A close-up photograph of several ripe mangoes in a white bowl with a red rim. The mangoes are yellow and green, and the background is a blurred pattern of blue and white.

Unlocking the Kenyan mango value chain

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SECOND YEAR POLICY ANALYSIS

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Acknowledgments

This project came to life in the summer of 2021 when we interned at agricultural organizations in Kenya. During those months, we spent our weekends remarking our observations of life in rural Kenya, particularly the complex and collaborative relationships that farmers had not only with one another, but also with other stakeholders in the village. In a similar fashion, it has taken a village to bring this project to fruition, and we have benefited from the support of experts and colleagues that provided knowledge, direction, and camaraderie.

We are deeply grateful to Professors Jie Bai, Michael Walton, Dani Rodrik and Matt Andrews of the Harvard Kennedy School of Government for their guidance and advice during the writing of this work. We would also like to thank our colleagues in the MPA/ID program for their assistance and constructive feedback.

Additionally, we are indebted to the many experts who generously offered their time to help us understand the structure of the mango industry in Kenya and the global mango value chain. In particular, we want to thank Mr. Saif Ahmed, Mr. Nima Bahramalian, Mr. Peter Johnson, Mr. Duy Duc Nguyen, Ms. Betty Kibaara, Ms. Rita Kimani, Mr. Patrick McMullin, Mr. Rajiv Jandu, Mr. Chris Mitchell, and Ms. Amandla Ooko-Ombaka, for providing their insights and institutional knowledge to the creation of this work.

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Executive Summary

The mango industry in Kenya presents a unique opportunity for the country's agriculture sector. The global export market for mangoes is large (at more than \$3.6 billion) and growing rapidly (at more than 10% p.a.). A variety of value-added processed mango products – such as dried mango and mango pulp – can transform and industrialize agriculture-based economies like Kenya's. In theory, the country is well positioned to take on these opportunities; domestic producers can grow the fruit at higher yields than global and regional benchmarks, and the growing season in the country coincides with months of the year when other international producers lack supply. However, these opportunities are currently not being realized by Kenyan producers.

Mango production in the country is highly disaggregated. Smallholders are responsible for the majority of current production, with little to no value-added processing capacity in-country to produce more lucrative products. Only 4-5% of production is exported, almost exclusively to the Middle East instead of higher value markets like Europe or the United States.

Our analysis identifies five key constraints that Kenyan producers face in accessing the potential value the industry offers: 1) a mismatch between the product type and quality that export markets demand vs. domestic producers supply; 2) poor domestic infrastructure and storage leading to insufficient aggregation; 3) political barriers between counties increasing costs of aggregation; 4) limited capacity to process fruits, and 5) export barriers that create matching frictions with international buyers. These barriers affect all steps of the mango value chain, representing a classic coordination failure where no one party has the incentive to make the necessary improvements to upgrade the mango industry.

