship through value-addition techniques.

Table 1: Fruits production by Area, Volume and Value in 2019-2020 Source: AFA-Horticulture Crops Directorate

Crop	2019			2020		
	Area (Ha)	Volume (MT)	Value (KES)	Area (Ha)	Volume (MT)	Value (KES)
Banana	71,901	1,512,013	24,622,881,364	72,486	1,871,521	29,028,891,206
Mango	56,090	900,863	15,260,446,464	56,437	809,857	15,379,435,988
Orange	9,291	78,040	1,907,023,284	12,604	145,445	3,522,833,425
Lime	4,955	74,590	2,951	2,380,839,822	82,110	2,161,375,000
Lemon	2,043	16,142	376,220,443	2,050	16,486	476,850,000
Tangerine	1,149	11,512	247,693,541	1,377	16,434	418,054,690
Grapefruit	173	2,821	47,528,747	193	2,468	36,100,045
passion	1,406	16,886	562,760,578	1,313	16,479	578,400,400
Avocado	20,240	420,430	9,003,403,239	26,481	500,274	9,438,124,806

<sup>1</sup> Global Fruit Industry Factsheet 2020

<sup>2</sup> Santacoloma, P., Telemans, B., Mattioni, D., Puhac, A., Scarpocchi, C., Taguchi, M. and Tartanac, F. 2021. Promoting sustainable and inclusive value chains for fruits and vegetables – Policy review. Background paper for the FAO/WHO International Workshop on Fruits and Vegetables 2020. Rome, FAO. (Also available at: <https://doi.org/10.4060/cb5720en>)

<sup>3</sup> Chebet, D. K. (2021). *Investigation of arbuscular mycorrhizal inoculation on growth of tropical fruit seedlings under saline, flooding, and nutrient stress conditions* (Doctoral dissertation, JKUAT-CoANRE).

### **1.1.2 Key county statistics on value chain performance (production, productivity, industry, and market trends)**

The selected counties for fruit (passion, banana, avocado citrus, and mango) are: Siaya, Kericho, Kisumu, Bomet, Kisii, Vihiga and Nandi. Data available on the selected counties shown below.

In Bomet county in 2016 banana was grown in 432ha and the production that year was 10,238 tonnes valued at 128,153,000 Ksh. Mango was grown in 20ha, and the production was 300 tonnes valued at 400,000 Ksh. Passion fruit was grown at 40ha, with the production of 600 tonnes valued at 18,000,000 Ksh<sup>4</sup>.

In Nandi 2017, the banana was grown at 320 ha and the production was 5747 tonnes valued at 115,000,000 Ksh. Passion fruit was grown in 15ha, and production was fifty tonnes valued at 17,500,000 Ksh<sup>5</sup>.

In Nyamira banana production has been on the increase both in the area under bananas and yields per unit area. Income from bananas has also risen especially after the intervention by County Government and other partners like USAID, INFAS/Africa Harvest, and ASDSP. In 2013, the area under banana was estimated at 2,105 hectares with a production of 31,575 Tons (15 tons/Ha) and by 2017, the total area under production was 2259 Ha giving a total production of 42,475 tons of bananas. This gave an estimated value of Ksh553, 600,000. In 2013/2014 Banana was identified as one of the flagship projects that would contribute to the economic development of the County. Passion fruit production is mainly done on small scale in Borabu, Nyamira north, Nyamira South, Masaba North, and Manga Sub Counties. The crop does well due to the prevailing climatic conditions and fertile soils. The major challenge however has been accessing clean planting material and the occurrence of fusarium wilt and woodiness diseases associated with uncertified planting materials.

In Siaya county 29,400 t of fruit was harvested in 2016, valued at 87,790,300 from 1075ha. The challenge however is that the specific fruit performance is not given. Other available county statistics on the value chain are discussed.

Kenya was the leading exporter of avocado in Africa in 2020 and among the top 10 world's largest exporters but only exported 10 of its total avocado production<sup>6</sup>. The leading counties in 2020 production were Kisii, Nyamira and Bomet. They contributed 6.8. 5.8 and 3.9 percent respectively of the total value.

## **1.2 Methodology**

### **1.2.1 Mixed methods approach (qualitative and quantitative)**

The research employed a mixed-methods approach comprising qualitative data through varied techniques including literature/desk reviews, key informant interviews, Focus Group Discussions, and interviews.

### **1.2.2 Desk Research**

Thorough literature review of all documents relevant to the review assignment (Subject to availability) to get a better understanding of the research and to sharpen the research processes.

### **1.2.3 Key Informant Interviews**

The secondary data research was complemented through qualitative interviews with key informants. This generated insights to get in-depth information on county level data on the value chain.

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<sup>4</sup> Department of Agriculture Livestock at cooperatives, 2016

<sup>5</sup> Agriculture report, 2017

<sup>6</sup> Horticulture vindicate report 2019-2020

### 1.2.4 Focus Group Discussion

A qualitative focus group discussion guide was developed to generate insights. Data generated from the FGDs was triangulated with data collected from other sources to offer explanations for trends and insights observed on the value chain.

### 1.2.5 Data collection, tools, processing, and analyses

The individual tools will be scripted into Mobile data collection software to integrate the collection of data and ease supervision of data quality through daily reviews of synchronized data onto a data aggregation cloud. Quantitative Analysis will use descriptive and Inferential and qualitative Analysis will use thematic/Content Analysis.

## 1.3 History of the Fruits Value chain

The fruit sector is important due to its tremendous contribution to the economy. The growth of the fruit sector in Kenya has not been a linear and smooth or continuous process <sup>7</sup>. There have been changes in factors like characteristics of farmers, climate change, the role of the state, marketing strategies and policies, among others. Fruits were grown before the colonial era (i.e., before 1860), and fruits were brought to Kenya by Arab and Indian traders from Asia, either directly or via southern Africa. Citrus (*Citrus* spp.), mango (*Mangifera indica* L.), and banana (*Musa acuminata* Colla) may be the earliest introductions, arriving before the sixth century. passion fruit (*Passiflora edulis* Sims) is among the most recent introductions and was imported by Portuguese explorers, missionaries, or colonialists. Avocado (*Persea americana* L.) in the family Lauraceae is a sub-tropical tree native to South Central Mexico. It is believed to have been introduced in Kenya by the Portuguese between 16th and 18th centuries. According to Hill (1956), the Imperial British East African Company was experimenting with temperate fruits as early as 1893. Colonial white settlers founded the East African Agricultural and horticultural society presently the Agricultural Society of Kenya<sup>8</sup>.

During early independence, the government made changes where farmers were given higher priority to improve their conditions. Evidenced by the land reforms by the government and the development of state enterprises. With the expansion of the fruit sector by the private sector, the government had little direct interference with the sector. The government never entirely ignored the sector, it established regional research stations to support the horticultural experiments<sup>9</sup>

### 1.3.1 Key turning points in the development of fruits over 50 years.

The fruit sector has undergone a series of both positive and negative changes overtime, the key turning points in the fruits in Kenya include the fruits research activities in the early 1990s by the colonial government which established Matuga agricultural research station that originated from experimenting with tropical fruits along Indian ocean. The second experiment station for tropical fruits was established close to where the National Agricultural Laboratories are currently located. These experiment stations helped to facilitate the adoption and expansion of areas planted with fruits developed in the stations.

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<sup>7</sup> Cramer, C., Sender, J., & Oqubay, A. (2020). *African economic development: Evidence, theory, policy* (p. 336). Oxford University Press.

<sup>8</sup> Lukalo, F. (2022). Putting Agriculture Ahead? Reflections About the Early Years of Neoliberalism in Kenya. In *Capital Penetration and the Peasantry in Southern and Eastern Africa* (pp. 163-177). Springer, Cham.

<sup>9</sup> Minot, N., & Ngigi, M. (2004). *Are horticultural exports a replicable success story? evidence from Kenya and Côte d'Ivoire*. Intl Food Policy Res Inst

World war II stimulated fruit production and processing in two ways. First, wartime enhanced tight control on imports, and this resulted in increased domestic markets where producers and processors benefited. Second, the expansion of experimental work started in 1994 with tropical fruit that expanded to Tigoni. The National Horticultural Research Center started in 1957 at Thika which evolved into KARI. During wartime, demands especially for provisions to the Allied forces in North Africa and the Middle East, the authorities launched a project to produce dehydrated vegetables. This pioneered the feasibility of engaging smallholders in fruit production by giving the right institutional support. It demonstrated that African farmers could be mobilized for commercial agricultural production of new crops if inputs, technical assistance, and a stable market could be provided. This model was later adopted in various crops and fruit production.

Early independence brought changes by giving higher priority to Africans in two ways. First land reforms, where governments purchased land farmed by European and distributed it to about ten thousand smallholder farmers. Second, state enterprises were created to implement and develop the goals of the government. Third, there was the creation of the Horticultural Crop Development Authority (HCD) in 1967. It played a facilitative role in attempting to coordinate various players and industries. Kenyan exporters through (HCD) were supported with shared and modern processing systems to meet the stringent regulatory requirements such as traceability, customers quality expectations, post-harvesting processes such as product combinations, presentations and packaging, logistics, and innovative ways that leverage the industry's asset specificity of Kenyan location, availability of cheap labor, and the tropical climatic conditions favorable for the year-round crop production. Finally, the key turning point during early independence was the growth of international investments in the Kenya horticultural sector.

Kenya's tourism industry has contributed to the growth of the fruit sector in Kenya. Nairobi's location is a center of air transport to various destinations, especially Europe. It has increased demand for high-quality fruits from hotels and restaurants. Another Key turning point is the increasing involvement of small smallholder farmers in the fruit sector. This has increased the volume of fruits produced in the country over time<sup>10</sup>.

### **1.3.2 Previous development activities**

The Horticulture crop Development Authority (HCD) was established in 1967 with the mandate to coordinate, develop and facilitate the horticultural industry. HCD focused on facilitative roles and coordination of various actors in the sector. It is never strongly involved in setting prices or a legal monopoly in the market. This led to the private sector taking the role and rapid growth seen in the sector <sup>11</sup>.

A nursery registration and inspection program were instituted in 1990 by the government to ensure farmers receive appropriate planting materials like the seed imported. It solves a challenge since new or improved cultivars have not been available to meet the local demand for fruits. The Fruit Tree Operators Association of Kenya (FTNOAK) is the apex organization representing fruit tree nursery operators/farmers in Kenya. FTNOAK aims to improve the livelihoods of the members through the propagation and sale of high-quality fruit tree planting materials to enhance production, household nutrition, incomes, and environmental conservation and reduce the spread of diseases such as citrus greening. This is a success since most research institutions, both private and public, and universities have established nurseries that produce high-quality fruits.

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<sup>10</sup> Chemeltorit, P., Saavedra, Y., & Gema, J. (2018). Food traceability in the domestic horticulture sector in Kenya: An overview. *Practice brief*, 5.

<sup>11</sup> Tyce, M. (2020). A 'private-sector success story'? Uncovering the role of politics and the state in Kenya's horticultural export sector. *The Journal of Development Studies*, 56(10), 1877-1893

Citrus production has been on the decline due to pests and diseases (African citrus triozid (ACT) and the false codling moth (FCM). The international Centre for Insect Physiology and Ecology (ICIPE) in collaboration with partners from Africa and Europe, developed and disseminated IPM measures for citrus-infesting diseases. The project strengthens the citrus production systems to improve productivity and yield and enhance the economic welfare of small and medium-scale producers. IPM strategy for managing fruit flies on mango done by ICIPE under the African fruit fly program (AFFP)<sup>12</sup>. The goal of the AFFP program is to reduce mango losses due to fruit fly infestation, lower the cost of production, increase income at the producer level and improve market access and processing through increased quality and productivity of mangoes, to meet the needs of both the domestic urban and export markets. The fruit fly IPM-based approach uses a combination of interventions that complement each other rather than work as a stand-alone management strategy<sup>13</sup>. The ongoing fruit fly IPM strategy dissemination and promotional activities by the program show clear indications of success with growers rapidly taking up the strategy<sup>14</sup>. Success seen since they collaborated with beneficiaries, including farmers and exporters and others along the value chain, from the earliest stage.

Commodity associations are among the development activities for the fruits like citrus, mango, passion fruit, and banana in Kenya. The association gives members an avenue to present their views to the government and the industry, collective marketing of produce, better pricing, investment in modern technology, communication, and information dissemination, disease control, value addition of produce, and bulk procurement of farm inputs and access to technologies. Banana Growers Association of Kenya (BGAK) for example, brings together the banana growers in the country intending to enhance their entrepreneurial capacities through economies of scale, improved planting materials, and championing for an improved sub-sector policy environment. Highbridge Banana Growers and Marketing Association was established in 2003 through the initiative of the International Service for the Acquisition of Agri-Biotech (ISAA), KARI, and the Government through the Ministry of Agriculture. This is a success since thousands of farmers are in these associations and they are benefiting from , marketing, and information on climate change, among others.

Fresh Produce Exporters Association of Kenya (FPEAK) is Kenya's premier private association which represents growers, exporters, and service providers in the horticultural industry. FPEAK provides a focal and coordination point for the horticultural export industry by supporting the growers and exporters through technical and marketing information and training, functioning as an information center, and running active lobbying and advocacy programs to enhance the competitiveness of the sector. Kenya through FPEAK has successfully lobbied for the formation of Kenya Gap and Horticultural Ethical Business Initiative (HEBI). These bodies have become collective lobbying agencies for public grades and standards and played a pivotal role in interpreting the global standards while advising their association members on the current trends and regulations that are to affect them.

### **1.3.3 Structure of the value chain**

The fruit value chain is a complex network of actors from research to the final consumer. The actors in the value chain include input suppliers through nurseries, farmers, and marketing agents which include village assemblers, brokers and wholesalers, processors, and exporters. There are challenges seen in the value chain like pests and diseases,

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<sup>12</sup> ICIPE fruit fly IPM

<sup>13</sup> Neuenschwander, P., & Tamo, M. (2019). Introduction: meeting challenges in plant health in sub-Saharan Africa. In *Critical issues in Plant Health: 50 years of research in African agriculture* (pp. 19-40). Burleigh Dodds Science Publishing

<sup>14</sup> Deguine, J. P., Aubertot, J. N., Flor, R. J., Lescourret, F., Wyckhuys, K. A., & Ratnadass, A. (2021). Integrated pest management: good intentions, hard realities. A review. *Agronomy for Sustainable Development*, 41(3), 1-35.

poor negotiation, and high investment costs. The value chain nodes, although complicated and inefficient, are structured.

## 2 FUNCTIONAL ANALYSIS

### 2.1 Value chain map

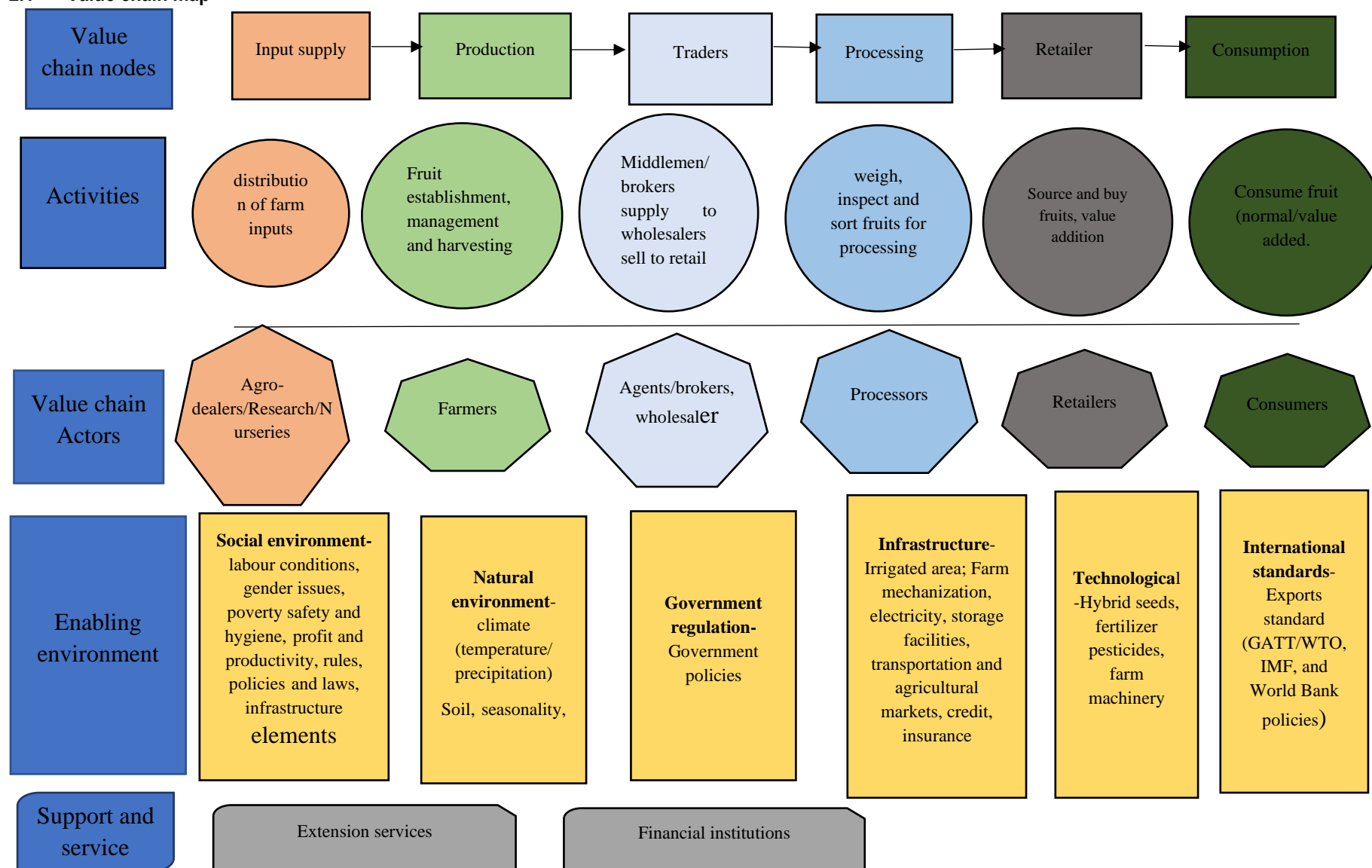


Figure 1: Fruit value chain map

## 2.2 End-market Analysis

Apart from fruit rich nutrient, mineral, and vitamin content, fruits are now known to lower blood pressure; reduce the risk of heart disease, stroke, and cancers; and help to lower the risk of eye and digestive system problems. The growing consciousness in Western countries and locals to adopt fruit-rich diets is one of the major drivers of the growing demand for fruits<sup>15</sup>

### 2.2.1 Mango demand

There are three sources of demand for mangoes in Kenya: the fresh market, the processing market, and the export market. The target includes open-air markets, supermarkets, hotels, juice processors, and export markets<sup>16</sup>. In 2021, the self-ban on exporting mangoes to the European Union was lifted, opening the lucrative market. Japan and China have opened new markets for dried mango chips. With the Asian and EU markets, the demand for fruit has exceeded the supply. Demand for the fruit has been on the increase across sectors, including supermarket retail, restaurant catering, and the hotel market<sup>17</sup>.

Neither processors nor exporters are currently able to satisfy their demand for mango, only 40 and 50 percent of their demand is met<sup>18</sup>. Domestic demand for fresh mango fruit is projected to grow from 610,000 MT in 2014 to 955,000 MT in 2022, driven by income and population growth. Demand for mango in the processing industry is projected to grow from 50,000 MT in 2014 to an estimated 250,000 MT in 2022, driven by increased demand for juice in the local and regional markets. Additionally, export demand for fresh fruit will grow from 13,900 MT in 2014 to 51,000 MT in 2022, driven by seasonal production advantages and diversification of the market and products<sup>19</sup>. Taking these markets together, total demand will increase from 623,900 MT in 2014 to 768,600 MT in 2017 and 1,006,000 MT in 2022.

### Export demand

Kenya remains a small player in the international mango trade, exporting approximately two percent of national production or one percent of the fresh mango traded on the world market<sup>20</sup>. In 2011, Kenya earned KSh1 billion (US\$11.8 million) from mango exports. Between 2006 and 2010, Kenya's mango exports grew by 17.7 per annum, the sixth fastest rate of growth across exporting economies<sup>21</sup>. It is projected exports will grow to 22.6 MT in 2017 and 51,023 MT in 2022, the projections corroborate the National Mango Business Plan estimate of 50,000 MT in 2022<sup>22</sup>. Like the processing sector, mango exporters cannot procure sufficient volumes of mango to meet the demand for their product. Exporters suggest that they can only meet 50 percent of potential export demand due to the limited supplies of quality fruit that meets export requirements<sup>23</sup>.

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<sup>15</sup> Nair, K. P. (2010). The agronomy and economy of important tree crops of the developing world.