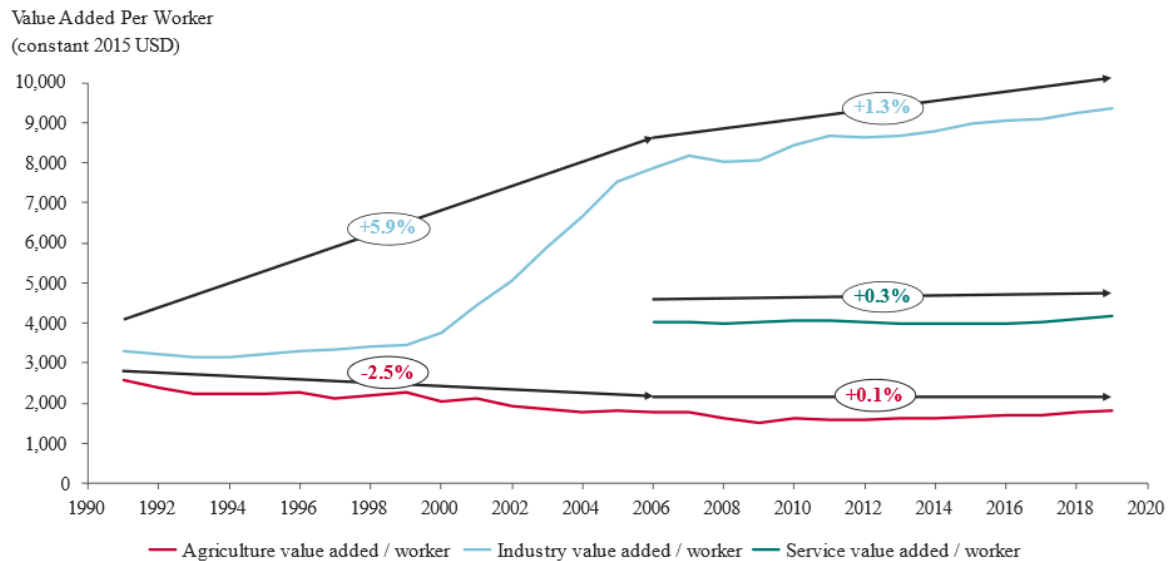
To address these challenges, we recommend a package of policy solutions that collectively provide the “big push” the industry needs. These include: helping processors obtain phytosanitary certifications, enhancing domestic agro-processing capabilities, and reducing financial constraints for industry players. Together, these policy solutions are expected to generate an additional Ksh 7 billion in value for the mango industry, but this will also require additional investments of Ksh 1 to 4 billion. The net benefits of these programs are estimated to increase the size of the domestic mango industry by up to 23%. More importantly, these interventions could lead to the development of a modern and industrialized mango sector, the successes of which may be replicated for other tropical fruits and agricultural products.

I. Introduction

Agriculture plays a critical role in the Kenyan economy, accounting for 23% of GDP, 53% of employment and 30% of exports.¹ Almost 50% of Kenyan land is used for agriculture, dominated by horticulture and cash crops (e.g., cereals such as maize), and the sector is a significant source of income for poor households.² Furthermore, agriculture employment as a share of total employment is growing, while employment in services remains stagnant and employment in industry is shrinking.³

Kenya's agricultural productivity is low relative both to other Kenyan sectors and to global standards, and has been decreasing over time. Relative to other sectors, agriculture value added per worker is significantly lower than industry or services and barely growing (Figure 1). In terms of land, Kenya has low agricultural yield relative to the world in key staple crops (e.g., maize, cereal, rice) although slightly higher than African averages in most categories. Notably, it has higher than world average productivity in fresh fruits (Figure 2).

Figure 1: Kenyan value-added per worker by industry, 1991-2019



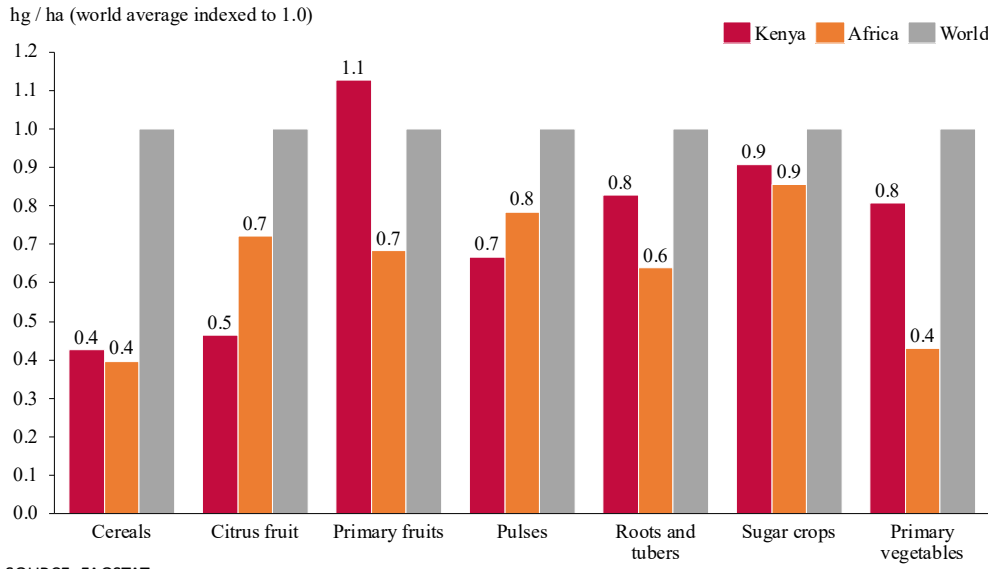
SOURCE: World Bank, World Development Indicators 2022

¹ World Bank Data 2020; GDP was 98.84B USD in 2020

² World Bank Data 2020

³ Statista data 2020

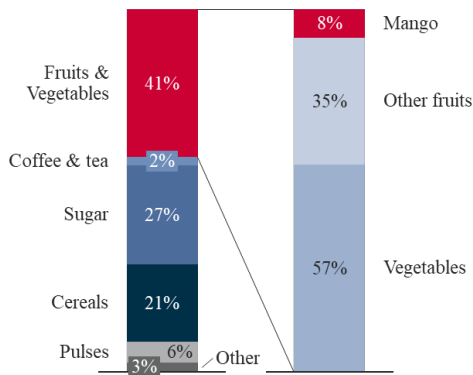
Figure 2: Yield of agricultural products by region, 2019 (hg/ha, world average indexed to 1.0)



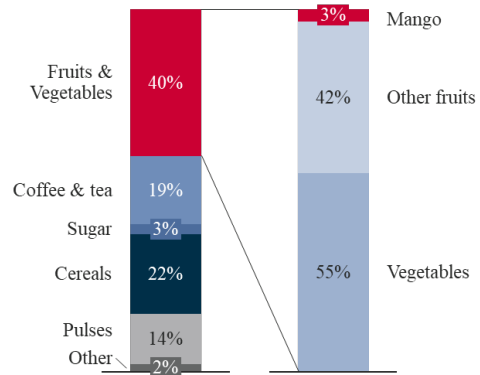
Fresh fruits and vegetables account for ~40% of Kenyan agricultural production by volume, production value, and export value; within fruits and vegetables, mango is a significant contributor, accounting for ~8% of production by volume but only ~3% of production value (Figure 3).⁴ Furthermore, Kenya has higher than global average yield in mango, indicating there is a potential comparative advantage (Figure 10).

Figure 3: Kenyan agricultural output and production value by type, 2015-2019⁵

Panel A:
2015-2019 Total Production
(tonnes)



Panel B:
2015-2019 Gross Production Value
(constant 2014-2016 thousand US\$)



SOURCE: FAO

⁴ UN Comtrade data

⁵ Note that mango production data from FAO and UN Comtrade also includes production of mangosteens and guavas, but Kenya produces and exports negligible quantities of the latter fruits

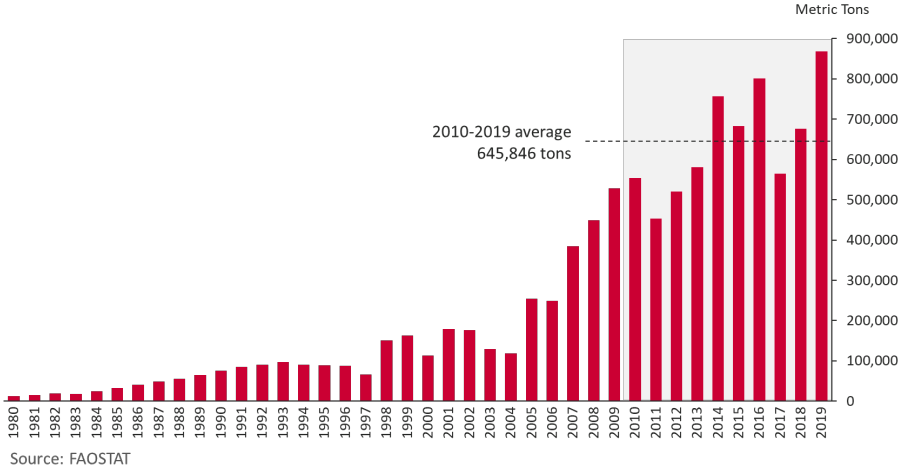
However, mango only accounts for <1% of export value (Figure 13)⁶ despite the large global export market for mango worth \$3.5B+, which includes higher value-added products such as dried mango, mango pulp, and single or mixed juices.⁷ Kenya only exports 4-5% of its production of fresh mango (worth 0.5% of global imports) and has almost no in-country value-added processing capacity.⁸

Cumulatively, this context underpins the key motivation of this paper: why have Kenyan mangoes not penetrated the global market and how can the industry’s value-added potential be unleashed to increase productivity in the Kenyan food system?