<sup>16</sup> Usaid-Kaves Mango Value Chain Analysis 2015

<sup>17</sup> Galán Saúco, V. (2002, September). Mango production and world market: Current situation and prospects. In *VII International Mango Symposium* 645 (pp. 107-116).

<sup>18</sup> Isaboke, H. N., & Musyoka, K. (2022). Analysis of the factors affecting farm-level output of mangoes among small-scale farmers in Mwala Sub-County, Kenya.

<sup>19</sup> Usaid-Kaves Mango Value Chain Analysis 2015

<sup>20</sup> FPEAK, 2012

<sup>15, 22</sup> ITC, Trade Map 2012

<sup>23</sup> Mango Working Group, July 2011



## Domestic and regional market

Currently, the domestic market for mango is significantly larger than the export market both in volume and value. Within the mango sector, the domestic market especially urban consumers are the largest contributor to the economy in terms of national revenue earnings income generation for smallholder producers<sup>24</sup>. Domestic demand for Mango has grown exponentially over the last years<sup>25</sup>. The domestic market is largely informal with a range of stakeholders engaged in specific segments of the supply system. The supply of the domestic market comes primarily from small-scale and medium-scale farms. There is a general lack of market information, a lack of transparency, and a lack of formal contracts between farmers and buyers in this food supply system.

### 2.2.2 Banana demand

In 2020, bananas production in Kenya was 1.86 million tonnes. Banana production in Kenya increased from 400,000 tonnes in 1971 to 1.86 million tonnes in 2020 growing at an average annual rate of 7.14%.

Kenya has over 400,000 smallholder banana farmers with 1.7 percent of Kenya's total arable land planted covered by bananas both the dessert ripening banana, cooking, and plantain varieties. Kenya has around 71,000 hectares of bananas which contribute to Ksh.25 billion annual income in a production of 1.5 metric tons of the product, according to KALRO. In 2019, the area under banana production was 71,102 Ha with a total production of 1.51 million tons valued at Ksh.24.62 billion.

The supply of bananas in the country is dependent on weather patterns and varies with the season. In October, November, January, and February the prices are low due to the glut while the highest prices are during August, and September. A report from HCD stated that there is a gap of 71,000 MT of unmet market demand in the banana market based on information from traders and retailers<sup>26</sup>.

The development of value addition for bananas in making crisps, flours, and essence has also increased the consumption and demand of bananas, especially for processing companies and individuals. Export prospects for the crop have improved over the last decade and entrepreneurs are exporting banana fruit and processed products, tapping into the organic market in Europe. However, the exported quantities are still exceedingly small as the main means of transportation from East Africa is by air, which is expensive<sup>27</sup>.

### 2.2.3 Citrus demand

Citrus is a wider name for species such as pomelo, lemon, citron, Tangerine, and mandarin, among others. Citrus remains a vital horticultural crop in Kenya. They can thrive well under wider areas, from low altitudes at sea level to highlands at 2100m above sea level. Sweet oranges, mandarin, and pixie are the main citrus species that a grown commercially.

In 2020, citrus fruit production for Kenya was 349,919 tonnes. Citrus fruit production in Kenya increased from 14,000 tonnes in 1971 to 349,919 tonnes in 2020 growing at an average annual rate of 11.14%.

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<sup>24</sup> Van Hoyweghen, K., Fabry, A., Feyaerts, H., Wade, I., & Maertens, M. (2021). Resilience of global and local value chains to the Covid-19 pandemic: Survey evidence from vegetable value chains in Senegal. *Agricultural Economics*, 52(3), 423-440.

<sup>25</sup> World Bank, 2020

<sup>26</sup> Horticulture vindicate result 2011

<sup>27</sup> USAID-KAVES VALUE CHAIN ANALYSES 2013

Production does not meet the local demand necessitating the importation of large quantities of citrus fruits and products<sup>28</sup>. However, local market demand for citrus outweighs the supply which in the case of Kenya is below 25% of the production potential, resulting in importation from South Africa and Egypt<sup>29</sup>.

#### **2.2.4 Passion fruit demand**

The demand for passion fruit is high both in local and regional markets as well as in the export market. There is the great market potential for passion fruit both in the domestic, regional, and global markets. In the domestic market, there is high demand for passion fruit for fresh juice and concentrate for use in fruit canning factories<sup>30</sup>. Passion fruit market include export, local fresh and processing. It is popular in the cottage industry for fresh juice processing in Uganda which is one of the leading market destinations<sup>31</sup>.

Kenya ranked among the leading five exporters of passion fruits to the EU. The EU demand for passion fruit has been expanding at 13 percent per year outstripping the global supply. However, Kenya's passion fruit supply to the EU has been declining by 2 percent per year and its market share dropped from 20 percent in 2006 to 11 percent in 2010. The decline in exports of passion fruit to the EU is attributed to a lack of clear planting material, inadequate linkages between smallholders and national exporters, low rate of compliance to the market requirements, and inefficient collection and onward distribution system which impedes smallholder success in capturing intermediate margins, and expensive and unreliable overland, air and ocean export transportation systems which lead to uncompetitive costs, excessive transit times, and unreliable quality upon arrival<sup>32</sup>.

The volume of Kenyan passion fruit exported to Europe is smaller but has increased over the past few years. While passion fruit exporters are optimistic about market growth for Kenyan fruit, they say that traceability systems must be present and pesticide residue levels controlled. Fruit supplied by brokers cannot provide this level of assurance, so exporters seek supplies more directly through contracts with smallholder groups. However, the volume of smallholder fruit supplied through contracts still meets only a small percentage of exporter requirements, so brokers remain the main player in this value chain.

The leading counties in production of purple passion are Elgeyo Marakwet, Bungoma Uasin Gishu, Kirinyaga and Embu counties. Kisii, Bomet, Nandi and Vihiga are selected counties that produce passion fruits. The area of land cultivated production and value for 2020 discussed above<sup>33</sup>.

#### **2.2.5 Avocado Demand**

Kenya was the leading exporter of avocado in Africa in 2020 and among the top ten world's largest exporters but only exported ten of its total avocado production. In 2019-2020, the area increased from 20,240ha in 2019 to 26,482ha in 2020 while production increased from 420,430tons to 500,274tons, 31 percent and 19 percent increase, respectively. The value on the other hand increased from Kshs9billion in 2019 to Kshs9.4billion in 2020, representing an increase in value of 5 percent.

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<sup>28</sup>MOA, 2003

<sup>29</sup> Muendo, K. M., & Tschirley, D. L. (2004). *Improving Kenya's Domestic Horticultural Production and Marketing System: Current Competitiveness, Forces of Change, and Challenges for the Future Volume I: Horticultural Production* (No. 680-2016-46735).

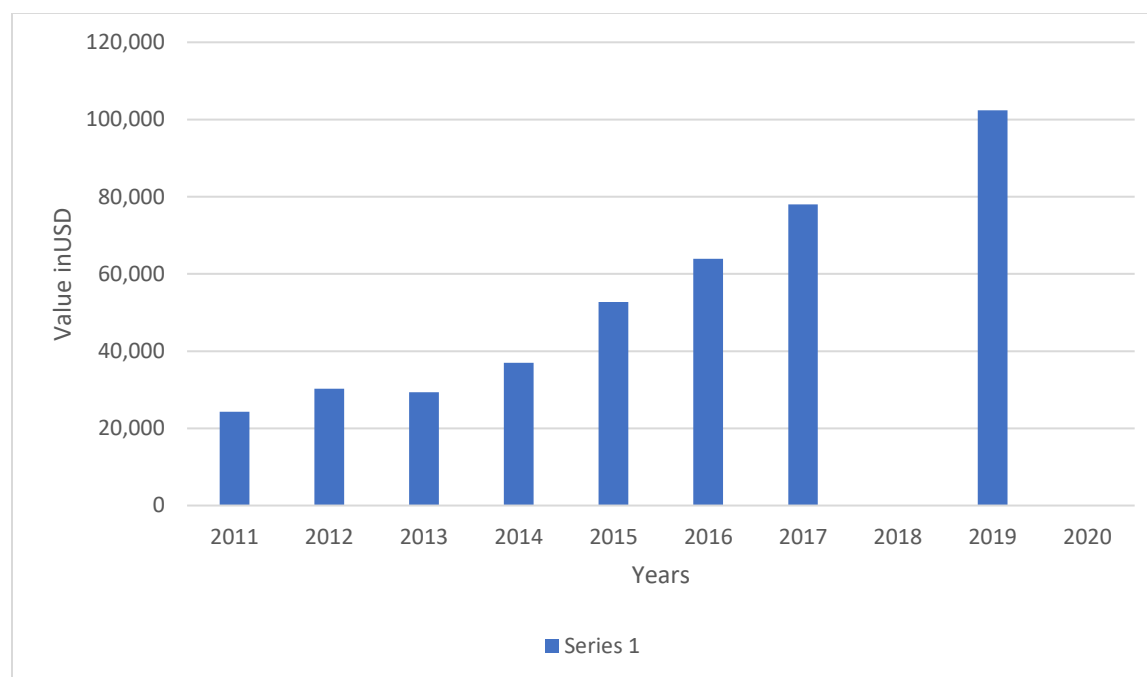
<sup>30</sup> Mukoye, B., Macharia, I., & Avedi, E. (2022). Distribution of passion fruit (*Passiflora* spp.) pests in Kenya. *African Phytosanitary J*, 3(1), 47-55.

<sup>31</sup> Validate horticulture report 2019-2020

<sup>32</sup> National Passion Fruit Business Plan, 2012 – 2022

<sup>33</sup> Passion fruit counties production 2020

The production volume in 2020 increased, due to the increased harvest area for avocado and improved prices in the international markets. As the global demand for avocados is increasing and the profitability of avocado is much higher than other tropical fruits, more farmers are starting to plant the fruit. In addition, the Kenyan government is also actively supporting avocado production by providing free avocado seedlings to farmers and subsidizing small scale avocado farmers<sup>34</sup>. 70 percent of the production are by small-scale farmers, which grow the fruits for subsistence, local markets, and export purposes<sup>35</sup>. There local demand for avocado is growing in Kenya. The rise in demand has been caused by realization of the health benefit as well as increased processing activities.



*Figure 2:Export value of Kenya avocado*  
Source: Freshela 2020

## 2.2.6 Market structure

Marketing systems are not static, they change as production patterns, consumption patterns, and technology change, and Kenya is no exception. The international trade in fruits is increasing in scale and variety. The competitiveness of African suppliers of high-value horticultural produce depends on their low costs of production, complementarity to European seasons, short flight times, and ability to supply products of the quality and quantity required by the international market. Kenya is facing a challenge in the fruit sector as its market share is being attacked by South African sales that are growing at twice the rate that Kenya's exports are growing<sup>36</sup>. Kenya exports its products to several markets in Africa, Europe, the Middle East, Asia, and the US. Liberalized economy and globalization of markets means, Kenyan exporters are expected to be more competitive and innovative if they are to effectively exploit the opportunities that world markets present.

<sup>34</sup> VALIDATED REPORT 2019-2020

<sup>35</sup> Statista 2020

<sup>36</sup> (USAID-KHCP, 2014)

The EU is Kenya's principal market in horticultural export produce with the UK, Netherlands and France being the main markets. Germany, Switzerland, Belgium, and Sweden are the other important markets in the EU<sup>37</sup>. There are two marketing chains linking Kenyan growers with UK customers that is, the wholesale chain and supermarket chain each serving two distinct markets. In the last seven years, the supermarket chain has become dominant, facilitating the export of 70 percent of Kenya's exports to the UK in this sector. It is now the major retailer that effectively regulates quality standards. This private interest re-regulation of the food sector means that the state is dependent upon retailers to provide safe and high-quality food; such power has enabled multiple retailers to develop their regulatory systems to ensure dominance over the supply of food products. Supermarkets are thus in a powerful position to influence what is grown in Africa, how it is grown and by whom, which reflects their need to keep profit margins as high as possible, as well as ensuring that the needs and demands of their customers are satisfied<sup>38</sup>.

Since the 1990s, supermarkets have emerged as the key market channel for food retail sales in Africa and have transformed African horticulture. Within a decade, the average share of supermarkets in food retail increased to 50–60 percent<sup>39</sup>. At the same time, the continent's supermarket segment consolidated as large multinationals such as Walmart, Carrefour, Tesco, and Royal Ahold entered developing markets. Supermarkets' degree of control over their supply chains increased, and they began coordinating the value chain, from sourcing to production and distribution to retail, by pushing for standards certification and traceability.

In Western Europe and in the Middle Eastern countries demand for fruits has attracted suppliers from different countries, both in the tropics and in the temperate climates, giving a wide array of several types of fruits<sup>40</sup>

Exports of fresh passion fruit to Uganda and fresh mango to Tanzania have also increased significantly over the past three years due to favorable climatic conditions and suitable varieties<sup>41</sup>. There is growing potential for Kenya export horticulture products and fruits specifically both internationally and in other Africa countries.

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<sup>37</sup> Walker, M. I., & Minnitt, R. C. A. (2006). Understanding the dynamics and competitiveness of the South African minerals' inputs cluster. *Resources Policy*, 31(1), 12-26.

<sup>38</sup> Neven, D., Odera, M. M., Reardon, T., & Wang, H. (2009). Kenyan supermarkets, emerging middle-class horticultural farmers, and employment impacts on the rural poor. *World development*, 37(11), 1802-1811

<sup>39</sup> Reardon, T., Timmer, C. P., & Berdegue, J. (2012). The rapid rise of supermarkets in developing countries: induced organizational, institutional, and technological change in agri-food systems. In *The Transformation of Agri-Food Systems* (pp. 71-90). Routledge

<sup>40</sup> Kayode, O. (2014). Marketing Communications. Bookboom Publishers.

<sup>41</sup> FPEAK 2017-2019

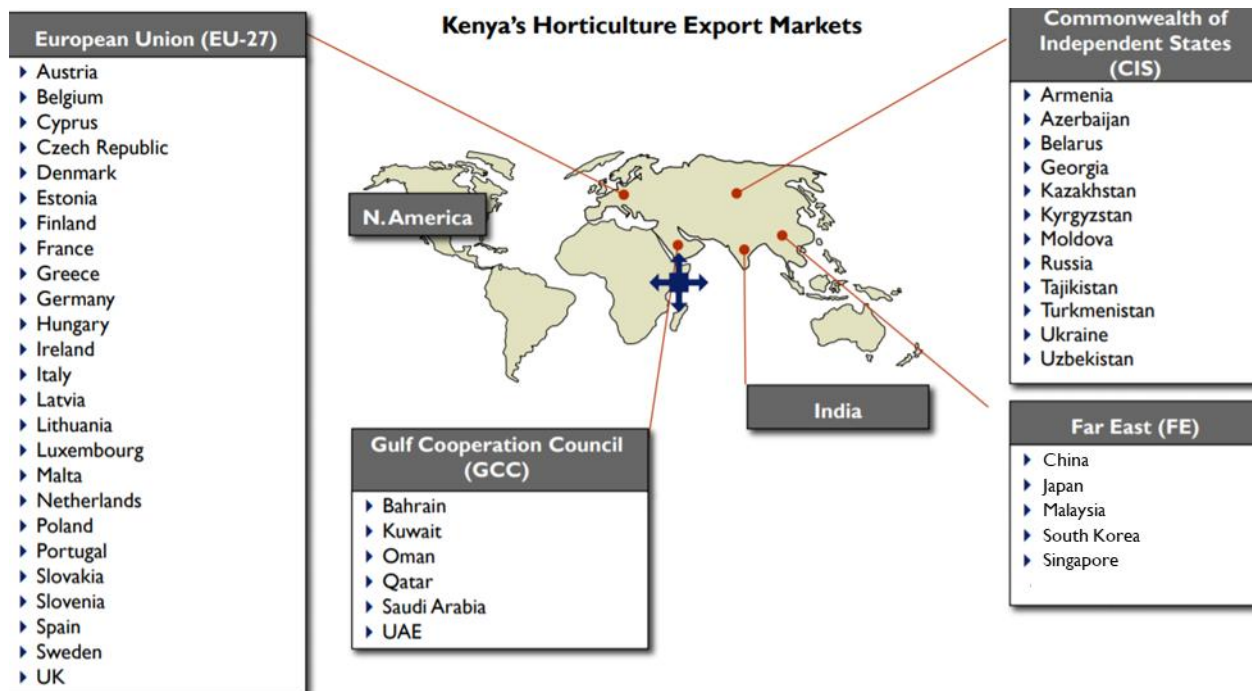


Figure 3: Kenya's horticulture international export markets potential Source: Global Competitiveness Study: Benchmarking Kenya's Horticulture Sector for enhanced Export Competitiveness

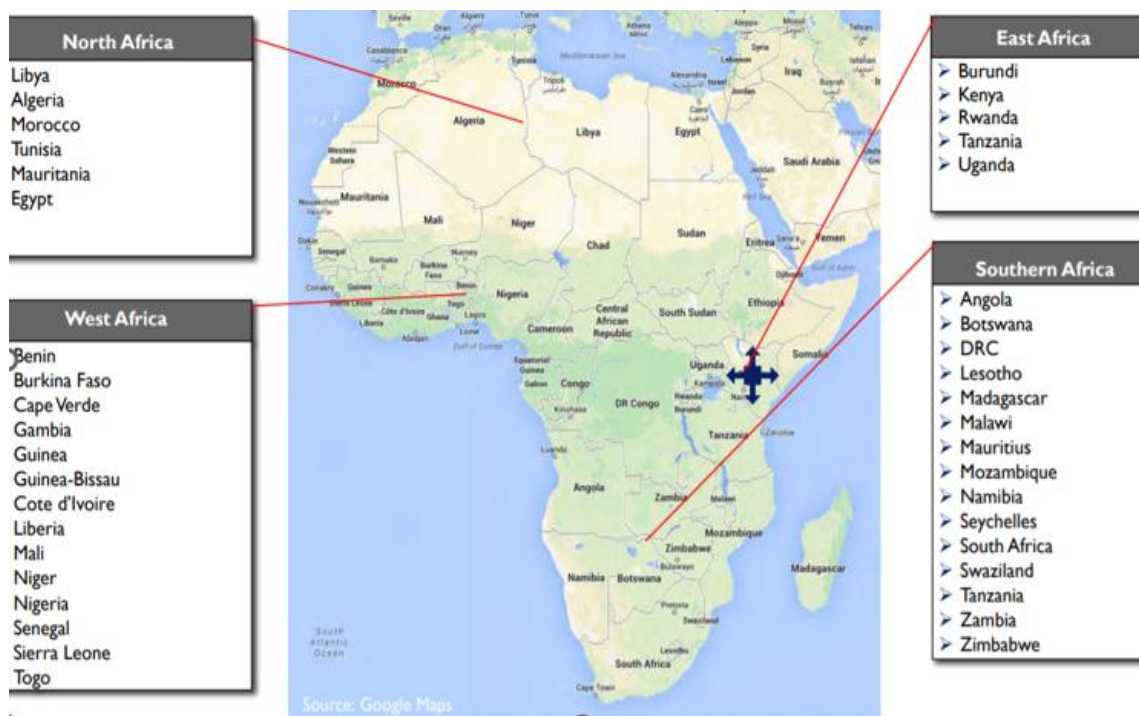


Figure 4: Kenya's Horticulture Export African Markets potential Source: Global Competitiveness Study: Benchmarking Kenya's Horticulture Sector for enhanced Export Competitiveness

### 2.2.7 Distribution Channel

The business is dominated by half a dozen UK retail chains that buy produce from large Kenyan exporters/processors that grow their fruits on their farms or source them from large contract farmers. Produce passes through four stages, the first phase is growing the crop. Done by smallholders, large contract farmers, or on plantations owned by the exporters. The second stage is processing, packaging, and exporting, which is conducted by the exporters. Harvested and taken into the hands of the exporters, who are responsible for processing, packaging, storage, and transport. These firms work with UK importers, who manage crops from various countries. The product is then delivered to the UK.

Figure 5 shows the various local, regional, and international marketing channels for horticultural produce in Kenya. The export market is served by a few large-scale own company farms and contracted smallholder farms. Independent smallholders produce the bulk of fruits for domestic markets. The main traders in the regional markets are the wholesalers<sup>42</sup>.

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<sup>42</sup> Muendo, K. M., & Tschirley, D. L. (2004). *Improving Kenya's Domestic Horticultural Production and Marketing System: Current Competitiveness, Forces of Change, and Challenges for the Future Volume I: Horticultural Production* (No. 680-2016-46735).