II. Context: The Kenyan mango industry

Kenya has produced ~650,000 metric tons of mango per year on average since 2010, generating an average of USD\$84.4M per year in gross production value (Figure 4).⁹ Production has increased rapidly since the mid-2000s, growing 9.2% per annum since 2005, correlating with an increase in mango exports (Figure 10). However, there is still significant scope for improvement, which will be explored throughout the rest of this paper.

Figure 4: Kenyan mango production, 1980-2019

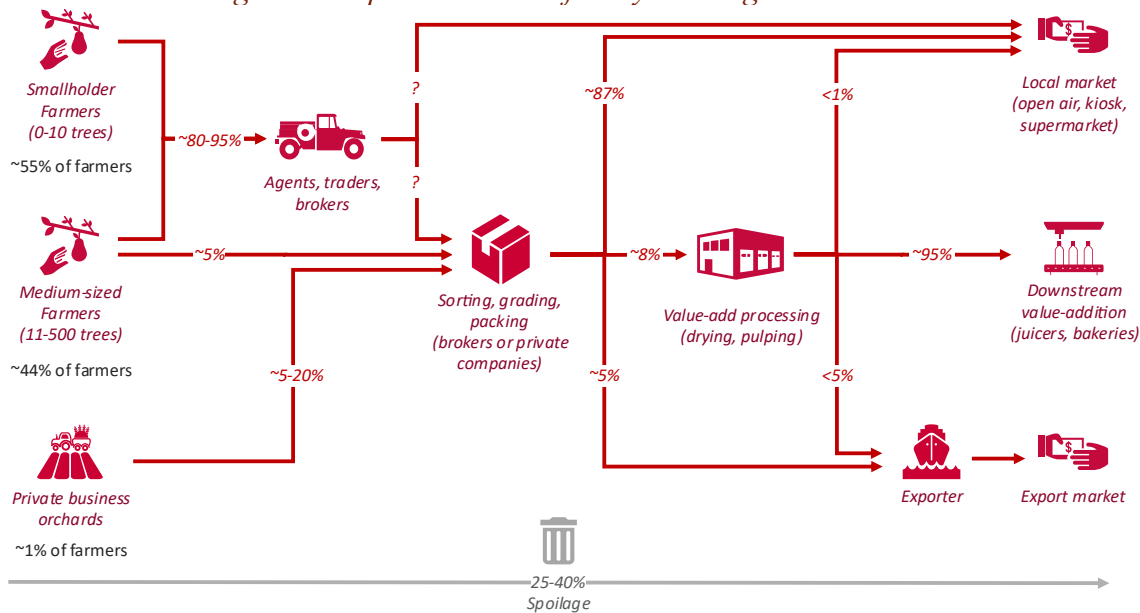


Mango production is concentrated among smallholder farmers with multiple crops and is geographically disaggregated, enabling intermediaries to capture significant margins rather than farmers and increasing losses along the value chain. Production of fresh mangoes