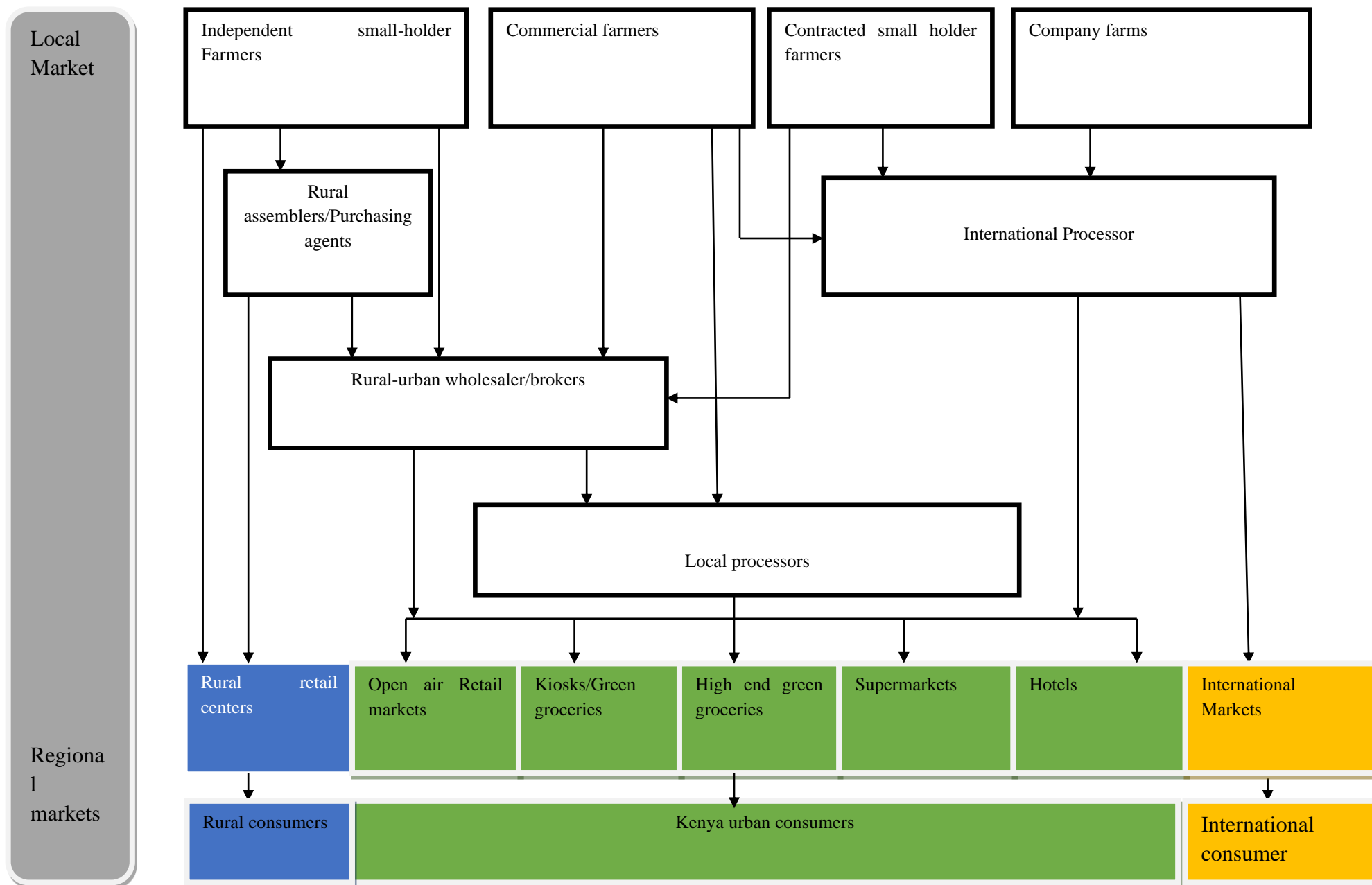


Figure 5: Domestic, Regional, and international distribution Channels for Fresh Horticultural Produce in Kenya

### **2.2.8 Drivers that initiated change**

Fruit production growth in Kenya has been driven by favorable climate that ensures year-round production, favorable conditions for foreign investors, rise in demand for fresh produce domestically, an enabling policy environment and an expanding domestic market.

Retailers are the main drivers of the fruit market, in this way, supermarkets can impose UK quality requirements and satisfy the new consumer demands through 'remote control.' Western retailers are becoming increasingly influential in the horticultural production and export trade from Kenya. With increasingly global sourcing policies, it is possible for decisions made in one place to dominate another place thousands of miles away. In this way, new food networks are evolving to satisfy both the consumer and the producer but are mediated and controlled by multiple retailers through the regulatory power vested in them.

Horticultural production for the domestic market faces the challenge of continued influx of similar products from regional markets. Wholesale marketplaces continue to play a key role in the domestic horticultural marketing system as the dominant source of supply for open-air retail markets and kiosks.



## 2.3 Analysis of Value Chain Elements -Value Chain Nodes, Actors & Activities

### 2.3.1 Mango value chain nodes<sup>43</sup>

#### Production

Mango production is a smallholder affair in Kenya. FPEAK (2012) estimates there are more than 200,000 smallholder farmers involved in mango production in the country<sup>44</sup>. The small-scale farmers grow multiple varieties, use no irrigation, and rarely use any fertilizers on their orchards. Because of the low production by individual farmers, coupled with the mixed growing of varieties, aggregation for marketing is a challenge, and exporters and processors one of the primary factors contributing to market inefficiencies. The small scale relies on village assemblers, export agents, and local traders to access markets. This tends to result in low farmgate prices for farmers. Studies have identified the lack of market organization as a major constraint to the development of the mango industry.

Large and medium-scale mango farmers can negotiate and sell directly to exporters, wholesalers, supermarkets, and agents. They grow specific varieties of mangoes for commercial purposes, unlike small-scale farmers who grow a mix of mango varieties. They are also well-capitalized and can apply necessary inputs to control pests, diseases, and soil fertility. Large scale farmers can stimulate flowering and, using supplementary irrigation, can produce an early September crop when there is a shortage of mangoes for export, and they can command higher prices. The below table illustrates the mango production in Siaya county, one of the counties under study.

*Table 2:Mango production in Siaya county 2020*

Crop/county	2020		
	Area (Ha)	Volume (MT)	Value (KES)
Siaya	1,435	12,028	342,775,000

Source: AFA-Horticulture Crops Directorate

#### Collection /aggregation

The actors involved in mango marketing in Kenya include farmers, brokers, village assemblers, wholesalers, retailers, and exporters. Village assemblers/brokers are the main links between farmers and the rest of the value chain. They purchase and sell either direct to retailers, wholesalers, processors, or to contracted agents. Wholesalers purchase directly from farmers or through brokers and supply urban markets, where they sell to retailers or agents acting for supermarkets. Retailers are the final link, bringing mangos directly to consumers. Exporters purchase directly from large-scale farmers or use appointed and trained agents to purchase mangoes on their behalf.

Rural mango assemblers and brokers are an important link to markets given their ability to penetrate remote areas in search of mangoes. They purchase directly from farmers and transport them to urban centers, where they sell to retailers in wholesale markets or agents that supply supermarket chains. They also sell directly to consumers in main urban centers. They typically have limited operating cash; therefore, they try to sell their acquisitions as soon as they can. Since their operations are more concentrated, rural assemblers are impacted by the seasonality of mango production, whereas brokers can shift from region to region and trade various commodities.

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<sup>43</sup> USAID-KAVES 2013

<sup>44</sup> FPEAK 2012

## **Wholesaling**

Mango wholesalers either source mangoes directly from farmers in rural areas or use local assemblers/ agents to purchase mangoes from farmers on their behalf. Others operate in urban wholesale markets where they purchase directly from rural assemblers or transporters and then sell to retailers. Wholesalers are an important link between rural assemblers and retailers, although the rural assemblers also sell directly to retailers.

## **Processors**

Farmers may harvest and deliver their mangoes directly to the processing firm, or through brokers and traders. Once mangoes are delivered to the factory they are weighed, inspected, and sorted to meet the general requirements. Losses at this stage are estimated at 10-31 percent. Higher losses were recorded for those delivered by the farmer, with lower-end losses for those delivered by brokers as they will have already done pre-selection. Major reasons for rejection include immature fruit, insect/pest damage, over-ripeness, and bruising.

Four main mango processors in Kenya transform mangoes into pulp, juice, and concentrates, including Milly, Sunny Mango, Kevian, and All fruits. Milly and All fruits are based in Coast Province, while Kevian and Sunny are based in Central Kenya near Thika. Milly and All fruits take advantage of their proximity to the Coast production zone, which is a major producer of Ngowe mangoes, which are preferred for juice processing. Sunny Mango owns a nuclear farm and gets supplies from Muranga, Embu, and Machakos counties. Milly is the only firm that processes concentrate.

The processing firms operate around 40 percent of installed capacity because of supply shortages that are the result of significant postharvest losses, fluctuating seasonal production, and competition with local fresh fruit and export markets, which offer better prices<sup>45</sup>. Processors rely on brokers and in some cases organized farmer groups for the delivery of mangoes. They don't venture into production zones to purchase mangoes. Harvesting and handling of mangoes for the processing industry are not as stringent as it is for the export markets.

## **Exporting**

There are about twenty mango exporting companies in Kenya. According to FPEAK, the leading mango exporters include: Kevitt Exporters Ltd, Mackay Import and Export Agents, Kankma Exporters Ltd, Zenith, Global Exporters, Jakal Services Ltd, Vegmon International, Kankam Exporters Ltd. These are responsible for about 90 percent of mango exports. Due to the seasonality of mango production, the exporters also deal in other fruits and vegetables to ensure continuous business operations. Export markets demand a level of quality that is much higher than that demanded by domestic fresh markets or processors. To ensure quality fruit, exporters rely more on their staff to supervise harvesting, sorting, packaging, and transportation. This ensures less waste because only the best mangoes are selected for harvest and carried in the best packages to prevent damage.

## **Retailing**

Mango retailers source their mangoes directly from farmers for those located in rural-urban centers and from brokers and traders/transporters for those located in large urban centers. Most retailers in rural-urban centers and road sites have little to no infrastructure for storing and/or displaying their products, which tends to further risk the durability and quality of the fruit.

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<sup>45</sup> (Mango Working Group, 2011)

### 2.3.2 Banana Value chain Actors

#### Production

Production is by smallholders with less than an acre of bananas but, with the availability of tissue-cultured plants for up-scaling quickly, strong market demand, and high margins, successful growers are expanding their farms to thirty acres.

Various banana cultivars are grown based on the final consumers. “Kampala” (Gros Michel) and the small “apple” (ndiizi) are popular niche varieties that sell for a premium price, but Cavendish varieties produce the highest yields and are coming to dominate the dessert banana market. In the western regions cooking varieties, Matooke and Mbidde are popular and traded in commercial quantities across the country. Table below illustrates the 2020 banana production in the selected counties under review.

*Table 3: Banana production in the selected counties 2020*

Crop/county	2020		
	Area (Ha)	Volume (MT)	Value (KES)
<b>Siaya</b>	1,446	15,106	463,935,00
<b>Kericho</b>	466	12,872	504,960,000
<b>Bomet</b>	415	13,459	351,210,000
<b>Kisii</b>	6,019	119,662	1,565,162,500
<b>Nandi</b>	623	12,060	260,622,500

Source: AFA-Horticulture Crops Directorate

#### Input suppliers

To achieve high yields, banana growers need disease and nematode-free plants or suckers each year for replanting. They have traditionally planted vegetative suckers obtained through the “informal” sector including farmers’ suckers or acquired from other farmers in their community. This has tended to increase levels of nematodes and other pests and diseases and harm yields. In recent years disease-free banana plants have become available derived from tissue-cultured sterile plantlets. These are accessible through the formal sector including KARI and established commercial nurseries. The Jomo Kenyatta University of Agriculture and Technology (JKUAT) produces plantlets in its laboratory and Aberdare Technologies Ltd (ATL) imports its plantlets from laboratories in South Africa and Israel.

#### Collection and aggregation

Local assemblers buy at farm gates and provide market access for small producers selling to intermediaries/brokers and sometimes directly to the wholesalers. Intermediaries/brokers supply to the wholesalers who in turn sell to retail outlets and institutions (schools, hospitals). Wholesalers also purchase directly from small-scale and limited large-scale producers. Within the banana marketing chain, there are up to four intermediaries between the buyer and the consumer, which sometimes leads to handling inefficiencies and reduces prices paid to farmers. Increasing direct contracts between distributors and farmers would provide opportunities for farmers to receive higher prices for their bananas. Achieving this requires greater coordination between marketing and value chain actors; improved marketing infrastructure; and wider access and dissemination of domestic and regional market information. Bananas are a major commodity in the wholesale markets of Nairobi, Mombasa, and other major towns.

## Wholesaling

Wholesalers make transport and loading arrangements from the bulking sites to the wholesale market where the ripening process is done. More often groups of wholesaler's pool transport thereby sharing the cost of transport and municipal charges for the produce. Twiga foods based in Kenya, is a mobile-based supply platform for Africa's retail outlets, kiosks, and market stalls. Twiga Foods allows grocers to access better-quality products, at lower prices, delivered directly to their shops. They sell bananas to retailers allowing smallholder farmers to access markets.

## Retailing

Retailers consisting of supermarkets, kiosk owners, hawkers, and greengrocers. They buy bananas at various stages of ripening from a wholesaler from green stage to full yellow.

### 2.3.3 Passion fruit Value chain actors

#### Production

Passion fruit production is done by smallholder farmers on 0.25 to 2 acres of land. Other than production in central and upper eastern which is under irrigation, passion fruit production in other parts of Kenya is under a rain-fed system which does not guarantee adequate soil moisture necessary for optimal productivity all year round. During 2019-2020 period, the area under passion fruit production dropped by 147Ha, a 7 percent decrease. The volume and value increased by 260 tons and Kshs103 million which represented a 1 percent and 7percent increase from the previous year respectively. The increase in value was attributed to high farm gate prices due to high demand for the fruits especially due to the Ministry of health advice on consumption of fruits to increase immunity<sup>46</sup>. Passion fruit producing counties during this period included Nandi, Kisii, Vihiga and Bomet<sup>47</sup>. In addition, under inadequate soil moisture, most fruits weigh less than 40 grams per fruit which are considered rejected for the export market<sup>48</sup>. Moreover, the rain-fed system is prone to severe pest and disease infestation thus necessitating heavy use of pesticides at the risk of the product failing to comply with the MRL requirements.

Passion fruit produced at high altitude areas takes too long to ripen, this has led to the picking of premature fruits by impatient farmers and unscrupulous exporters thus negatively impacting the competitiveness of the produce at the international markets<sup>49</sup>. Eastern Kenya is accredited for producing the best quality passion fruit for the export market compared to other areas in Kenya<sup>50</sup>. Due to high input investment requirements in passion fruit production, most smallholders do not apply optimal recommended inputs leading to low productivity and uncompetitive quality production in the international market.

Table 4: Passion fruit production in the selected counties 2020

Crop/County	2020		
	Area (Ha)	Volume (MT)	Value (KES)
Bomet	105	730	48,234,000
Nandi	56	844	49,877,400
Vihiga	17	324	16,434,000

<sup>46</sup> Horticulture validated results 2019-2020

<sup>47</sup> *Passion fruit counties production 2020*

<sup>48</sup> Prusky, D. (2011). Reduction of the incidence of postharvest quality losses, and prospects. *Food Security*, 3(4), 463-474.

<sup>49</sup> Fischer, G., Melgarejo, L. M., & Cutler, J. (2018). Pre-harvest factors that influence the quality of passion fruit: A review. *Agronomía Colombiana*, 36(3), 217-226.

<sup>50</sup> Abasi, E. A., Muui, W. C., & Mwangi, M. (2018). Canopy Management for Sustainable Passion Fruit Production. *Asian Journal of Agricultural and Horticultural Research*, 2(1), 1-7.

Kisii	51	670	51,120,000
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Source: AFA-Horticulture Crops Directorate

### Inputs/input suppliers

In Kenya, passion fruit categorized as a minor crop; a fact that has limited pesticide efficacy trials on passion fruit production leading to fewer pesticides recommended for pest and disease control in passion fruit. There are less than five pesticides registered in Kenya for use in controlling pests and diseases in passion fruit. KARI is currently the sole supplier of seeds for improved sweet yellow passion varieties<sup>51</sup>.

However, there are smallholder farmers at the coast who grow local yellow passion fruit for the supply of seed. The cost per kilogram of yellow passion seed is Ksh 6,000 making growing yellow passion fruit for purposes of seed production a lucrative business. There is farmer-owned insect-proof passion fruit nurseries intended to supply woodiness virus-free purple passion fruit seedlings in major passion fruit producing areas. The insect-proof passion fruit nurseries with a capacity of supplying more than 60,000 per year purple passion fruit seedlings are in Busia (75,000), Lugari (75,000), Bungoma (6200,0000), Kigumo (60,000), Siaya (75,000), Homa Bay (75,000), Kisii (60,000), Keiyo (310,000), and Eldoret (250,000)<sup>52</sup>.

### Processing

Passion fruit processors in Kenya operate under installed capacity this is the maximum amount of electricity that a generating station can produce under specific conditions designated by the manufacturer. This has been attributed to the inadequate supply of quality raw materials partly due to low productivity associated with the rain fed production system that is common among smallholder farmers. The major passion fruit processors include Delmont, Sun Mango, Millie fruits, all fruit ETZ limited, Coca-Cola Ltd, Kevian Ltd, Milly processors, and FIPS Ltd<sup>53</sup>.

### Exporting

The main export market is Uganda, supplied by truckers/traders who collect from areas accessible from the border including Uasin-Gishu and Elgeyo-Marakwet every week. The number of exporters to Europe dealing in passion fruit has declined due to uncompetitive quality produce attributed to excessive MRLs, and immature and under-size fruits. Picking of immature fruits is common in high-altitude passion-producing areas partly due to difficulty in ascertaining fruit physiological maturity under cold environments. The main cause of under-size fruits is low soil moisture associated with the rain-fed production system<sup>54</sup>.

## 2.3.4 Citrus Value chain actors

### Production, input supply and marketing

The main players in the citrus value chain are smallholder farmers, who invest on their own in the development of tree nurseries and farm cultivation and planting. Once the fruits are ready for sale, there is the entry of two types of middle

<sup>51</sup> MICHOMA, J. M. (2019). *SOIL WATER, GROWTH AND YIELD OF YELLOW PASSION FRUIT RESPONSE TO MULCH AND HYDROGEL IN EMBU AND KIAMBU COUNTIES, KENYA* (Doctoral dissertation, School of Agriculture and Enterprise Development, Kenyatta University).

<sup>52</sup> Kenya Agricultural Value Chain Enterprises Project (Kaves) 2013

<sup>53</sup> Kenya Agricultural Value Chain Enterprises Project (Kaves) 2013

<sup>54</sup> Kenya Agricultural Value Chain Enterprises Project (Kaves) 2013

agents: those buying fresh fruits for the domestic rural and urban market (wholesale buyers/traders and vendors/hawkers); and local brokers who buy on behalf of wholesale traders for the export market<sup>55</sup>.

Lack of adequate funding has hampered its role in supporting horticulture value chains and as such, there is no specific national-level association responsible for citrus like those for mangoes

*Table 5: Citrus production in selected county*

Crop	County	2020		
		Area (Ha)	Volume (MT)	Value (KES)
Lime	Kisumu	55	33	6,600,000
Orange	Kisumu	11	43	5,190,000

Source: AFA-Horticulture Crops Directorate

### 2.3.5 Avocado value chain actors

#### Production.

Smallholder farmers grow 70 percent of avocado while medium and large farmers grow 20 percent and 10 percent of avocado, respectively. Many agro-ecological zones grow avocados primarily as a cash crop for the home or international market. Avocado production among smallholder farmers is still low because of poor agronomic procedures caused by a lack of extension services and inadequate input application brought on by restricted access to input financing. Low or no fertilizer application and inadequate fruit fly pest management influence low productivity and large postharvest losses.

*Table 6: Avocado production*

Crop	County	2020		
		Area (Ha)	Volume (MT)	Value (KES)
Avocado	Kisii	1,981	80,652	644,000,000
	Bomet	687	11,566	363,456,000
	Kisumu	101	393	29,012,000
	Nandi	368	7,661	257,755,000

Source: AFA-Horticulture Crops Directorate

Avocado growers, exporters, and other value-chain players in Kenya have recently founded the Avocado Society of Kenya. The society aims to promote cooperation among stakeholders in the value chain and gain access to new export markets<sup>56</sup>.

#### Input suppliers

Avocado farmers are not able to produce quality avocados because they lack good planting materials. In addition, the high cost of seedling has also deterred planting of high-quality seedling among smallholder farmers. Imparting grafting skills among local nursery operators is necessary in reducing seedling prices to an affordable level and increasing accessibility. Farmers buy avocado seedlings at Kakuzi company, Kakuzi PLC is a listed Kenyan agricultural company. It engages in the cultivation, processing and marketing of avocados and is based IN Makuyu. Avocado seedlings can

<sup>55</sup> Mwatawala, M. W., Baltazari, A., Msogoya, T. J., Mtui, H. D., Samwel, J., & Chove, L. M. (2018). Reduction of Preharvest and Postharvest Losses of Sweet Orange (*Citrus sinensis* L. Osberck) Using Hexanal in Eastern Tanzania. *Postharvest Biology and Nanotechnology*, 255-264.

<sup>56</sup> <https://kenyaavocados.co.ke/index.php/about-us>

also be acquired from JKUAT university, KEPHIS, KALRO, informal sellers along the roads and other certified nurseries.

### **Storage, transport, and trade**

Most small-scale farmers (approximately 99 percent) engage with marketing agents who cover the costs of harvesting and transportation of the produce. Marketing agents supply the wholesale markets, small retail outlets, supermarkets, and hotels and at times also to exporters. Very few avocado farmers sell directly to exporters or processors<sup>57</sup>. Although farmers receive a low farmgate price when selling to marketing agencies, most small-scale farmers prefer to connect to the market through them. Marketing agents tend to pay for the purchased avocados on the spot, and at times even in advance. In addition, they cover all the costs of harvesting, grading and transportation<sup>58</sup>.

Avocados are transported to local markets on motorcycles, in buses and on the top of lorries. During harvest, transport and storage, the fruit stored in sacks is handled roughly and temperature management is virtually non-existent. These elements have a significant impact on rejection rates, which in turn affect post-harvest losses. The marketing representatives provide very low farm-gate pricing to farmers in anticipation of these losses as their "invisible" costs<sup>59</sup>. Avocados that are sourced for the export market are considered high value products which are harvested, handled, transported, and traded with care. Transactions for the export market are handled per unit of avocado, whereby they are packed into cartons of approximately four kilograms (4-6 units of avocado). Adequate investments in postharvest handling, transport, and packaging of avocados for the export market have proven to greatly reduce post-harvest losses<sup>60</sup>.

### **Avocado processing**

There are not many avocado processing businesses in Kenya. Most of the time, they turn avocados into crude oil for export and additional processing elsewhere. Currently, one business is working to locally refine avocado oil so that it can be exported as a higher-grade, consumable oil. In the upcoming years, there will likely be a rise in the demand for avocado oil.

Kenya has been attempting to enter the expanding Chinese avocado market since 2017. The tight adherence to phytosanitary regulations, lack of traceability, and quality assurance have alarmed Chinese inspection officials. As a result, exporting fresh avocados was prohibited, but exporting peeled, sliced, packed, and frozen avocados was an option<sup>61</sup>. Only two export businesses have been able to comply with the rules and conditions to ship to China as of 2019. According to estimates, the Chinese market has the capacity to consume 40% of Kenya's avocado supply<sup>62</sup>.

The growth in consumer demand for healthy foods creates an array of possibilities to add value to avocado processing it into consumer products such as baby food, avocado flour, cosmetic products, and many more.

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<sup>57</sup> Owuor, T., 2020. Mango Value Chain Road Map, Makueni County, Republic of Kenya.

<sup>58</sup> Amare, M., Mariara, J., Oostendorp, R., & Pradhan, M. (2019). The impact of smallholder farmers' participation in avocado export markets on the labor market, farm yields, sales prices, and incomes in Kenya. *Land Use Policy*, 88, 104168.

<sup>59</sup> Owuor, T., 2020b. Mango Value Chain Road Map, Embu Country, Republic of Kenya.

<sup>60</sup> Owuor, T., 2020. Mango Value Chain Road Map, Makueni County, Republic of Kenya

<sup>61</sup> <https://developmentreimagined.com/2020/10/02/fresh-or-frozen-should-kenya-and-china-renegotiate-their-2019-avocado-deal/>

<sup>62</sup> Amare, M., Mariara, J., Oostendorp, R., & Pradhan, M. (2019). The impact of smallholder farmers' participation in avocado export markets on the labor market, farm yields, sales prices, and incomes in Kenya. *Land Use Policy*, 88, 104168.

## Wholesale and retail

Wholesalers of avocados are present all throughout Kenya in wet marketplaces close to urban areas and major cities. Avocado retailers can be found in rural and urban settings. In most cases both wholesalers and retailers obtain their avocados through marketing agents. Due to the informality of the sector and the lack of traceability it is virtually impossible to distinguish the origin and source of the avocados sold at wholesale and retail level. The volumes of fresh avocado that are currently sold through supermarkets, restaurants and hotels is limited. There is a growing trend of middle-class urban dwellers who shop at supermarkets and are willing to pay premium prices for safe and high-quality avocados.

## Exporting

Between 10 to 30 percent to Kenya's avocado production is either exported as fresh product or processed locally and exported as crude avocado oil. The export market for avocados is growing exponentially due to an ever-increasing demand. According to the Horticultural Crops Directorate Kenya's avocado exports in 2020 hit 72,000 tons, a considerable increase from the 59,000 tons exported in 2019<sup>63</sup>. Traceability, product regulations and GAP certificates are important requirements to enter the export market. Most Kenyan produced avocados do not meet the stringent requirements to access the high-value export market. Significant on farm investments are required to change that. Small-scale farmers are not always able to make these investments, nor do they have access to Agri-finance products that cover these types of costs. Therefore, the highly profitable export market is inaccessible for most small-scale avocado farmers<sup>64</sup>.

Kenyan avocados used to be exported by air freight. The associated transportation costs made them less competitive in the market. The introduction of reefers (refrigerated shipping containers that can cool avocados during sea transport) has changed the market logistics and created new possibilities to access distant and lucrative markets such as the European market through sea freight<sup>65</sup>.

Kenya mainly exports avocados to Europe and the Middle East. Freshela Exporters is one of the leading avocado exporters in Kenya. Kakuzi is a renowned company that produces, packs and exports avocados, Sunripe processes and markets fresh and frozen avocados, Kenya Horticultural Exporters also exports avocado, Biofarms Limited, East African Growers, Avocado Society of Kenya among others are the top exporters of Kenya Avocado<sup>66</sup>.

## Domestic market

The domestic market consumes more than two-thirds of the total national production of avocados and is largely informal. Avocados are a popular product in Kenyan diets and are sold in wholesale markets and smaller retail shops. Supermarkets in commercial urban hubs sell avocados that are frequently of better quality than those found in small rural retail shops. There is a general absence of market information and lack of transparency in the domestic avocado

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<sup>63</sup> Amare, M., Mariara, J., Oostendorp, R., & Pradhan, M. (2019). The impact of smallholder farmers' participation in avocado export markets on the labor market, farm yields, sales prices, and incomes in Kenya. *Land Use Policy*, 88, 104168.

<sup>64</sup> Amare, M., Mariara, J., Oostendorp, R., & Pradhan, M. (2019). The impact of smallholder farmers' participation in avocado export markets on the labor market, farm yields, sales prices, and incomes in Kenya. *Land Use Policy*, 88, 104168.

<sup>65</sup> Yousefi, H., Su, H. M., Imani, S. M., Alkhaldi, K., M. Filipe, C. D., & Didar, T. F. (2019). Intelligent food packaging: A review of smart sensing technologies for monitoring food quality. *ACS sensors*, 4(4), 808-821.

<sup>66</sup> <https://victormatara.com/list-of-top-avocado-exporters-in-kenya/>



market. Only a small number of avocado farmers are formally organized into producer organizations and have contractual arrangements with marketing agents and buyers<sup>67</sup>.

Avocado society of Kenya (ASK) link growers and exporters of the avocado to ethical buyers locally and abroad. They train members in Good Agricultural Practices and help them set systems to be compliant with local and global standards.

### 2.3.6 Technologies used in each node

Increasing the uptake of preharvest, harvest and post-harvest technologies reduce losses and increase incomes in small-scale agriculture. Private-sector actors, development initiatives, or governmental institutions identify a set of desirable technologies, which can increase smallholder livelihoods, and try, through a combination of marketing, subsidies, and agricultural extension service, to persuade farmers to invest in them. However, there is a risk that such initiatives set too much store by the technologies, and do not sufficiently consider the users' motivations, preferences, and constraints about technologies, or the realities of the value chain.

#### 2.3.6.1 *Mango technologies*

**Hybrid seedlings-** KARI is the main research institution producing and releasing improved varieties in Kenya and has mango seedling nurseries at its Thika and Katumani centers, where certified mango seedlings purchased. Seven varieties (Apple, Ngowe, Haden, Kent, Sabine, Tommy Atkins, and Van Dyke) are commercially produced in nurseries. The advantage of mango hybrid seeds is they grow faster, grow alike, and give higher yields. The only disadvantage is they are expensive.

#### **Improved Variety**

Kerio Valley Development Authority (KVDA) produces good seedlings from the various improved varieties that we have which grow fast, have bigger fruits, and give bumper harvest. The fruits mature after about three to four years. The seedlings are also resistant to pests and diseases, have higher yields and are easy to maintain due to their shorter height.

**Disseminate climate smart Integrated Pest Management (IPM) technologies for control of fruit fly and seed weevil in mangoes-** Working with over seven mango exporters, five IPM technology providers, and two major mango cooperatives, KCDMS has supported more than 45,000 mango farmers to adopt IPM technologies and good agricultural practices to reduce damage from fruit flies.

**Evaporative charcoal cooler-**The aggregation center is equipped with an evaporative charcoal cooler (ECC) and a series of zero-energy brick coolers (ZEBC). The ECC and ZEBC operate on the principle of evaporative cooling. (Ref) When water evaporates from the wet charcoal and sand in the ECC and ZEBC, respectively, the heat is removed from the surrounding environment and the stored produce remains cool. Evaporating water results in a cooling effect and increases the relative humidity around the stored produce. This slows down the spoilage of stored fruits or vegetables. The evaporative cooling facilities in this center can hold 2-3.5 tonnes of mango fruits. Technology helps slow down the deteriorative processes and extend the marketing period of the fruits<sup>68</sup>.

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<sup>67</sup> Rampa, F., Dekeyser, K., 2020. AgrInvest-Food Systems Project – Political economy analysis of the Kenyan food systems. Key political economy factors and promising value chains to improve food system sustainability. Rome, FAO. <https://doi.org/10.4060/cb2259en>.

<sup>68</sup> Mujuka, E., Mburu, J., Ogutu, A., & Ambuko, J. (2020). Returns to investment in postharvest loss reduction technologies among mango farmers in Embu County, Kenya. *Food and Energy Security*, 9(1), e195.

Table 7: Mango technologies summary

Technology	Climate relation
Hybrid seedlings	-Avoid climate risk to agricultural seasons by growing easily and faster - Reduce the impact of extreme weather by becoming drought resistant
Improved variety	- The seedlings are also resistant to pests and diseases, have higher yields
Integrated Pest Management (IPM) technologies for control of fruit fly and seed weevil	- Integrated pest management (IPM) is an ecologically friendly method to increase crop production and lower the damage sustained by pests. - Reduces environmental risk associated with pest management
Evaporative charcoal cooler	-It is used in dry and hot areas with no electricity

Own conceptualization

#### 2.3.6.2 Banana technologies

**Propagation method for the production-** Tissue culture (TC) offers the opportunity of producing large numbers of disease-free seedlings. The use of tissue culture technology in banana production is highly efficient, as it allows a timely large turnover of clean planting materials within a limited space. Tissue culture technology has the potential to contribute significantly to yield<sup>69</sup>. Tissue culture provides a method of rapidly multiplying clean uniform planting material with high vigor and good chances of high survival rates after establishment.

Key among the benefits is higher income generation than reliance on the traditional banana suckers. Other notable benefits include increased production enhanced by a harvestable bunch of bananas thus promoting food security between harvesting seasons of cereals. Constraints- are Lack of finance to buy inputs, poor infrastructure, decision making at household, high input requirements, poor agricultural extension services, lack of TC plantlets, labor intensity, other practices that meet farmer's needs, culture, and traditions, and risk avoidance mechanisms.

**Hardening Nursery-** This is a structure with at least a 55% netting roof to reduce sunlight and temperature, with an insect-proof net to protect from pest attack and uses sterilized potting media to enhance root formation and vigorous growth before transplanting. Plants remain in the structure for at least two months

Banana is an important crop in Kenya used for food and income generation. However, there is inadequate clean planting material and guarantee of true to type. In addition to this, the distribution of clean planting material is poor thus farmers and producer groups cannot access these materials from TC Labs and Macro propagation units. The establishment of Hardening nurseries will ensure the availability of quality planting material to farmers and producer groups

**Drought-tolerant banana varieties (Williams and Chinese Cavendish)-** Due to climate change most parts of the country experience erratic rains that are poorly distributed. This results in the deficient performance of rain-fed banana crops. Most farmers plant local varieties that are susceptible to drought resulting in low yields. The tolerant varieties can withstand dry periods and still produce optimally. This makes them a viable option in adapting to climate change.

**Zai pits to enhance banana production in ASALs-** Zai Pits are small planting pits typically measuring 60-90 cm in width, 60-80 cm deep and spaced 60-80 cm between them-The pits store water for crop use. Banana planting materials (TC and sucker) are planted into the pits after filling with two debes of organic material such as manure, compost, or dry plant biomass. The technology is suitable for areas with unpredictable rains, especially the drought-prone areas in the ASAL. The major disadvantage of this technology is the demand for supplementary efforts from the farmer who must watch over the state of the holes.

<sup>69</sup> Shukla, S. K., Verma, A. S., Miheso, M., & Shukla, S. (2020). INDO-KENYAN COLLABORATIVE APPROACH AND POTENTIAL FOR COMMERCIALIZATION OF PLANT TISSUE

**Drip irrigation system**-Climate change leading to prolonged drought resulting in reduced Banana production. Increased crop water stress caused by seasonal rainfall variability in rain-fed production leads to low yield or crop failure. Drip irrigation It can operate at a lower pressure and saves water and electricity. It is costly to set up.

**Banana fruit protection bags/banana ripening bags/banana bunch covers**- Damage by insects, pathogens, wind damage, leaf, and petiole scarring, dust, light, hail, sunburn, and bird feeding, on banana bunches. A translucent polythene bag cover is placed from the base of the bunch and tied at the top, right at the scar of the first bract<sup>70</sup>. Polythene covers speeds up the maturity time by between five days. It reduces frost and cover and leads to increased bunch weight due to optimum photosynthesis and reduced pest attack. The cover is placed from the base of the bunch and tied at the top, right at the scar of the first bract. Early bagging helps in preventing thrips from attacking the banana.

Table 8: Technologies used in Banana production

Technology	Climate relation
propagation method through TC	-TC survives any varying climatic conditions
Zai pits	- suitable for areas with unpredictable rains especially the drought-prone areas
Drought-tolerant banana varieties	-Survive harsh climatic conditions
Hardening Nursery	- netting roof to reduce sunlight and temperature
Drip irrigation system	-Curb prolonged drought caused by climate change
Banana fruit protection bags	Reduce the adverse effect of climate change like frost

#### 2.3.6.3 Citrus Production technologies

Strengthening Citrus production systems through the introduction of IPM measures for pests and diseases<sup>71</sup>. Major constraints to citrus production are insect pests and the diseases they transmit<sup>72</sup>. Two of the most serious pests are the African citrus triozid (ACT) and the false codling moth (FCM). To control these two pests, farmers have resorted to widespread and unguided use of pesticides, which are not only expensive but also often highly toxic with serious negative effects on people and the environment. The disadvantage is that the farmers must be aware of these methods<sup>73</sup>.

#### Grafting technique

This is a technical task that needs a detailed demonstration of how to be done by extension employees. and follow-up sessions to allow for a proper graft to form. It helps manage pests and diseases. This initial cost of establishing an orchard may be high but decrease as the trees mature

#### Soil cover systems

A permanent soil cover is a critical component in the orchard cultivation system for citrus crops. Locally adapted leguminous crops e.g., cover crops help to restore degraded soils; they successfully suppress weeds, fix nitrogen, and

<sup>70</sup> Amarante, C., Banks, N. H., & Max, S. (2002). Effect of preharvest bagging on fruit quality and postharvest physiology of pears (*Pyrus communis*). *New Zealand Journal of Crop and Horticultural Science*, 30(2), 99-107.

<sup>71</sup>

<sup>72</sup> Kelemu, S., & Prideaux, C. (2016). ICIPE Annual Report 2015

Wangithi, C. M. (2019). Evaluation of The Magnitude of Citrus Yield Losses Due to African Citrus Triozid, False Codling Moth, the Greening Disease and Other Pests of Economic Importance in Kenya.

<sup>73</sup> Wangithi, C. M. (2019). *Ex-ante Economic impact Assessment of Integrated Citrus Pests and Diseases Management Interventions in Selected Counties, Kenya* (Doctoral dissertation, Egerton University).

prevent erosion. They also help avoid competition between the cover crop and citrus. Suitable management of the cover crop is necessary. Reduce the percentage of living soil coverage to optimally adapt the soil, the crop, and the climate conditions. One solution is the sandwich system whereby the farmer plants a crop in between the rows of citrus trees and mulches the rows which have citrus.

*Table 9: citrus technologies summary*

Technology	Climate relation
IPM strategy	-Reduce the negative effects of pesticides on the environment
Grafting technique	- It is Environmentally Friendly
Soil cover	Soil adapts the climate conditions

*Own conceptualization*

#### 2.3.6.4 Passion fruit technologies

##### **New passion fruit varieties**

Kenya Agricultural and Livestock Research Organization (KALRO) commercialized three new high-quality passion fruit varieties. They are passion fruit number 4(KPF 4), 11(KPF 11), and 12 (KPF 12) developed for over twenty years of research. They can grow in any part of the country, and they are tolerant of harsh weather conditions. The fruits are juicer, sweet, large, and tolerant to soil and foliar diseases. Fact that they are sweet and juicer, farmers will gain more return from the fruit. It delivers quick returns both from domestic and export markets due to its fast maturity<sup>74</sup>.

*Table 10: Passion fruit technology summary*

Technology	Climate relation
<b>New passion fruit varieties</b>	- tolerant to harsh weather conditions -They mature fast

*Own conceptualization*

#### 2.3.6.5 Avocado technologies

##### **Evaporative (zero-energy) cooling**

Farm-level, evaporative (zero-energy) cooling technologies offer costs-effective post-harvest management interventions that have proven to be effective and provide a good return on investment at farm, co-operative or community level<sup>75</sup>. Evaporative cooling is a relatively low-cost pre-cooling solution that allows to slightly lower ambient temperature and core temperature of the freshly harvested avocados (typically 3 to 5 degrees below ambient temperature). This method is effective because of the significant reduction of respiration degradation and reduction of moisture loss from the product. In the case of avocado, it reduces the maturing rate and prolongs shelf-life. A variety of effective technologies exist for this level of application that are affordable for small-scale farmers.

##### **Climate smart Integrated Pest Management (IPM) technologies**

Fruit fly infestation at production stage causes major losses at farm and post-harvest levels. The total loss is estimated to be as high as 30% at both levels. In addition, fruit fly infestation affects market access of the crop since the pest is a quarantine pest. Over the years KALRO has developed integrated pest management options which are environmentally friendly, for the control of fruit fly on avocado. These include pheromone traps, field sanitation, use of

<sup>74</sup> Mwirigi, P., Gweyi-Onyango, J., & Mwangi, M. (2016). Agronomic management of yellow passion fruit among farmers in Mbeere sub-county, Kenya.

<sup>75</sup> Manyozo, F.N., J. Ambuko, M.J. Hutchinson, J.F. Kamanula, 2018. Effectiveness of evaporative cooling technologies to preserve the postharvest quality of tomato. Int. J. Agron. Agri. R., Vol. 13, No. 2, p. 114-127, 2018

attractants, and soft chemicals. These technologies if disseminated to farmers would reduce infestation by at least 20%.

### **Good agronomic practices**

**Proper plant spacing-**in which the avocado plants are established Closer spacing will lead to overcrowding of the plants and hence lead to competition for nutrients as well as inadequate air and light penetration. As a result, the plants will harbor pests and diseases thereby leading to reduced yields.

**Pruning-**It is one of the major important agronomic practices that must be carried out on avocados for the realization of high yields of quality fruits. The purpose of pruning is to remove dead and entangled branches as well as diseased branches. The canopy is also opened during the process of pruning to allow lighter and air penetration to the plant.

**Coppicing and top working-** These technologies that are undertaken in avocado orchards with the aim of rejuvenating the trees to ensure higher yields. The practice involves the cutting down of the upper portion of a tall avocado tree and allowing it to sprout. The sprouted shoots are either grafted with scions of other avocado varieties or left to grow in a well-managed manner to enable proper spraying and harvesting of fruits. In most cases, coppicing is done on old and tall avocado trees that are difficult to manage as they are.

**Weeding of the avocado fields-**this ensures that they are always weed free. Weeds compete with avocado for space, nutrients, and water.