⁶ UN Comtrade data
⁷ FAOSTAT
⁸ BCG KCDMS 2021; FSD Kenya, 2015; Owuor 2015; ProFound 2018; YieldWise, 2021
⁹ FAOSTAT; Gross Production Value (constant 2014-2016 US\$)

is concentrated among smallholders, many of whom are in the Eastern and Coastal regions of the country, where climatic conditions are more favorable to production. Majority of smallholders cultivate multiple crop types to help smooth varying production cycles and variable income. Regardless of the region, smallholders are dependent on brokers to access markets; it is estimated that 80-95% of their production goes through middlemen (Figure 4). While farmer-broker relationships exist for many agricultural products in Kenya, mango farmers are particularly reliant on brokers – and thus vulnerable to asymmetric power in this relationship – due to the seasonality (leading to most trees bearing fruit in a short period) and sensitivity (leading to high risk of spoilage within a few days of harvest) of the mango. Farmers have limited capital investment in their plantations (most do not have irrigation systems on their farms) and receive little to no technical assistance, leading to insufficient transfer of knowledge regarding key topics like varieties to plant, extension of the growing season of the mango tree, or negotiation with buyers.¹⁰ Some farmers are engaged with local cooperatives to assist in production and marketing, but the services provided by these organizing structures are heterogeneous across regions.

Figure 5: Representations of Kenyan mango value chain¹¹



Source: BCG & KCDMS, 2021; FSD Kenya, 2015; Kibaara, 2022; McMullin, 2022; Wuor 2015; FAOSTAT; ProFound 2018

¹⁰ Kenya National Bureau of Statistics (KNBS), 2020

¹¹ Note that the distribution of farmers and production can vary by region and county. This value chain presents an author-assessed average based on the variety of sources consulted and interviews conducted to provide a general sense of the flow. Please see Appendix 3 for region-specific composition.

Some larger scale orchards exist in the country, but they account for a minority of production and have developed only limited competitive advantages compared to the traditional model of producing mango. Smallholders (0-10 trees) account for ~55% of mango production in the country, with farmers operating mid-sized farms accounting for most of the remainder (Figure 5; Appendix 3). Large orchards owned by private businesses account for 5-20% of production that is often exported. From the farmgate, fresh mangos are transported to basic processing (sorting, grading, packing) or local markets by brokers. High quality fruit of certain varieties (usually Apple) is flagged for export and low-quality fruit is flagged for pulping. Of the pulped and dried production, most goes to local juicers and bakers and a small portion is exported. For exporters, sea freight is most common, followed by air freight. Finally, it is estimated that post-harvest losses are between 25-40%; the upper end of this range is significantly higher than most mango-producing countries, however, countries such as Vietnam and Thailand can report losses up to 25%.¹² Potential causes include poor pest management, harvesting and storage techniques, and limited cold chain from farmgate to at the market seller.¹³

Currently, segmentation of the mango value chain disproportionately advantages brokers, and reduces incentives to increase production or investment in processing capacity.

Smallholder farmers typically do not harvest at sufficient scale to fill entire trucks. As a result, brokers who buy from multiple farmers and handle logistics to the cities (where product is sold) are required and absorb much of the value in the chain. It is estimated that aggregators add only 8% of the total value in the mango industry but earn 22% gross margin in their handling (Figure 6). The overrepresentation of broker interests in the mango value chain points to not only the services brokers provide for producers, but also the economic power relatively few brokers in each county command in determining final prices. Corporations either source mangoes (directly or through a broker) or directly produce on their own farms. In both cases, it is common to see minimal levels of post-harvest processing before the product is either sold domestically or exported, although significant margins are present.

¹² Asia Pacific Mango Network 2020

¹³ BCG KCDMS 2021; FSD Kenya, 2015; Owuor 2015; ProFound 2018; YieldWise, 2021

Figure 6: Estimated cost and gross margins of mango value chain actors

	Producer	Assembler/ aggregator	Wholesaler	Retailer	Processor	Exporter
Purchase price (Ksh / kg)	0	18	24	42	13	36
Additional costs (Ksh / kg)	2.30	1	12	15	4	76
Total cost (Ksh / kg)	2.30	19	32	57	17	112
Selling price (Ksh / kg)	18	24	42	75	36	151
Gross margin (Ksh / kg)	16	5	10	18	18	39
Gross margin (%)	87%	22%	22%	24%	51%	26%
Value added (Ksh / kg)	16	6	18	33	23	115
Value added as a percent of total value chain (%)	22%	8%	25%	45%	68%	77%

Source: BCG KCDMS, 2021

Most mango production is sold domestically, and there is virtually no processing capacity.