### **Digital innovation**

The Avocado sector is characterized by many informal transactions and a lack of market information, transparency, fixed buyers, and fixed prices. Small-scale farmers are often unable to fully invest in productivity increase, improved agricultural practices and post-harvest management as they are constrained in accessing the high revenue avocado market. It results in the harvest of mixed quality avocados that are sold at low farmgate prices.

Digital innovations appear on the market to help smallholder farmers and the value chain actors they interact with to access market information, digitize production records, and make supply chain transactions more transparent. Transparency and traceability are increasingly considered as important product information to potential buyers. Kenya has experience with several digital applications linking procurement with traceability, digital records, and payments, and even access to markets and services<sup>76</sup>.

Fresh Produce Consortium Kenya, the leading organization committed to promoting the production and supply of high-quality fresh horticultural produce in Kenya, has created an avocado and banana digital communication and marketing strategy. The strategy is intended to address the information challenges by providing a framework for the effective digital market.

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<sup>76</sup> GSMA, 2020. Digital Agriculture Maps 2020 State of the Sector in Low and Middle-Income Countries. <https://www.idhsustainabletrade.com/uploaded/2020/10/GSMA-Agritech-Digital-AgricultureMaps.pdf>

## Support services in the extended value chain

### Suppliers of physical inputs

There is a wide range of service providers of the product, but who play a significant role in the development and management of the fruit sector. Small agro-dealers and stockists are the primary sources of inputs for smallholder fruit (passion, mango, citrus, avocado and banana) farmers. The number of agro-dealers has increased over the last decade from 8,000 to 10,000 nationwide<sup>77</sup>. More nurseries are operating on the side of roads and selling seedlings of unknown quality. The lack of quality seedlings is one of the main impediments to the establishment of quality orchards<sup>78</sup>. Input suppliers also provide agro-inputs, extension services, training and some provide spraying services.

Seedling nurseries are registered by HCD and certified by Kenya Plant Health Inspectorate Services (KEPHIS), which is responsible for the certification of domestically produced seeds and providing permits for seed imports. It also provides training and registration of seed stockists and registers authorized seed sellers. KARI is the main research institution producing and releasing improved varieties in Kenya and has mango seedling nurseries at its Thika and Katumani centers. Farmers obtain planting materials from uncertified sources. Most farmers have learned to graft fruit trees on their own, notwithstanding the negative impact of using rudimentary technologies on the viability of the seedlings and productivity eventually.

Fertilizer is another major input. Fertilizer in Kenya is imported, with both state agencies and the private sector playing a major role. Out of ten fertilizer importers in Kenya, four firms control over 85 percent of the market. Public sector institutions, such as the National Cereals and Produce Board (NCPB), the Kenya Tea Development Agency (KTDA), and sugar companies/out-grower schemes are also major players in the fertilizer market. An estimated five hundred wholesalers/distributors, as well as 8,000 retailers and agro-dealers and local fertilizer companies participate in fertilizer supply<sup>79</sup>.

Other farm chemicals (pesticides, herbicides, fungicides) are widely available through stockists and all major leading manufacturers are represented in Kenya. Selection, safe use, and appropriate disposal remain serious issues. The Agrochemicals Association of Kenya (AAK), affiliated with CropLife International, is the umbrella organization for 48 Kenyan pesticide manufacturers, formulators, re-packers, importers, and distributors. The Pest Control Products Board (PCPB) is responsible for product registration (with about 200 products currently registered), and it also provides inspection services to identify improperly repacked, unregistered, counterfeit, mislabeled, or adulterated products<sup>80</sup>.

Small agro-dealers and stockists are the primary sources of input for smallholder farmers, many of which also carry other items (hardware, general wares, etc.). Their numbers have increased substantially. This has resulted in better access to primary inputs by farmers, although average distances for farmers to the nearest seed or fertilizer supplier

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<sup>77</sup> Mbata, J. (2019). Agribusiness indicators: Kenya. *Gates Open Res*, 3(172), 172.

<sup>78</sup> De Corato, U. (2020). Agricultural waste recycling in horticultural intensive farming systems by on-farm composting and compost-based tea application improves soil quality and plant health: A review under the perspective of a circular economy. *Science of the Total Environment*, 738, 139840.

<sup>79</sup> Aloo, S. Y., Andemariam, K., & Nyiva, M. (2022). Effect of entrepreneurial orientation on financial performance of agro dealer firms in Kakamega County, Kenya. *International Academic Journal of Human Resource and Business Administration*, 4(1), 252-267.

<sup>80</sup> Loha, K. M., Lamoree, M., Weiss, J. M., & de Boer, J. (2018). Import, disposal, and health impacts of pesticides in the East Africa Rift (EAR) zone: A review on management and policy analysis. *Crop protection*, 112, 322-331.

remain high. Agro-dealers should have a license from local government authorities, as well as receive certification from the Pest Control Products Board to sell pesticides and other farm chemicals. Not all agro-dealers register with PCPB.

## **2.4 Support services provided to actors along the Value Chain**

**Research-** Kenya Agriculture and Livestock Research Organization (KALRO) and different universities study various aspects of fruit production. The World Agroforestry Centre (ICRAF) has also supported the introduction of improved varieties through its Tree Genetic Resources and Domestication Programme. Kenya Agriculture Research Institute (KARI) Thika is Responsible for research and breeding and tree nursery for quality planting material. Local universities, the University of Nairobi, and JKUAT, research on breeding and crop protection, agronomic practices, socioeconomic studies, and training in farm management. National Agricultural Research Laboratories (NARL), national mandate and responsibility for agriculturally related research in Natural Resource Management, including soil fertility testing. Private agribusiness companies, including regional centers for multinationals and seed multipliers.

### **Climate advisory services**

Extension services oriented towards improved horticultural production and especially towards short- and long-term climate change adaptation and commercially viable productivity-enhancing strategies are unavailable to fruit farmers. While farmers always aim to optimize their production systems within the circumstances they operate in, there is a clear need and demand for quality extension services. In the past, public extension officers advised farmers (free of charge) on crop and soil management and the general trends and development in the markets. But the services were abandoned about 20 years ago due to the high public costs.<sup>81</sup>

The Kenya Climate Smart Agriculture Project (KCSAP) is a Government of Kenya project jointly supported by the World Bank. KCSAP has been implemented over five years (2017-2022) under the framework of the Agriculture Sector Development Strategy (ASDS) (2010-2020) and the National Climate Change Response Strategy (NCCRS, 2010). The overall goal of the KCSAP project was, to increase agricultural productivity and build resilience to climate change risks in the targeted smallholder farming and pastoral communities in Kenya, and in the event of an eligible crisis or emergency, to provide an immediate and effective response. The project has been supporting adoption of climate smart technologies in the agriculture sector.

### **AgriFi Challenge Fund Kenya (Self Help Africa).**

This is a European Union initiative to support productive and market-integrated smallholder agriculture through the provision of financial support worth EUR 18 million to Agri-enterprises. Contributed to improvements in the capacity of smallholder farmers and pastoralists to practice environmentally sustainable and climate-smart agriculture as a business in inclusive value chains. Project Cost: KCSAP cost a total of USD 279 M with USD 250 M in financing from the World Bank and a Government contribution of USD 29 M.

### **Kenya Crops and Dairy Market System Development program (USAID, RTI)**

The KCDMSD program is part of USAID's Feed the Future, the U.S. Government's global hunger and food security initiative that helps to increase agricultural production and reduce poverty and malnutrition in Kenya. The KCDMSD activity implemented in 12 Kenyan counties and designed to spur competitive, resilient market systems in Kenya's horticulture and dairy sectors. The programme focused on strengthening the following value chains: dairy, fodder/feeds, and horticulture (mango, passion fruit, avocado, banana, pineapple, and sweet potato). Grants range between KES 2.5 million and KES 25 million and 50% co-funding.

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<sup>81</sup> Agricultural Policy in Kenya: Issues and Processes 2006

## Financial services

Financial institutions are important players in the agriculture sector through the financing of activities, including farm inputs, trading, and processing. The Kilimo Biashara initiative is an example of how farmers have been able to access loans for the production process, despite the risk associated with rain-fed agriculture. The fund was also financing small-scale farmers, farmers groups/self-help groups, and cooperatives and farming companies for the purchase of farm inputs; fertilizers, chemicals, and seeds (up to KSh150,000). It was a \$ 5 million facility financed by IFAD and AGRA to cushion banks against risks of lending to the agriculture sector (participating Banks include Equity and Family Bank).

Although there is documented evidence of funding of cereals and the dairy sector, there is no documented evidence of financing of fruit production or trade. One challenge is that fruit production is a long-term investment with two years of no harvest after the establishment of the orchard. This may pose challenges to financial services providers. However, financial products could benefit producers with already productive orchards and especially for the purchase of inputs.

Smallholders accessing financial services are influenced by several factors. Farmers find the loan application process tedious while others fear the consequences of defaulting as most farmers can only access loans as a group and therefore one farmer defaulting could have consequences for the others. Farmers have also indicated that loans are very risky due to the uncertain nature of rain-fed agriculture<sup>82</sup>.

## Climate Financing<sup>83</sup>

In terms of climate financing the Kenya government is implementing a 5-year Financing Locally Led Climate Action (FLLoCA) Program. The FLLoCA Program seeks to address the financing gap while building resilience at the community level. Specifically, the Program's objectives are to:

1. Support the development and strengthen policy, legal and regulatory frameworks at national and county levels for accelerated access to climate financing for building resilience at local levels.
2. Strengthen the capacity of national and county level institutions and stakeholders to accelerate climate financing at the local level.
3. Increase access to climate finance to support investments in climate resilience and low carbon emissions at the local level (urban & rural);
4. Support community-led local initiatives for enhanced community resilience and enhanced sustainable development;
5. Increase access to green/environmentally friendly technologies to deliver low carbon climate-resilient development at national and local levels; and
6. Enhance transparency and accountability on the support provided and actions implemented.

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<sup>82</sup>Barrett, H. R., Ilbery, B. W., Brown, A. W., & Binns, T. (1999). Globalization and the changing networks of food supply: the importation of fresh horticultural produce from Kenya into the UK. *Transactions of the Institute of British Geographers*, 24(2), 159-174.

<sup>83</sup> Financing locally led climate action (FLLoCA) Program, County readiness assessment report. Strengthening the capacity of counties to access climate finance, The Treasury and Planning 2021



In 2021 the government conducted an assessment of the status of implementation of the program in the counties on 6 components: Policy, Legal and Institutional Framework, Capacity Building, Climate Finance Results Framework, Supporting Community-Led Actions, Technology and Innovation, Monitoring, Reporting, and Verification Plus (MRV+)

The assessment provided critical insights into the state of preparedness by the counties to implement locally-led climate change actions. A majority of the counties have requisite legal, policy and institutional frameworks that are necessary to support the achievement of the FLLoCA program objectives. The findings indicate that most of the counties have a designated CECM in charge of Climate Change and established functional county and community level institutions. However, there remains capacity gaps particularly with respect to the development of climate change and climate finance policies, and the establishment special purpose account for the CCCF.

The FLLoCA Program emphasizes the need for the counties to have climate change actions plans for the purposes of identifying, prioritizing and mainstreaming climate change adaptation and mitigation actions. The assessment revealed that less than half of the county governments had put in place climate change action and adaptation plans possibly due to slow adoption of climate change-specific programming by the counties. However, more than three quarters of the counties have mainstreamed green technologies.

To enhance county readiness to identify, prioritize, implement and monitor locally led climate actions, the report recommended that the FLLoCA Program in collaboration with County Governments, relevant MDAs and other community stakeholders responsible for climate actions should:

1. Strengthen the capacity of the county governments to formulate, enact and operationalize the necessary policy and legal frameworks to enable implementation of climate actions.
2. Support the establishment and operationalization of County Climate Change Funds and the requisite institutional arrangements for the management of the Funds.
3. Strengthen coordination mechanisms between national, county and community institutions and stakeholders to enhance implementation of locally led climate actions.
4. Strengthen the capacity of county governments to track and report local climate change actions and climate finance flows.
5. Encourage prioritization and mainstreaming of climate change and adaptation actions in the county planning processes.
6. Develop strategies and programs to promote private sector participation in local level climate investments and mobilization of resources.

Table 11: Legislations on horticulture in Kenya

Stage of value chain	Official control	Institutions responsible (who)
1. Farm inputs	Fertilizer and seed quality <u>Relevant legislation</u> *PCP Act Cap 346 *Crops Act 2013. *Seed Act Cap 326 *Plant protection Act Cap 324 * Fertilizer and animal feeds Act. Cap 345	County Department Agriculture (CDA) PCPB HCD KEPHIS KEPHIS
2. Production *Site selection.	Environmental impact. EMCA Cap 387.	NEMA HCD KEPHIS CDA
*Planting	Seed quality Cap 326.	KEPHIS
*Crops management	Field management. Crops Act 2013. Crop protection. Cap 324	PCP CDA
Irrigation	Irrigation water quality. Cap 372. Public Health Act 242.	County Director of Water (CDW) KEBS
Harvesting	Produce quality. Cap 346. Public Health Act 242. Food drugs and chemical substance Act Cap 254.	KEBS CDA
3. Aggregation	Crops Act 2013. Public Health Act 242. Food drugs and chemical substance Act Cap 254.	CDA HCD
4. Transportation	Crops Act 2013. Public Health Act 242. Food drugs and chemical substance Act Cap 254.	CDA HCD PUBLIC HEALTH
5. Processing	Public Health Act 242. Food drugs and chemical substance Act Cap 254. Standards Cap 496 KEBS	Public Health. KEBS CDA
6. Storage & warehousing	Public Health Act 242. Food drugs and chemical substance Act Cap 254. Standards Cap 496 KEBS. Crops Act 2013. PCP Act Cap 346	Public Health. KEBS CDA PCPB
Marketing and distribution (sales and retailing)	Public Health Act 242. Food drugs and chemical substance Act Cap 254. Standards Cap 496 KEBS. Crops Act 2013. PCP Act Cap 346	Public Health. KEBS CDA PCPB

### Extension services

NGOs collaborate with farmers to optimize production and increase the smallholder incomes from fruit farming through input supply and extension services. Ministry of Agriculture Conduct training on proper agronomic practices geared towards optimizing productivity also offer extension services. Production support (CPP, spraying, nurseries and grafting, extension) is critical to increasing productivity. Kenya's horticultural sector is characterized by insufficient extension services, ineffective extension messages, and a poor delivery system. The Ministry of Agriculture, Livestock, and Fisheries are present in every County up to the location level, providing extension and advisory services; however, the delivery is weak and sometimes not available to farmers in remote locations.

**Transporter services:** Transporters provide transport services to a range of actors in the value chain. Transporters have diverse transport services and they do not rely on the fruit transport business alone.

### **2.4.1 Societal environment**

#### **Sanitary and phytosanitary requirements**

Kenyan fruits compete in a global market governed by stringent standards and requirements for safety and social accountability. These standards, such as adherence to maximum residue levels (MRLs) of pesticides in food or the need for a phytosanitary certificate are legal requirements, while others such as traceability, adherence to good agricultural practice (GAP), and the possession of a hazard analysis and critical control point (HACCP) system for processors are imposed by buyers.

Kenya has developed the Kenya Gap, benchmarked with the Global Gap, for ease of interpretation and acceptance of Kenyan produce in the world export market. Fruits (Mango, passion, avocado, citrus, and banana) are only supposed to be exported from farms certified by HCD for export; equally, exporters require certification from HCD and FPEAK to export fruit after meeting the minimum set standards. Due to economies of scale, the costs of implementing and maintaining the elevated levels of compliance and certification tend to favor larger businesses.

#### **Trade regulations**

Exports from Kenya enjoy preferential access to world markets under several exclusive access and duty reduction programs. Kenya is a signatory to various agreements aimed at enhancing trade amongst member states, and notable amongst these are the regional trade agreements under the East African Community (EAC), the Common Market for East and Southern Africa (COMESA), and trade agreements with the European Union. While these partnerships offer Kenya great opportunities to widen and broaden its market access for fruits, there are various challenges that present barriers to entry into these markets<sup>84</sup>.

#### **Policies**

Policy support has proven effective at establishing high-quality research and extension services and institutions, promoting standards and certification, and facilitating access to finance. The policy regime in Kenya consists of support functions for the national government and the regulatory and facilitating functions of the new county governments. At the national level, policy reforms and interventions relevant to the horticulture industry and fruit sector include the following: Agricultural Sector Development Strategy (ASDS), 2010-2020; National Agricultural Sector Extension Policy (NASEP), 2012; National Horticulture Policy, 2012; National Agricultural Research System Policy, 2012; National Agribusiness Strategy, 2012; and the National Seed Policy, 2011.

In 2010, Kenya published its first Horticulture Policy document whose main theme is to promote the growth and competitiveness of the horticulture industry including the fruit subsector. The policy documents capture some of the factors ailing the fruit industry and potential solutions, including intentions to improve infrastructure, promote value addition, increase domestic and export trade, promote increased production of high-quality products, and develop appropriate credit packages for small-scale horticulture farmers. The policy document also highlights the need to support the formation and capacity building of common interest groups to enhance market efficiency and provision of extension services.

#### **Contracts**

Like other agricultural sectors, the fruit value chain suffers issues to do with contract enforcement emanating from both producers and buyers. They range from produce and input diversion and selective picking of produce by buyers to inefficient dispute resolution methods, informal relationships, and market dynamics like price and demand volatility.

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<sup>84</sup> Kenya Agricultural Value Chain Enterprises Project (Kaves) 2013

## Grades and Standards

Kenya applies the United Nations Economic Commission for Europe (UNECE) fresh fruits standards but for only export fruits. Within the domestic market, the country does not have stipulated fruits standards. Standards apply to processed fruit products, such as juices and jams. Processors are required by law to register all processed products on offer for sale to the public and acquire the KEBS mark of quality.

*Table 12: Value chain activities and key players*

Value chain activities	Institution responsible
Sanitary and phytosanitary requirements	Africert, SGS, KEBS, HCD, and FPEAK (Independent auditors)
Multinationals in formalizing local supply	ABD, SNV, and Technoserve (Provide technical advice, financial assistance, capacity development, and business linkages)
Trade regulations	East African Community (EAC), the Common Market for East and Southern Africa (COMESA), and the EU (offer opportunities to widen and broaden its market access for fruits)
Policy regimes	Agricultural Sector Development Strategy (ASDS), National Agricultural Sector Extension Policy, National Horticulture Policy, National Agricultural Research System Policy, National Agribusiness Strategy National Seed Policy (regulatory and facilitating functions)
Grades and Standards	United Nations Economic Commission for Europe (UNECE)
Contracts	The fruit value chain suffers contract enforcement for producers and buyers.

*Own conceptualization*

## Business Environment

In Kenya, only 4% of all the horticultural produce (Fruits and Vegetables) is exported while 96% is consumed locally. Over 90% of all this produce consumed locally is by small-scale farmers. Recently, there are more opportunities for farmers to access international markets like the UAE, USA, and more. The Horticulture sector performed well in 2020 where earnings for fruits stood at Ksh 18B<sup>85</sup>.

Market transparency is hindered by the lack of accurate and free market information in Kenya, which has led to an increased sense of risk and uncertainty, resulting in high transaction costs for actors along the value chain. Subsequently, markets are inefficient and unresponsive to producer needs. Smallholder farmers are especially affected by these conditions and find it difficult to penetrate formal markets with a lack of collective action as a major challenge<sup>86</sup>.

## Price Control and Taxation

The Price Control (Essential Goods) Act No. 26 of 2011, an Act of Parliament, commenced on 19th September 2011 and aims to provide regulation of the prices of essential commodities to secure their availability at reasonable prices. The Minister from time to time may determine the maximum prices of the commodities in consultation with the industry. The list of the prices for the essential commodities is not announced. In addition, the Consumer Protection Act of 2012 came into force on March 14, 2013, and provides for punishment of businesses that knowingly sell sub-standard goods and lie on pricing and prohibits the use of misleading information to sell goods and services. The fruit industry is not subject to price controls as the products are not classified as part of the essential commodities.

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<sup>85</sup> Update on The State of The Horticulture Industry in Kenya 2020

<sup>86</sup> Muthini, Davis & Nyikal, Rose & David, Jakinda. (2017). Determinants of small-scale mango farmers market channel choices in Kenya: An application of the two-step Craggs estimation procedure. *Journal of Development and Agricultural Economics*. 9. 111-120. 10.5897/JDAE2016.0773.

Although the new Value Added Tax Act of 2013 (CAP 476) exempts fresh fruits from taxation, it imposes a 16 percent VAT on processed juices. Maina (2013) analyzes the differences between exempt and zero-rated status and concludes that the difference in the price of exempted supplies and those charged 16 percent VAT is negligible, and prices of zero-rated supplies are the lowest. This is a result of the fact that businesses supplying exempted goods/services have no mechanism to claim back input VAT, which then must be converted into a cost, while those under the 16 percent VAT category do. The 16 percent VAT on distribution will increase the cost of production inputs, transportation costs, and fruit prices.

### **Cooperation of the value chain with government and donor projects**

Private-sector members of the taskforce, including the Fresh Produce Exporters Association of Kenya (FPEAK), the Fresh Produce Consortium of Kenya (EPC) and the Agrochemicals Association of Kenya (AAK) and the government taskforce from the Ministry of Agriculture, Livestock, Fisheries and Cooperatives (MALFC) the Ministry of Health (Public Health Food Safety Unit), the State Department for Trade, and the National Treasury. Government agencies include the Horticultural Crops Directorate (HCD), Kenya Plant Health Inspectorate Service (KEPHIS), Pest Control Products Board (PCPB), Kenya Agricultural & Livestock Research Organization (KALRO) and the Kenya Export Promotion and Branding Agency (KEPROBA and The Council of County Governors are working to provide an enhanced public-private sector coordination mechanism on strategic and policy issues to adequately address the challenges facing the horticulture industry<sup>87</sup>.

The agriculture sector has been disadvantaged by limited data, for example on nutrition, food utilization, agricultural products, yields and prices. So, the taskforce intends to develop an integrated information management system that will process all the data collected along the value chain, linking to existing systems with relevant information on horticulture. The task force has created a Data, Information Management, Market Development and Trade Facilitation Committee to guide this process.

### **Kenya Agricultural Value Chain Enterprises (KAVES)**

The Kenya Agricultural Value Chain Enterprises (KAVES) activity collaborates with smallholder farmers, businesses, and national and county government partners to address constraints up and down the value chain (such as agro-processors, input suppliers, transporters, exporters, retailers, financiers) and develop fully-functioning, competitive value chains. KAVES aimed to increase the productivity and incomes of smallholder farmers, and other actors along the value chain, who are working in the dairy, maize (and other staples) and horticulture sectors.

The activity worked with more than 30 Kenyan government and private sector organizations including: Ministry of Agriculture, Livestock and Fisheries, county governments, Agricultural Sector Development Support Programme (ASDSP), Kenya Dairy Board (KDB), Kenya Plant Health Inspectorate Services (KEPHIS), Kenya Food Security Steering Group, Pest Control Products Board (PCPB), Horticulture Competent Authority Structure, Horticultural Crops Development Authority (HCDA), Kenya Agricultural Research Institute (KARI), public and private sector actors in the dairy, maize, and horticulture value chains.

The activity developed smallholder enterprises that combine high value horticultural crops and dairy farming to generate wealth, thereby enhancing food security, improving nutrition, and increasing economic opportunities for women, youth,

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<sup>87</sup> COLEACP 2021

and other vulnerable populations. Engagement with the private sector in a meaningful, comprehensive way ensured the sustainability of the activity's work.

**USAID Kenya Horticulture Competitive Programme.** The Kenya Horticulture Competitiveness Project improved food security and nutrition and raised incomes for more than 200,000 smallholder farmers. The project helped farmers grow more and better-quality fruits, vegetables, and flowers, with a special focus on strengthening the value chains related to eight crops: sweet potato, Irish potato, passion fruit, mango, banana, tomato, cabbage, peas, and beans. The Project also expanded the processing of horticultural produce, linking small-scale farmers with local and export markets, and improving the overall agricultural policy environment. It aimed to increase the incomes of smallholder farmers through new product development, domestic market interventions, marketing services, policy interventions, and environmental management.

**Kenya Market-led Horticulture Programme** also known as hortIMPACT was a 5-year project, funded by the Embassy of the Netherlands in Kenya (EKN). HortIMPACT was implemented across Kenya by a SNV-led consortium whose other core partners are HIVOS, Solidaridad & DLV Plant. The project focused on selected fresh fruits and vegetables. HortIMPACT goal was to contribute to increased food security & increased incomes for 75,000 farmers and the development of a dynamic and sustainable horticulture sector in Kenya in 5 years. The programme focused on enhancing the entrepreneurial capacities & performance of 75,000 small & medium sized farmers for improved access to domestic & international markets.

## **State of infrastructural elements**

### **Transport infrastructure**

The fruit industry is affected by the state of rural infrastructure given the perishable nature of the product. Rural feeder roads, which are critical for the collection of production, are in dire need of repairs and maintenance. In some areas, village assemblers and brokers are forced to use donkey and ox carts to penetrate remote areas to purchase fruits. In addition, packaging infrastructure is important if the harvested fruits are to be kept under suitable conditions. For export fruits, port infrastructure and shipping lines are also critical factors for ensuring the competitiveness of fruits exports.

There is heavy reliance on air transportation, which is expensive and makes Kenya fruits cost more compared to imports from competing countries. As part of the national expansion of infrastructure, the Government has initiated the construction of the Lamu Port and its Corridor linking coastal Kenya with South Sudan, Ethiopia, and Uganda. Within this Corridor, the Government has identified the production and processing of fruits as a key value chain along with the livestock industry<sup>88</sup>.

### **Rural and Urban Market Facilities**

Rural and urban market facilities (retail and wholesale) are not for horticulture production only but other crops too. Trading takes place on open floors within wholesale markets and the commodities are also traded while loaded on the trucks and only off-loaded after a deal is made. Given the perishable nature of mangoes, bananas, avocados, citrus, and passion fruits these conditions provide the right environment for the fast deterioration of the fruits leading to heavy losses. Exporters and processors have also highlighted a lack of collection and sorting facilities in the main fruit-producing areas as one of the key logistical challenges that add to marketing costs.

### **Irrigation**

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<sup>88</sup> Gok 2012

Although Kenya has invested in irrigation agriculture, there has been extraordinarily little attention towards providing irrigation for fruit crops and especially mangoes, passion fruit, banana, avocados, and citrus. In areas that utilize supplementary irrigation, such as large-scale farms along river Athi, mangoes can produce better quality fruit. Irrigation allows the production of early-season fruits, allowing the farmers to get better prices.

### **Socio-cultural elements**

Women are concentrated along different nodes of the fruit value chain with men dominating at the production stage and women being active participants at the marketing level. Decisions regarding the use of land are predominantly man's affairs. The gender gap in agriculture has been aggravated by women having less access to productive resources and opportunities along different value chains compared to their male counterparts. Women are faced with several challenges and constraints that hinder them from being optimally productive. Limited access to land, the unequal power relations within the household reinforced by a low bargaining power in decision-making, barriers to credit, and information access on the prices offered by the different marketing channels as some of the constraints faced by women.

Women's labor is divided into household labor provision and farm labor whereas men either work in the agriculture or non-agriculture sector. This suggests that the burden of both productive and reproductive roles has been endowed upon women thus their household labor contribution is not productive<sup>89</sup>.

Socio-cultural constraints include illiteracy; limited access to resources; land utilization rights; high workloads (low involvement of men) and low participation of women in decision-making processes. In production, women are less likely to own land or to have access to rented land and if they have access to land, it is often of poor quality and smaller in size.

### **Consumption**

According to recent surveys, the affordability of brands is the top factor affecting consumer purchasing decisions in Kenya. Brand loyalty, product labeling, and packaging are also key factors affecting consumer habits in Kenya. Nearly 70% of people in Kenya do their daily shopping through the informal sector, and Kenya is the second largest formal retail sector in Africa. Accordingly, consumer packaged goods account for 30% of monthly household spending<sup>90</sup>.

Urban and rural consumers are very different in Kenya. In urban areas, consumers rely on online search engines to make more informed purchase decisions and pay closer attention to labels. M-commerce, the use of mobile payments to shop has tripled in the past two years<sup>91</sup>.

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<sup>89</sup> Picchioni, F., Zanello, G., Srinivasan, C. S., Wyatt, A. J., & Webb, P. (2020). Gender, time-use, and energy expenditures in rural communities in India and Nepal. *World Development*, 136, 105137. Picchioni, F., Zanello, G., Srinivasan, C. S., Wyatt, A. J., & Webb, P. (2020). Gender, time-use, and energy expenditures in rural communities in India and Nepal. *World Development*, 136, 105137.

<sup>90</sup> Kenyan Market, 2019

<sup>91</sup> Keding, G. B., Kehlenbeck, K., Kennedy, G., & McMullin, S. (2017). Fruit production and consumption: Practices, preferences, and attitudes of women in rural western Kenya. *Food Security*, 9(3), 453–469. <https://doi.org/10.1007/s12571-017-0677-z>

### 3 Sustainability Assessment

#### 3.1 Economic Analysis

##### 3.1.1 Mango Margins Analysis

Smallholders have planted mango as a long-term investment over the past 5-10 years. If grafted trees of specific varieties planted and cultivated commercially, it takes five years to recover start-up costs and start making an annual profit. From year gross returns should be at least Ksh 300,000 per acre

Table 13: Mango gross margin

Activity/Input	Year 1-4	Year 5	Year 6	Year 7
Seedlings/suckers	12,300	0	0	0
Fertilizer	11,600	3600	3600	3600
Agrochemicals	8500	6500	6500	6500
Labor	42,530	7,000	8,000	8,000
Other	430	130	130	170
Total direct cost	73,360	17,230	18,230	18,270
Yield-fruit/ha	18,450	36,900	61,500	98,400
Production cost/fruit	4	<1	<1	<1
Price-Ksh/fruit	5	5	5	5
Sales value	92,250	184,500	307,500	492,00
Gross Margin	16,890	167,270	289,270	473,730

Source: USAID-KAVES Value Chain Analysis

##### 3.1.2 Citrus gross margin

###### Pixie

Pixie farming is very profitable with an acre giving a turnover of up to Ksh1.2 million per year as reported by farmers in Makueni. These fruits are sold at an average price of Ksh80 per kilo at the farm gate<sup>92</sup>. A well-tended tree will give 60 kilos of fruits in a year and an acre can accommodate 270 such trees. The cost of starting a pixie farm is just one-time and would be about Ksh150,000. Of this initial capital, you only need about Ksh100,000 for purchasing seedlings (around Ksh67,500) and planting labor (around Ksh33,000) at first. The remaining 50,000 is needed over time since it's used for maintaining the orchard in terms of pest control and irrigation where needs are. Once established, the farm will be generating income for you every year for the next 20 to 30 years.

###### Orange

orange and sweet orange lime stabilized in the 10th year. From there, the average yield rises to 400+ fruits per tree for oranges and 200+ for sweet orange lime. At a price of Ksh 8 per fruit, a farmer can earn a minimum of Ksh 800,000 for orange lime and Ksh 400,000 for sweet orange.

###### Lime/ Lemon

Lime/lemon producers can produce 50-60 fruits per tree in the 2nd/3rd year. At a price of Ksh 8 per fruit, a farmer will earn Ksh 100,000 in the first harvest. Lime/lemon stabilizes in the eighth year. From there, one tree yields 700+ fruits per season. At a price of Ksh 8, a farmer can pocket 1.4M.

##### 3.1.3 Passion fruit's gross margin

Commercial passion fruit production requires investment in poles and wire for trellising, grafted seedlings and a consistent supply of fertilizer and agrochemicals for yield maximization. Irrigation is also necessary to

<sup>92</sup><https://minnetonkaorchards.com/how-to-grow-an-orange-tree/>



achieve year-round production and maintain healthy vines. For farmers who can make this investment, high returns of over Ksh 4 million per hectare (1.6 million per acre) are possible in the second year of full production.

*Table 14: Passion fruits gross margin*

Activity/Input	Year 1	Year 2	Year 3
Seedlings/suckers	66,000	0	0
Fertilizer	95,700	95,700	95,700
Agrochemicals	81,000	81,000	81,000
Labor	93,400	61,100	61,100
Irrigation	450,000	0	0
Trellising	420,000	0	0
Total direct cost	1,206,100	237,800	237,800
Yield-fruit/ha	14,000	84,000	50,000
Production cost/fruit	86	3	3
Price-Ksh/fruit	60	60	60
Sales value	840,000	5,040,00	3,000,000
Gross Margin	-366,100	4,802,200	2,762,200

Source: USAID-KAVES Value Chain Analysis

### 3.1.4 Banana gross margin

Yields of over fifty metric tons per hectare (20 MTs per acre), about 4,500 bunches are possible by the third year of production, with gross margins of Ksh 350,000 (US\$ 4218) per hectare or Ksh 140,000 (US\$ 1686) per acre. On average, farmers receive about 25 percent of the final retail price. The other 75 percent is distributed evenly amongst different levels of traders with retailers taking the highest proportion, presumably because they take the biggest risk on spoilage and price reduction.

*Table 15: Banana gross margin*

Activity/Input	Year 1	Year 2	Year 3	Year 4
Suckers	82,500.00	0	0	0
Fertilizer	32,500	40,000	47,000	47,000
Agro-chemicals	30,000	0	0	0
Labor	33000	7000	5000	5500
Others	1780	470	520	525
Total cost	179,780	47,470	52,520	53,025
Yield-Kg/acre	0	12,375	18,555	24,750
Production cost Ksh/acre	-	3.84	2.83	2.68
Price-Ksh/Kg	10	10	10	10
Sales value	0	123,750	188,550	247,500
Gross Margin <sup>82</sup>	-179,780	76,280	133,030	144,975

Source: USAID-KAVES Value Chain Analysis

### 3.1.5 Avocado gross margin

Avocado requires a high establishment cost. Seedlings, fertilizer, and agrochemicals account for 43 percent of the crop establishment with seedlings costing about of the cost. In addition, the cost of fertilizer and agrochemicals for each year in the subsequent years is more than 50 percent of direct cost (Table 30). This implies that an average smallholder farmer without access to input credit can't undertake economically viable avocado farming. In view of this, there is need to facilitate access for input credit to smallholder farmers and to build capacity of local avocado

nursery operators to reduce cost of seedlings and increasing accessibility. The viability of the proposed input credit is supported by bigger gross margin for the smallholder farmer in the successive years<sup>93</sup>.

*Table 16:Avocado gross margin*

Activity/Input	Year 1-4	Year 5	Year 6	Year 7
Seedlings/suckers	12,300	0	0	0
Fertilizer	11,600	3600	3600	3600
Agrochemicals	8500	6500	6500	6500
Labor	42,530	7,000	8,000	8,000
Other	430	130	130	170
Total direct cost	73,360	17,230	18,230	18,270
Yield-fruit/ha	18,450	36,900	61,500	98,400
Production cost/fruit	4	<1	<1	<1
Price-Ksh/fruit	5	5	5	5
Sales value	92,250	184,500	307,500	492,00
Gross Margin	16,890	167,270	289,270	473,730

### 3.1.6 Employment

In terms of wage employment, the fruit subsector experienced a decline in the share of wage employment in 2018 in comparison to 2001. The slow or declining growth in wage employment in horticulture attributed to structural changes within the sector<sup>94</sup>. The fruit sub-sector is characterized using more mechanized systems and/or automation in its production process, which may lower demand for wage employment at the firm level in the short run. It is also established that Automation amidst innovation usually spurs sector-wide development and growth in wage and non-wage employment. In the fruit sector, small-scale producers (mainly self-employed and contributing family workers) have increased over time. This explains the increased output and exports in horticulture and the apparent slack in wage employment.

The horticulture sector employs about 10 million people directly and indirectly predominantly women and youth. About 6 million people are directly involved in production, processing, and marketing, while about 3.5 million people benefit through other related activities along the value chain. For instance, clearing agents, government institutions (pest control board), and other entrepreneurs <sup>95</sup>.

Due to the intensity of labor involved, the sector continues to create more employment opportunities compared to other agricultural sectors along the value chain from production, packaging, storage, processing distribution, as well as within the marketing segment. The sector also shows promise for the transition of smallholder farming into commercial farming. Despite this continued growth, there were questions around the quality of wages/jobs and the extent to which they contribute towards outcomes such as poverty alleviation, food security, and healthcare.

### 3.1.7 Value Addition

Value addition is any action that takes a (raw) product a step closer to the form in which it can conveniently meet the needs of the users. This enables small-scale farmers to reduce post-harvest losses for perishable fruits and thereby offering them opportunities to maximize returns. The major contributor to food scarcity in the country has been the

<sup>93</sup> USAID-KAVES VALUE CHAIN ANALYSES 2013

<sup>94</sup> Munga, B., Onsomu, E., Laibuni, N., Njogu, H., Shibia, A., & Luseno, S. (2021). Industries without smokestacks in Africa: A Kenya case study

<sup>95</sup>Kangai, E., & Gwademba, G. (2017). Creating employment in horticulture sector in Kenya: productivity, contracting and marketing policies. *Utafiti Sera Policy Brief*, 2.

massive post-harvest losses that occur due to low-value addition and inadequate cold chain facilities. Food Agriculture Organization's (FAO 2014) report on Food Loss Assessments, approximates that Kenya losses between 20% – 50% of its agricultural production due to post-harvest losses. There is a rising demand for organic, super fruit, and 100 percent natural fruit juices without any sweeteners and preservatives. This added demand from fruit juice manufacturers is allowing farmers across Kenya to process their harvested fruits into less perishable concentrates thereby reducing spoilage and earning them more money.

Value addition opportunities from mango and citrus include natural juices, dessert, slice, and package, sorting and grading, packaging, and cold storage. Upon harvest, the mango fruit is highly perishable, therefore farmers have taken up farm-level value-addition strategies to enhance the shelf life to improve market access. Pulp is sold to juice processors within the country and within the East African region, as well as the wider COMESA (Common Market for Eastern and Southern Africa).

Harvested bananas either raw or ripe are usually prone to spoilage and wastage if in plenty and not consumed on time. Many farmers do not know this but there is quite a good number of products that can be processed from bananas adding value to them other than the mere fresh ripe bananas or the green raw bananas cooked. Passion fruit, avocados and citrus value addition is also done and there is a huge market potential for these products.

One of the major banana producing counties in Kenya, Kisii has established a banana processing plant at a cost of Kes 170M with funding from the EU and the County government. The project is part of the Instrument for Devolution Advice and Support (IDEAS) programme which was brought about by a partnership between the national government and the EU and supports devolution at the grassroots.

The facility will be contracted to a private investor who will operate the plant producing banana flour and wine. The factory will serve Kisii, Nyamira, Migori, Homabay and Bomet Counties among others.

### **3.1.8 Effects in the county and national economy**

The horticulture sector accounts for 65 percent of the export earnings and provides the livelihood (Employment, income, and food security needs) for more than 80 percent of the Kenyan population and contributes to improving nutrition through the production of safe, diverse, and nutrient-dense foods. The volume of fruits exported increased from 99.5 million kilos in 2020 to 110.5 million kilos in 2021 representing 17.57 billion Ksh. It employs people in farming areas<sup>96</sup>. It has led to the development of related industries like fruits and vegetable canning, manufacture of cans and tins, as well as juice processing as a furnisher of industrial raw materials. It is an important contributor to economic activity in other sectors of the economy. Higher fruit value added per worker implies that more income generated from agriculture which contributes to lower levels of poverty in rural areas.

### **3.1.9 International competitiveness**

Kenya's horticulture industry continues to face growing competition both regionally and globally. Kenya exports mostly semi-processed and low value-added products, which account for 90 percent of horticultural processed products due to technological limitations and high costs of value addition, underperformance, and underdevelopment of the firms. Moreover, inadequate infrastructure and inconsistent production of horticultural raw materials has resulted in operations below capacity. Subsequently, the processed products in Kenyan markets are less competitive and lack a comprehensive database of processors<sup>97</sup>.

### **3.1.10 Value for end-consumers**

Apart from their rich nutrient, mineral, and vitamin content, fruits are now known to lower blood pressure; reduce the risk of heart disease, stroke, and probably some cancers; and help to lower the risk of eye and digestive system problems. Nutritional value of Mangos In addition to income opportunities, mango fruit is critical in combating nutritional disorders.

The mango compares favorably in food value with both temperate and tropical fruits and contains almost all the known vitamins and many essential minerals. The calorific value of mango derived from sugars. It is as high as that of grapes and even higher than that of apples, pears, or peaches. The protein content is generally a little higher than that of other fruits except for the avocado. Mangos are also a relatively good source of thiamine and niacin and contain some calcium and iron. Passion fruit is a good source of fiber, vitamin C, and vitamin A. Calorie for calorie, it's a nutrient-dense fruit. Passion fruit contains antioxidants. It is rich in vitamin C, beta carotene, and polyphenols. Passion fruit containing fiber is important for keeping your gut healthy and preventing constipation. Passion fruit is used as food, and reduces iron deficiency anemia since it has high content of iron and vitamin C. The pulp and juice act as a mild laxative and protect the stomach lining (constipation). Bananas are a healthy source of fiber, potassium, vitamin B6, vitamin C, and various antioxidants and phytonutrients. They help support the immune system. Citrus fruits contain mostly carbohydrates such as sucrose, glucose, and fructose and are good dietary fiber sources, which help prevent gastrointestinal disease and promote high circulating cholesterol. Besides, citrus fruits are also significant sources of vitamin C and various bioactive compounds. Avocado is rich in healthy mono and poly unsaturated fats, protein and

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<sup>96</sup> Mbabazi, E., (2019). Kenya's Horticulture Exports Earnings Rise to KSh145 Billion. Agriculture Kenya news.