Brokers are responsible to sell to packhouses, urban markets, and supermarkets in the cities.

Typically, the highest quality product is sold to exporters and high-end grocers; it is estimated that a total of 4-5% of mango volume is exported, with the remainder being sold and consumed domestically.¹⁴ Processing capacity and infrastructure is extremely limited, with only seven major processing plants processing ~8% of total mango production.¹⁵

Of the diverse stakeholder group involved in the mango value chain, brokers, national and county-level administration, and regulators have played the largest roles in its development (detailed breakdown of all actors in Appendix 1). Brokers are still the core group responsible for mango distribution to markets and to the few processors and exporters. National bodies such as the Ministry of Agriculture, Livestock, Fisheries, and Cooperatives (MOALFC) and the Ministry of Industrialization, Trade and Enterprise Development (MoITED) set national strategic priorities and allocate budget for agricultural development. Regulatory bodies such as the Kenya Plant Health Inspectorate Services (KEPHIS) have heavily impacted the export opportunities with a ban placed on mango exports to Europe to rein in significant fruit fly outbreaks. Finally, county-level administration in productive regions (e.g., Eastern, Coast) provide funding for and implement specific projects, such as county-level processing facilities.

The rest of this paper will focus on the value chains that directly affect smallholder and mid-sized mango farmers. Given that these producers control a vast majority of mango

¹⁴ International Trade Centre, 2014

¹⁵ BCG USAID KCDMS, 2021; FSD Kenya, 2015

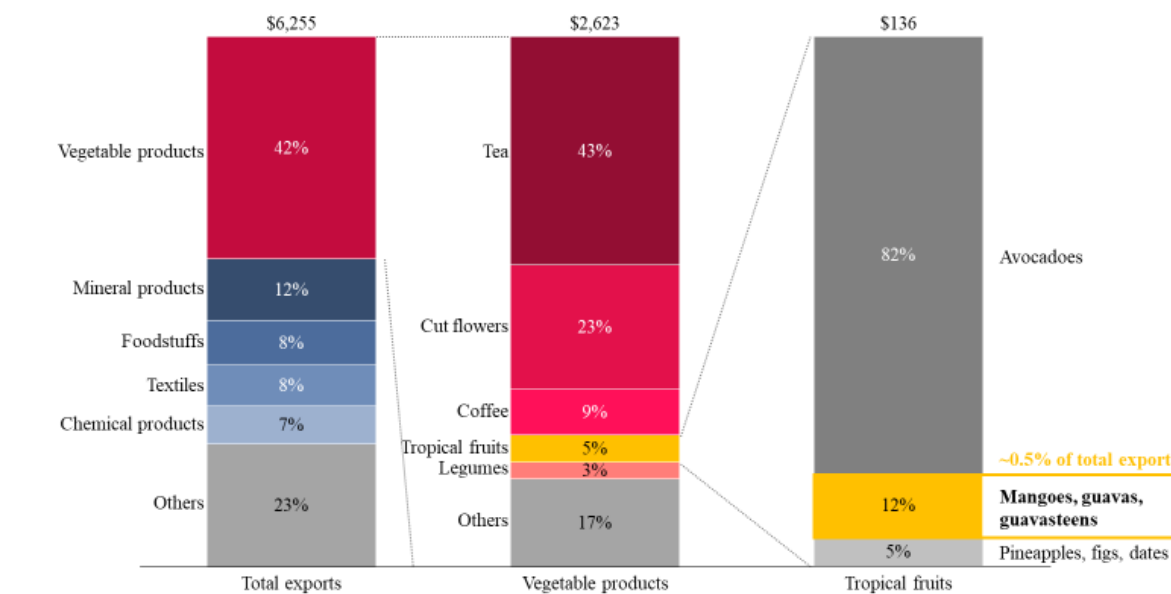
production in the country, they are most exposed to risks and challenges that currently exist in the Kenyan mango industry.