<sup>97</sup> Fukase, E., & Martin, W. (2018). Agro-processing and horticultural exports from Africa. Industries without Smokestacks: Industrialization in Africa Reconsidered, 90-112.

an array of vitamins including Vitamin A, Vitamin C, Vitamin B6 and B12, Vitamin E, Vitamin K. Avocado contains dietary fibers, minerals that are essential for healthy human growths which include Calcium.

## **3.2 Social Analysis**

### **3.2.1 Inclusiveness**

The professionalization of production in the fruit sector increased employment, particularly for women, who benefited from new permanent jobs at packhouses with higher wages and skill requirements. Similarly, opportunities for linkages increased as large exporters expanded their contract farming arrangements. The need to provide a more diverse range of products, together with the severe fines imposed if exporters were unable to supply the quality and quantity of products promised to supermarkets, increased contracts for smallholders, who could supplement the exporters' products and share their risks (such as demand peaks and crop contagion). The largest exporters contracted with between 1,000 and 2,000 farmers, who benefited from the provision of inputs, training, finance, and help with quality assurance.

Women-waged workers have different wages and employment conditions to men, flexible employment heightens uncertainty, there is limited access to training and sexual harassment by male supervisors is common. Vulnerable women may be subject to significant levels of sexual harassment, while discrimination against women often prevents promotion to better positions. Given the scarcity of job opportunities and limited labor mobility, sexual harassment often goes unreported. In the fruit sector, female employment is often temporary, low-paid, informal, and insecure. Insecure workers are highly vulnerable to poverty, which compounded in the case of women who juggle their reproductive role with that of the wage earner. Women workers are generally segregated in certain nodes of the chain (e.g., processing and packaging) that require relatively unskilled labor, reflecting cultural stereotypes on gender roles and abilities. Women workers caught between productive and reproductive roles, their exposure to risk and vulnerability is magnified<sup>98</sup>.

Poverty is heightened by their productive and reproductive roles. Benefits (maternity leave, childcare provision, and transport) that enable women to balance unpaid caring work with paid work are often not extended to temporary workers. The vulnerability of women workers is made worse by the lack of employment security and involuntary periods out of work.

### **3.2.2 Gender equality**

In the fruit sector jobs dominated by women include (nursery work, transplanting, quality control, washing, grading, and packing), which require skills of attention to detail, careful handling of the product, and the ability to identify defects. Jobs that are dominated by men involve operating machinery, such as transportation and logistics. Women temporary and contract workers are likely to work for shorter periods in the year than men and in both.

Women are more likely to be juggling paid work with childcare and family responsibilities. They not only carry the risks arising from insecure and often informal work, but they also carry the risks of illness and accidents, and old age among family dependents. If a child or elderly relative is sick, and a temporary or contract worker must take time off, she may not only lose income but possibly her job<sup>99</sup>. Women need permission from their partners if they want to grow crops. Legal land ownership is in the hands of men and women have less or no power to impose any decisions.

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<sup>98</sup> Bolzani, D., de Villard, S., & de Pryck, J. D. (2010). *Agricultural Value Chain Development: Threat or Opportunity for Women's Employment*. ILO.

<sup>99</sup> Barrientos, S., Kritzinger, A., Opondo, M., & Smith, S. (2005). Gender, work, and vulnerability in African horticulture.

### **3.2.3 Food and nutrition security**

The World Health Organization (WHO) states that Food Security is achieved when all people, always have physical and economic access to adequate/sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

#### **Food availability**

Food availability means that there is a sufficient supply of food, in terms of quantity and quality, in a certain area. supply of food is determined by food production within a country's boundaries, food stock levels, and net food imports. Fruit exports have increased sharply during the last two decades while also food availability has improved. Fruit exports contribute positively to foreign exchange earnings and a country's trade balance, thereby increasing a country's capacity to import food. There are nevertheless concerns that increased agricultural exports are associated with increased dependency on global food trade and reduced availability of food. Competition for resources is uneven and reduces national food availability<sup>100</sup>.

Fruit export growth does not necessarily jeopardize food availability at the macroeconomic level. Competition over resources between horticultural export production and food production might exist but whether this reduces a country's food availability depends on whether the reduction in domestic food production is compensated for by increased food imports. There is not necessarily a trade-off between horticultural export production and domestic food production; both may grow at the same time.

#### **Food access**

Implies that an individual, a household, a community, or society can obtain sufficiently nutritious food. that participation of rural households in fruit export chains, either through contract farming or through wage employment, improves households' indirect access to food. Especially female employment in horticultural export sectors may be conducive to food and nutrition security. Reallocation of land and labor resources to export production may reduce households' direct access to food although the technology and investment spillover effect may increase food production as well, this is likely compensated by higher incomes and purchasing power.

#### **Food utilization**

Refers to aspects of nutritional quality and safety and sanitation of food consumption. Fruits exports may increase households' nutritional intake and the use of stringent standards in these sectors may contribute to improved food safety and sanitation of domestic food consumption. Empirical evidence on these effects is lacking.

#### **Food stability**

Refers to continued availability and access to food at the macro- and microeconomic level. available evidence indicates that fruit exports can contribute to the stability of food security in developing countries but that there are challenges, most importantly stable and secure employment in export sectors and the sustainable use of water resources.

### **3.3 Environmental Analysis (Ecological Footprint)**

#### **3.3.1 Climate change**

Uncertain climate patterns have implications for the rural populations who derive their livelihoods from farming and related enterprises<sup>101</sup>. Agriculture in Kenya is largely (98%) rainfed and thus extremely vulnerable to increasing

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<sup>101</sup> Van Ruijven, B. J., De Cian, E., & Sue Wing, I. (2019). Amplification of future energy demand growth due to climate change. *Nature communications*, 10(1), 1-12.

temperatures, droughts, and floods. Smallholder farmers are especially hard hit by these changes, often confronted with crop failures, and related income and livelihood losses. Projections show increases in mean annual temperature of 1 °C to 1.5 °C by 2030. Relatedly, changes in rainfall distribution and more frequent extreme events, such as prolonged drought and flooding, Projected Changes in Temperature and Precipitation in Kenya by 2030.

Drought affects all stages of fruit (banana, citrus, mango, avocado and passion fruit) value chains, although in different ways. In the production, stage suffers from low germination rates, hardened soils, and increased incidence of pests and diseases due. Planting requires more time and labor due to hard soils; low germination increases the need for irrigation; and water stress leads to greater crop susceptibility to pests and diseases, low yields, and poor-quality produce. Flood on production delays, poor stand establishment, higher costs for labor and weed management, increased incidence of pests and diseases, and rotting of plants. Flood damages roads and this damage to transport infrastructure can also hinder access to storage facilities, processing infrastructure, and markets consequences that often have knock-on effects for processors, agricultural buyers, and their employees.

### **3.3.2 Natural environment**

#### **Fruit value chain and water**

Water is used in many stages of the fruit value chain including growing (rainfall, irrigation), processing (washing produce, pack-house wash-down, sanitation), and distribution (wash-down). As such, a secure and reliable supply of water of appropriate quality is critical to businesses that grow and process fruit and consequently to the security of supply to retailers and consumers<sup>102</sup>. Drought may mean that water is not available for irrigation of the fruit value chain, leading to plant water stress that during critical growth periods (which vary by species) can adversely affect a plant's ability to accept nutrients, limiting growth, yield and affecting the quality of the resulting produce<sup>103</sup>. At the extreme, water stress may lead to the abortion of flowers and eventually plant death. This can have potentially severe economic consequences for stakeholders within the value chain<sup>104</sup>.

#### **Fruit value chain and climate change**

Climate change in fruit value chain production alters the crop calendar and seasons, water availability, and incidences of pests and diseases. This changes the input availability, cost of inputs, on-farm production(yield), harvesting, storage, and processing. Product marketing (wholesale and retail marketing) and consumption (prices)<sup>105</sup>.

Climate change, especially rainfall and temperature have adverse effects on the fruit. Rainfall and extreme temperatures have affected output of mango, passion fruit, avocado and citrus. Unpredictable rains cause delayed flowering, and the mangoes quality is affected when the fruiting season overlaps with summer rains. Increased

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<sup>102</sup> Hess, T., & Sutcliffe, C. (2018). The exposure of a fresh fruit and vegetable supply chain to global water-related risks. *Water international*, 43(6), 746-761.

<sup>103</sup> Kumar, P., Roupael, Y., Cardarelli, M., & Colla, G. (2017). Vegetable grafting as a tool to improve drought resistance and water use efficiency. *Frontiers in Plant Science*, 8(June), 1130. [\[Crossref\]](#), [\[PubMed\]](#), [\[Google Scholar\]](#)

<sup>104</sup> Ripoll, J., Urban, L., Staudt, M., Lopez-Lauri, F., Bidel, L. P. R., & Bertin, N. (2014). Water shortage and quality of fleshy fruits-making the unavoidable. *Journal of Experimental Botany*, 65(15), 4097–4117. [\[Crossref\]](#), [\[PubMed\]](#), [\[Web of Science ®\]](#), [\[Google Scholar\]](#)

<sup>105</sup> Parajuli, R., Thoma, G., & Matlock, M. D. (2019). Environmental sustainability of fruit and vegetable production supply chains in the face of climate change: A review. *Science of the Total Environment*, 650, 2863-2879.

temperature affects passion fruit production, it increases the incidence of pests and disease<sup>106</sup>. High temperatures affect citrus plants, increasing transpiration and photosynthesis, destabilizing their cell membranes, and increasing oxidative damage. It reduces the size and quality of the yield drastically<sup>107</sup>. Banana requires a well distributed annual rainfall of more than 1400mm<sup>108</sup>.

By the end of the century, climate change may be the dominant direct driver of biodiversity loss and changes to ecosystem services globally, such as crop cultivation. This will create an imbalance in the raw material supply and demand, leading to considerable price increases. Weather shocks play a significant part in trajectories associated with extreme poverty. According to the World Bank Climate Change Knowledge Group, Kenya faces an increase in temperatures and precipitation. The research indicates that climate change may affect crops, exacerbate violent environmental shocks, such as droughts and flooding, as well as throw agricultural ecosystems off balance<sup>109</sup>.

Stakeholders on climate smart agriculture support climate smart agriculture practices in fruit production, by providing financing, facilitating knowledge and information management, and advancing technology development. Some important climate smart practices may include:<sup>110</sup>.

- Crop rotation which helps maximize soil nutrients, reduce pest and disease risks, improves soil fertility, and maintains or improves soil carbon stocks and soil organic matter content which have effect on improved yields and income.
- Climate-smart services, such as tailored weather agro-advisories for farm planning and management, allowing continued improvement. These services to be delivered via mobile phones, enabling farmers to be protected from extreme weather.
- Inclusion of agroforestry in the cultivation of fruit trees and establishment of nurseries will make it possible to deliver high-quality tree seedlings.
- Water-efficient irrigation technologies to reduce water use. Alternate Wetting and Drying (AWD) can reduce methane emissions and ensures greater yield stability during dry seasons and contributes to increased yield per unit area.
- Mulching which promotes soil and water conservation. It increases soil nutrients upon decomposition, prevents erosion, maintains, or improves soil carbon stocks and soil organic matter content.
- Manure composting and application improves soil nutrients and yields per unit area. It promotes soil conservation, reduces soil salinity, and improves water retention. This reduces methane emissions and can lead to a reduction in the number of inorganic fertilizers required. It increases productivity because of enhanced soil health and fertility.

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<sup>106</sup> Oluoch, P., Nyaboga, E. N., & Bargul, J. L. (2018). Analysis of genetic diversity of passion fruit (*Passiflora edulis* Sims) genotypes grown in Kenya by sequence-related amplified polymorphism (SRAP) markers. *Annals of Agrarian Science*, 16(4), 367-375.

<sup>107</sup> Balfagón, D., Arbona, V., & Gómez-Cadenas, A. (2022). The future of citrus fruit: The impact of climate change on citriculture. *Metode Science Studies Journal*, (12), 123-129.

<sup>108</sup> Climate Change Impacts on Banana Yields in Murang'a, 2022

<sup>109</sup> Eichsteller, M., Njagi, T., & Nyukuri, E. (2022). The role of agriculture in poverty escapes in Kenya—Developing a capabilities approach in the context of climate change. *World Development*, 149, 105705. CULTURE. *BIONATURE*, 52-65.

<sup>110</sup> Climate-Smart Agriculture in Kenya



- Inter cropping, improves soil quality (physical and chemical), increases efficiency in water and soil use, contributes to increases of soil organic matter, maintaining soil carbon stock, and reduces economic vulnerability by diversifying production
- Conservation agriculture promotes soil and water conservation. It helps avoid crop losses during dry periods, facilitates carbon sinking in soil and reduces nitrogen loss.

### Fruit value chain and biodiversity

**Land use change:** Agricultural expansion is the most important proximate cause of land use change globally, followed by infrastructure development and deforestation. Driven by global population growth, pressures for increased food have been one of the primary drivers to convert nature into land for agricultural use. Changes in the landscape due to such activities are recognized in the literature as major causes of the loss of biodiversity<sup>111</sup>.

**Water scarcity:** According to IFPRI, in 2025, 72% of the world's water use will be for irrigation. Moreover, the Millennium Ecosystem Assessment found that 5-20% of freshwater use exceeds the long-term sustainable supply, and 15-35% of irrigation withdrawal is estimated to be unsustainable.

**Deforestation:** Deforestation results in the immediate release of the carbon stored in trees as CO<sub>2</sub> emissions. It is estimated that deforestation contributed globally to 20% of annual greenhouse gas emissions in the 1990s. According to the IPCC's Fourth Assessment Report, reducing and/or preventing deforestation is the mitigation option with the largest and most immediate carbon stock impact in the short term<sup>112</sup>.

Table 17: Environmental factors linked to the fruit Value chain

Factors	Relation to the fruit value chain
Water	Used across the value chain in growing (rainfall, irrigation), processing (washing produce, pack-house wash-down, sanitation), and distribution
Biodiversity	-Land usage decline -water scarcity -deforestation
Climate change	It changes the input availability, cost of inputs, on-farm production(yield), harvesting, storage, and processing. Product marketing and consumption (prices).

Own conceptualization

<sup>111</sup> Djama, M., Fouilleux, E., & Vagneron, I. (2011). Standard-setting, certifying, and benchmarking: A governmentality approach to sustainability standards in the agro-food sector. *Governing through standards: Origins, drivers, and limitations*, 184-209.

<sup>112</sup> Hickmann, T., Widerberg, O., Lederer, M., & Pattberg, P. (2021). The United Nations Framework Convention on Climate Change Secretariat as an orchestrator in global climate policymaking. *International Review of Administrative Sciences*, 87(1), 21-38.

Table 18: Climate hazards, impacts, and climate resilient practices for tree fruit<sup>113</sup>

VALUE CHAIN STEP	CLIMATE HAZARD	CLIMATE IMPACTS	IMPLEMENTED PRACTICES	ADAPTATION RECOMMENDATIONS
Input supply	Droughts / reduced moisture	Delayed access to agricultural inputs; challenges to digging holes due to soil pan for land preparation	Application of manure and inorganic fertilizers to increase soil moisture during dry spells. Use of early warning systems	Application of organic matter as mulch to conserve soil moisture and protect seeds and seedlings; improve mechanized and early land preparation; integrate irrigation systems and water purification
	Change in seasons (onset and length)	Increased wilting; delayed access to inputs; increased storage costs for inputs	Use of manual irrigation techniques (water buckets and watering cans)	Application of organic matter as mulch to conserve soil moisture and protect seeds and seedlings; mechanized and timely land preparation according to agro-meteorological information and advisory
	strong winds, heavy rainfall, and hailstorms	Loss of topsoil and nutrients, increased demand for fertilizers/manure; damage to suckers; nutrient leaching; water logging and limits to planting holes and manure application	Use of net shed in nurseries, covering of manure with nylon	Use of net sheds, green-grey infrastructure to prevent runoff
Production	Droughts / reduced moisture	Reduced quantity and size of fruits; delays in planting after the dry spell; increased vulnerability to pests and diseases	Manual irrigation techniques (water buckets and watering cans). minimum tillage, use of tissue culture planting materials; intercropping practices to maintain water content	Introduction of early maturing, drought- and pest-tolerant varieties such as purple banana. Promote crop diversification with poultry. Use of low-cost irrigation systems such as drip, flood, and sprinkler irrigation; use of water and soil moisture conservation practices (e.g., pits, mulching, minimum tillage); cover bananas while on the tree; removal of excess shoots to reduce water competition

<sup>113</sup>. Climate Risk Profile for Kericho County. Kenya County Climate Risk Profile Series. The Ministry of Agriculture, Livestock and Fisheries (MoALF), Nairobi, Kenya.

	<b>Change in seasons (onset and length)</b>	Increased soil pans and challenges to land preparation; reduced soil moisture, delayed planting, and weeding	Delayed land preparation and planting	Introduction of early maturing varieties
	<b>Strong winds, heavy rainfall, and hailstorms</b>	Delays in planting and manure decomposition; rotting of bananas, water logging, water-borne pests, and diseases; damage to trees	Optimization of planting dates, shifting cropping areas; construction of collection and grading points; use of packaging and crates; solar drying and refrigeration practices; cover bunches with banana leaves to protect from scorching	Introduction of wind lodging-resistant varieties. Agroforestry practices with grevilleas plantation; climate risk-based crop insurance; optimization of drilling pits and planting; construction of dams and canals; use of packaging and crates; solar drying and refrigeration practices; cover bunches with banana leaves to protect from scorching
<b>Harvesting, storage, and processing</b>	<b>Droughts / reduced moisture</b>	Reduced quantity and quality of products; increased food spoilage and post-harvest losses; higher transportation costs; rapid ripening of bananas	Manual conservation techniques to preserve food quality and reduce spoilage (e.g., spraying water on harvested products)	Improved cold storage facilities and use of moisture and relative humidity monitoring systems; increase support by cooperatives to promote storage in common facilities; increase de-handling and processing practices (drying, frying) for value addition
	<b>Change in seasons (onset and length)</b>	Product spoilage due to changes in relative humidity during storage	Harvest crop early in the morning and bring products directly to storage and conservation facilities	Strengthen climate-proofed packaging and storage facilities for farmers to wait for better market prices while preserving shelf-life; use moisture and relative humidity monitoring systems; increase support by cooperatives to promote storage in common facilities
	<b>Strong winds, heavy rainfall, and hailstorms</b>	Rapid ripening of fruits, reduced quality; damage to storage, processing, and transportation facilities; need for premature harvesting	use of ripening chambers	use of ripening chambers; improve water harvesting practices and technologies

<b>Markets</b>	<b>Droughts / reduced moisture</b>	Rapid fruit ripening and spoilage during transportation; reduced quality and quantity of final products at market; changes in food prices; irregular, low supply, and income for producers	Diversification of market opportunities. sell produce locally to avoid post-harvest losses although at low prices	Improved storage, product preservation techniques, and transportation to reduce food spoilage; increase cooperatives' support to collect products and increase marketing opportunities
	<b>Change in seasons (onset and length)</b>	Irregular food supply, marketing opportunities, and income due to irregular seasons	Optimization of fruit transportation to markets before ripening; refrigeration to increase shelf-life	Link food production and marketing timing according to agro-meteorological information and market advisory; increase support by cooperatives to promote storage in common facilities
	<b>Heavy rainfall and hailstorms</b>	Damage to market facilities, impediments to accessing markets; reduced shelf-life at markets and quality for sorting; reduced prices	Incentives for consumers to buy ripened fruits	Improved market infrastructure with shelter; increase farmers' coordination on prices and volumes at markets through cooperatives; optimize transportation timing to markets according to weather advisory; policy support for climate-resilient market regulation

### Electricity use

Specific information on electricity used in the studied fruit value chain is not available. Lack of electricity and poor access to modern and affordable energy services on farms, reduce the area of land under irrigation. Total monthly electricity consumption is positively and moderately correlated with fruit prices. For fruit like mango, coolers use evaporative cooling to keep temperatures at or below 12°C, to slow the ripening process. The most common coolers in the market are evaporative charcoal and zero-energy brick coolers.

the figure below illustrates the value of fuel and power used in Kenyan agriculture from 2016-2019. The data, however, is not specific to the horticulture or the selected analyzed fruits. It will just give an overview of the fuel and power used.

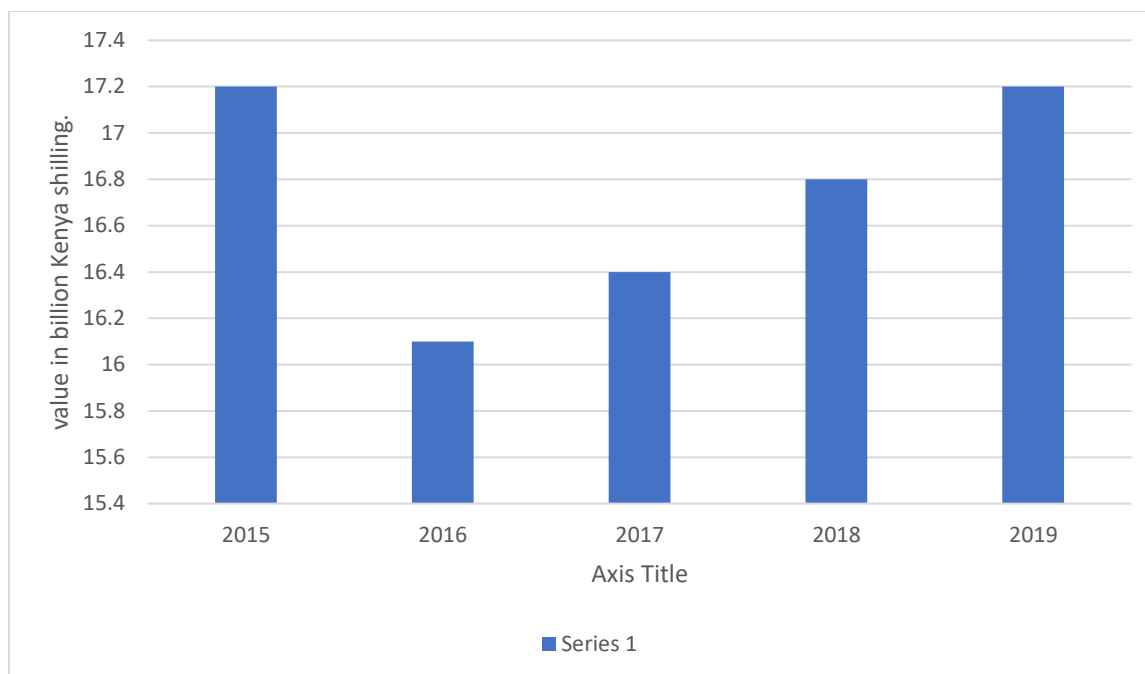


Figure 6: Value of fuel and power consumed in agriculture in Kenya 2016-2020

### Renewable energy

The capital investment costs of renewable energy technologies continue to decrease while access to energy services in Sub-Saharan Africa severely lacking in many rural areas. On renewable energy, solar drying is one of the earliest technologies used to remove moisture and preserve fruits e.g., mango to prolong shelf life. Well-dried mangos are golden brown, and different varieties of mango have different drying requirements. Solar-drying techniques range from simple plastic tunnel dryers to stainless steel cabinet dryers. Drying is easy because of the favorable conditions of periods of sunshine, temperature, and relative humidity.

### GHG

Greenhouse gas emissions come from a variety of sources throughout the production chain, including farm operations, packinghouses, importers, and retailers. Slightly more than 50% of all emissions come from the production of fruits (Mango, banana, citrus, avocado and passion fruit) while 42% come from packing emissions together contributing more than 92% of total emissions to the mango value chain. The use of fossil fuels, the use of refrigerants in packinghouse cooling equipment, the energy required to produce agrochemicals and fertilizers, employee business travel on commercial aircraft, and emissions related to transportation were all included in the emissions. The use of agrochemicals (including fertilizers) and the transport of fruits together account for approximately 60% of the industry's greenhouse gas emissions<sup>114</sup>.

#### 3.3.3 Water footprint

Average water usage to produce mangos appears to be at the high end compared to other produce. Research shows that mangos use 1,000 liters of water per 1 kg mango on average, while other crops use substantially less water (oranges use 330 liters/kg; passion fruit satisfactorily with an annual rainfall of between 800 to 1750 mm, well distributed

<sup>114</sup> Dora, M., Biswas, S., Choudhary, S., Nayak, R., & Irani, Z. (2021). A system-wide interdisciplinary conceptual framework for food loss and waste mitigation strategies in the supply chain. *Industrial Marketing Management*, 93, 492-508.

throughout the growing season. Passion fruits of all varieties require well-distributed rainfall of 900 mm to 2,000 mm per year. On average, about 283 litres of applied water are required to produce a kilogram of avocados. Excess rainfall causes poor fruit set and encourages diseases. The total water requirement of banana plants is about 900-1200 mm for their entire life cycle, and this can be met both through natural precipitation (rainfall) as well as supplementary irrigation.

Water storage facilities vary in size and shape. The construction of a water storage facility involves many steps taken care of to ensure it is operational and meets all safety standards. Water may be harvested from roofs and ground surfaces as well as from intermittent or ephemeral watercourses. Water harvesting and storage enable farmers to store water so that it is available during periods of water scarcity. Water-saving methods like mulches prevent soil crusting, act as barriers against the loss of moisture from the soil and protects the soil surface from the impact of raindrops, thereby enhancing water infiltration.

### **3.3.4 Biodiversity and ecosystems**

Biodiversity in plants, cultivated crops, and particularly in horticultural crops, is a gift of nature that underpins sustainability, nutritional security, and above all a diversified food basket. Together with natural resources overall, biodiversity in fruits production is the key to crop and dietary diversification, and indeed human well-being and survival.

Genes for desirable traits are embedded in biodiversity and as such crop genetic diversity has a critical role to play in increasing and sustaining production levels and nutritional diversity throughout the full range of different agro ecological conditions. In addition, natural pollination for fruits remains important to sustaining the diversity of farmers' varieties that are adapted to the local environment and to climate changes<sup>115</sup>.

Sustainability regarding biodiversity and ecology in the fruit industry focuses on issues like habitat protection, balancing production with conservation efforts, protecting native vegetation and wildlife, pest control, and managing soil. Industries that embrace continued natural biodiversity in the regions where they raise their crops show that they are forward-thinking in their approaches and indicate that they have a long-term view of the success of their industry. Fruits value chain conserve biodiversity and ecosystem in the following ways; creating natural buffer zones approximately 5 meters in width lining all borders of orchards, including fence lines and waterways, that connect native vegetation patches inside and outside the orchard, use integrated pest management to control pests, using biological agents, native species, and chemical solutions to specifically target pests and preservation of native pollinators (like bees) by conserving their habitat within and outside fruits orchards<sup>116</sup>.

Sustainable farming practices save on the usage of natural resources through efficient applications of inputs and the use of ecosystem farming approaches. Water harvesting and storage technologies are key interventions with the potential to contribute to rapid improvements in the yields of rainfed crops by holding water in a contained area for some time.

### **3.3.5 Toxicity/ pollution**

Growth causes a process called carbon sequestration or carbon uptake. The tree absorbs carbon dioxide from the environment. The waste generated from fruits is due to mechanical damage, spoilage during harvesting, culling, poor storage and distribution, process interruptions at the processing plants and grading, consumption, and over-ripening.

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<sup>115</sup> Litaladio, N., Burlingame, B., & Crews, J. (2010). Horticulture, biodiversity, and nutrition. *Journal of Food Composition and Analysis*, 23(6), 481.

<sup>116</sup> Krishnan, R., Agarwal, R., Bajada, C., & Arshinder, K. (2020). Redesigning a food supply chain for environmental sustainability—An analysis of resource use and recovery. *Journal of cleaner production*, 242, 118374.

Fruit waste has an impact to the environment it contributes to carbon footprint as it contributes to greenhouse gas emission. Fruits brings flies, rats, and general air pollution when they rot<sup>117</sup>.

Through the accumulation of nitrogen, organic matter, and microorganisms in the soil, which enhance soil structure and increase the soil's ability to hold water and nutrients, conservation agricultural methods also make it possible to restore damaged land to productive use.<sup>118</sup>.

### 3.3.6 Food loss and waste

Postharvest loss is one of the major problems along the fruit value chain. Production will grow and food security will be improved by reducing post-harvest loss without incurring any production costs. Fruit losses occur in the maturation, harvesting, pre-cooling, field storage, sorting and grading, packaging, loading/unloading, transportation and marketing stages. Inappropriate handling and lack of proper storage facility causes about 20% loss of the fruits purchased by retailers were lost before reaching consumer. Loss of fruit occurred along the value chain at the marketing, transporting, and harvesting stage.

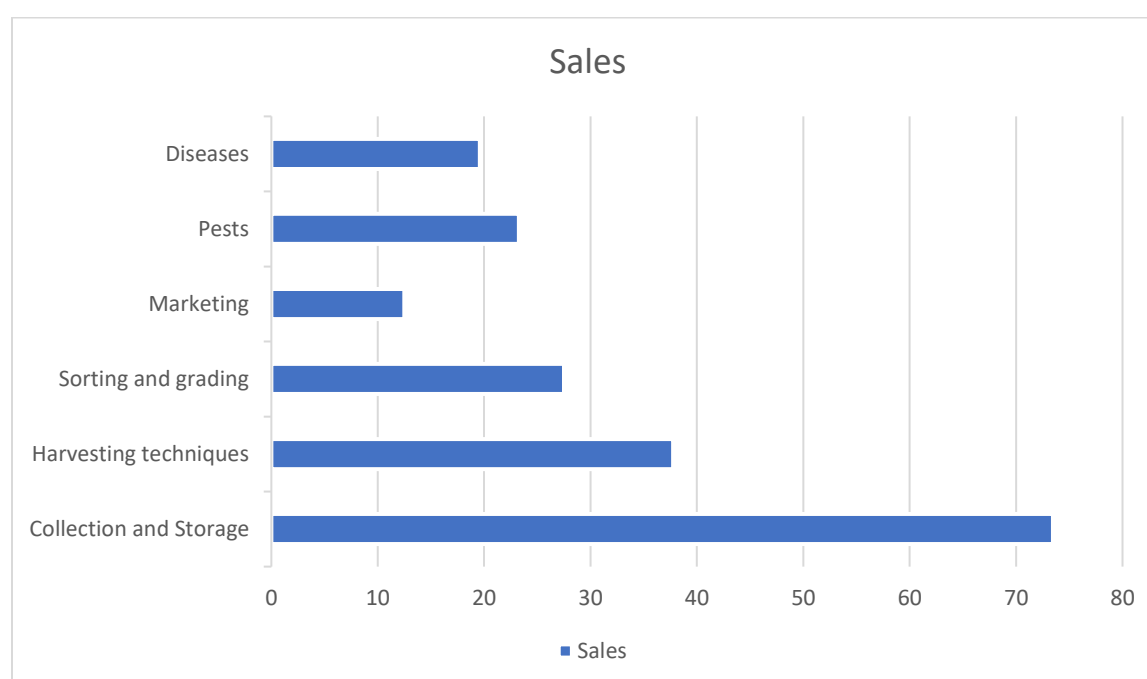


Figure 7: Driving factors for mango loss:

Source: Survey results by Fassa & Fasika

The above figure 12 on the drivers of mango loss can be replicated to the other fruits; banana, passion fruit and citrus since they share a lot in common. The loss might slightly vary on the other fruits but not so much.

This can be addressed by introducing improved varieties and distribution of seedlings for farmers on large scale; increasing availability of disease, insect, and pest control chemicals; modifying the existing harvesting, introducing blue

<sup>117</sup> Runyora, T. N. (2016). *Waste management practices in the fruit value chain development: The case of mango fruit in lower Eastern and Nairobi counties of Kenya* (Doctoral dissertation, University of Nairobi).

<sup>118</sup> FAO, 2012

sheet withstands; development of sorting and grading guidelines; introducing improved fruit harvesting, processing, storage machine/materials and strengthening cooperative marketing through value addition<sup>119</sup>.

### **3.3.7. Competitive advantages and weaknesses**

The fruit value chain concentrated on capabilities and strategies of quality, consistency, variety of products, processing levels, product combinations, packaging, reliability of supply, and price; other capabilities in the sector include quality, delivery dependability, product innovation and time to market

Competitive advantages include: First, Nairobi's location as a center of air transport to various destinations especially Europe; second, preferential treatment and agreement under the Lomé Convention between African Caribbean Pacific Countries. Third, sustained demand for fruits all year round. Fourth, Kenya's close cooperation with supermarkets and other market sources. Fifth, non-interference by government in the commercial transactions; sixth, economies of clustering which provides support in the coordination, market penetration, and market identity

Kenya benefits from a strategic geographical location and climatic conditions that favor year-round production an essential input in the horticulture sub-sector and one of the most significant factors in retaining a competitive advantage over the rest of the world. Kenya's diverse ecological zones allow for a wide range of horticultural crops to be produced including tropical crops (mangoes, citrus, avocado, bananas, French beans), temperate crops (apples, carrots, and snow peas), and crops such as aloe, which are best adapted to semi-arid areas. Kenya also experiences 12 hours of daylight all year round from the sun shining overhead, ideal to produce high-quality fruits<sup>120</sup>.

The growing rural population in Kenya is expected to exert huge pressure on land, and water resources. Today, arable land is being converted to housing estates, added to which already small plots of land in much of rural Kenya are being subdivided resulting in unsustainable plots only big enough to build a house for the family. The land policy may need to restrict the sub-division of agricultural land in the future if Kenya is to maintain its competitive advantage in export markets<sup>121</sup>.

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<sup>119</sup> Tarekegn, K., & Kelem, F. (2022). Assessment of Mango Post-Harvest Losses along Value Chain in the Gamo Zone, Southern Ethiopia. *International Journal of Fruit Science*, 22(1), 170-182.

<sup>120</sup> Karani, C., 2022 Capabilities required for competitive advantage in the supply chain management of horticultural produce research project [master; s dissertation]

<sup>121</sup> Kebede, Y., Baudron, F., Bianchi, F. J., & Tittonell, P. (2019). Drivers, farmers' responses and landscape consequences of smallholder farming systems changes in southern Ethiopia. *International Journal of Agricultural Sustainability*, 17(6), 383-400.



### 3.4 SWOT Analysis

Table 19: SWOT Analysis:

<p><b>Strength</b></p> <ul style="list-style-type: none"> <li>• -Export companies undertake contract farming and provide input and agronomic advice to their producers. <ul style="list-style-type: none"> <li>- Availability of subsidized fertilizer</li> <li>- Availability of grafted seedlings</li> </ul> </li> <li>• -Availability of fertile and productive land</li> <li>• -Favorable climatic conditions with reliable rains</li> <li>• -Availability of fresh, processing and export markets Increasing demand for juices</li> <li>• -Value chain with actors</li> <li>• -Production season advantage over competing countries in the Middle East market</li> <li>• -Diverse end markets for fruits reduce marketing risks.</li> <li>• -Fruits are important contribution to healthy diets (Vitamins/Minerals)</li> <li>• -Large number of women involved as they participate activities such as harvesting, sorting, and packaging.</li> </ul>	<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>• -Introduce new harvesting tools</li> <li>• -Demand is still growing for fruits in local and international markets.</li> <li>• -Because of export opportunity, there is political interest, making it easier to garner support from agencies</li> <li>• -Substantial installed processing capacity</li> <li>• -Growing domestic markets</li> <li>• -Value addition into other products</li> <li>• -Formation of producer groups for better marketing</li> <li>• -Export markets in Middle East</li> <li>• -Production of early maturing varieties for export markets</li> </ul>
<p><b>Weakness</b></p> <ul style="list-style-type: none"> <li>• -Few and untrained extension officers on the specific value chain</li> <li>• -High cost of inputs, including pesticides, fuel, fertilizer, and seedlings</li> <li>• -Price fluctuations and delayed payment by buyers</li> <li>• -Inadequate storage facilities Poor postharvest management and Good Agricultural Practices</li> <li>• -High cost of aggregation</li> <li>• -Production of varieties in small, scattered quantities</li> <li>• -Lack of water for supplementary irrigation</li> <li>• -High postharvest losses</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>• -Pest and diseases affecting the yield.</li> <li>• -Access to knowledge for smallholders on the fruit value chain is not well organized. <ul style="list-style-type: none"> <li>- Difficult to meet market standards and certification with high-cost implication</li> </ul> </li> <li>• -Rapidly declining soil fertility</li> <li>• -High and escalating cost of inputs</li> <li>• -Unpredictable weather patterns/ Climate change</li> <li>• -High prevalence of pests and diseases</li> <li>• -Competition of cheap fresh fruits imports in Kenya's mango export destinations.</li> <li>• -Competition from cheap imported juice concentrate</li> </ul>

- Own conceptualization.

## **4 Recommendations**

### **4.1 Key recommendation for value chain improvement**

#### **Temperature-controlled storage**

Also referred as climate-controlled storage, specially designed to maintain steady temperatures and humidity levels. Typically, the temperature will remain stagnant at between 55 degrees and 85 degrees Fahrenheit. Managing the cooling, humidity, heat, and airflow are critical to ensuring the long-term storage of fruits. With Kenya's plan to increase export market, temperature-controlled storage infrastructure become even more important. This offers increased opportunities for value addition on Kenyan soil. Investments range from EUR 22,000 (including taxes and imports) for a solar-powered, mobile container up to EUR 60 million for an industrial-sized, multi-purpose warehouse.

#### **cold chain solutions**

Fruits are highly perishable and have less shelf-life. During the peak harvesting period the market gluts reduce prices of fruit. It is a commercial facility that stores perishable goods such as fruits, for longer periods of time under regulated conditions. Cold storage facilities are crucial for maintaining produce quality, prolonging product shelf life, and minimizing traffic jams during peak production. It aids in providing farmers with fair compensation while making farm products easily accessible to consumers in good condition at reasonable and aggressive prices. Locations for cold storage should be kept close to consumer hubs or agricultural production facilities.

#### **Funding the grower schemes**

The declines in smallholders supply linked to the concerns of supermarket buyers about issues such as consistency of product characteristics and product quality, maximum residue levels for pesticides and social and environmental issues such as child labor and handling and use of pesticides. While these problems can be overcome through grower schemes, the schemes become increasingly expensive as the levels of traceability, monitoring and verification increase.

Realizing the value-addition potential of crops through better farmers' organizations, extension services, and research and development support.

Investment in and encouragement of irrigation farming, this will help to increase agricultural productivity and improve resilience to climate change risks. Climate change has made rain-fed agriculture less reliant.

Because fruit value chains require economies of scale, the right balance between promoting smallholders and developing large-scale and capital-intensive farms is paramount for competitiveness.

Strengthening the environmental sustainability of horticulture production. Sustainable horticultural practices may reduce production input, reduce environmental impact, increase resource use efficiency, and improve water body and soil biodiversity.

Interventions are needed at marketing level to provide incentives for smallholders to invest in seed and other inputs that would increase their productivity.

Organization to work with credit agencies to develop financial products that are accessible by smallholder fruit growers. Fruit like mango and avocado provide high annual returns but require investment and a long start-up period of five years. This would give more farmers incentive to invest and maintain the fruits.

Develop the basic business and accounting skills of farmers and training farmers on how to 'farm as a business' by using the available market information to make informed decisions (e.g., crop selection) and maximize their final selling price.

Improving competition in the input and transportation sectors.

#### **4.2 Key recommendation for value chain development actors**

For the domestic market of fruits, the investment conditions will be different. Although post-harvest losses can be cut by as much as 50% a much more integrated sector approach is required to make that happen. This includes the collaboration of private and public partners to jointly build a conducive environment for private sector investments across the entire value chain. Such initiatives could include groups of farmers improving the yield and quality of production, a transport and trade segment with improved market information system, a commercially run processing facility, an integrated cold storage chain at the different levels of production including refrigerated transport, all input suppliers from nurseries to packaging, and agro-finance institutions.

More linkages established between nursery operators and fruit farmers; these would solve the issues of farmers buying seedlings that are of poor quality from the sides.

Farmers have more information on different improved fruit varieties that are resistant to climate change pests and diseases and are high yielding.

Productivity, standards compliance, and technology use. Use of growth regulators, grafting, drip irrigation for water economy, tissue culture will help increase productivity and curb the adverse climate hazards

The government should focus on increasing the number of paved roads, especially in rural areas where fruit farming takes place. This will help reduce wastage of fruits which translates to more incomes to farmers.

Encouraging farmers to try diverse ways to work together to supply large quantity products of produces and sharing the resulting profit (E.g., Market committees). They will be able to attract traders and institutional buyers and increase their negotiating power.

Input suppliers and farmers have more information on approved agrochemicals. Effective agro-chemicals will protect crops from pests, diseases and weeds as well as raising productivity. Inappropriate and excessive agrochemical use contaminated air, water and soil, degraded land, soils, and increased greenhouse gas emissions.

More collection center established. Collection centers are a location where farmers take their produce for selling to the local and regional markets, through traders. They serve as a central point, which brings together the most important value chain actors like farmers, traders and transporters. Collection centers bring together many buyers; this is a leverage to farmers because they are sure to sell their products, offering favorable prices, market information, and security of farmer's stocks.

Farmers trained and adopting new national standards, there have been stiff competition from world markets and farmers must produce quality fruits. Meeting the international requirements have benefits to the farmer since it translated to increased income.