III. Opportunities for growth in the Kenyan mango industry

Kenya’s agricultural production is split across multiple product groups, with staples and sugars accounting for a large share of total volume. Crops like sugar cane and maize account for 15-25% of total agricultural product, but fresh fruits and vegetables are also significant contributors (Figure 3). Within the fresh fruits and vegetables categories, bananas, cabbages, mangoes, and tomatoes collectively account for 15% of volume.¹⁶

However, the set of significant agricultural product categories shift dramatically when considering trade value. Vegetable products account for 42% of Kenyan exports, and, within this category, tea, coffee, and cut flowers account for more than 75% of exports (Figure 7). Notably, these are largely export-oriented categories with high market value outside of Kenya. Although Kenya is a large producer of tropical fruits like mangoes, its exports of these fruits are less significant due to high domestic consumption and low outward orientation of the products.

Figure 7: Kenyan exports by product category, 2019 (USD M)



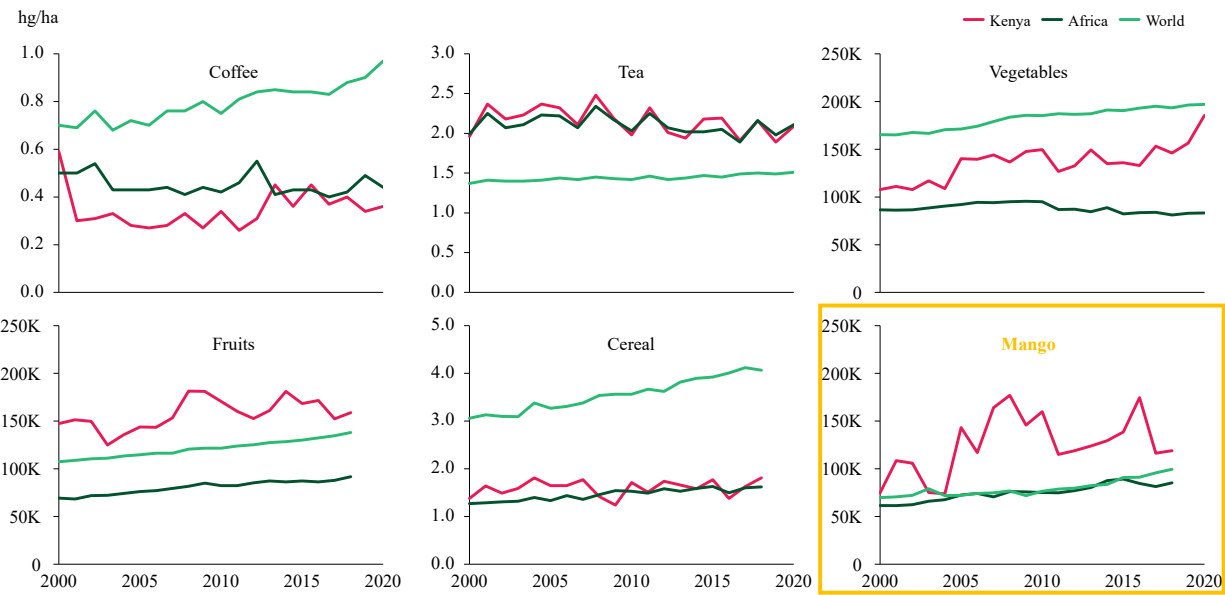
Kenya’s competitive advantage among agricultural products lies in mangoes. Despite the country’s large market share in products like coffee, the country lags global and regional peers in

¹⁶ FAO

terms of agricultural productivity (Figure 8). A similar story persists in certain fresh produce and staple categories, with Kenya performing at or below global benchmarks. However, when looking at fruits, and more specifically mangoes, mangosteens, and guavas, Kenyan farmers consistently outperform most of the top mango exporting countries and can produce fresh mangoes more efficiently than global benchmarks.

Given Kenyan farmers’ high productivity in fresh mangoes and the small contribution they currently have to the country’s exports, we hypothesize that the product category and adjacent industries present an important opportunity for value addition in Kenyan agriculture. Fresh mango, which account for most Kenyan mango products, is only one of multiple end products that are consumed and exported globally; countries like Thailand, Vietnam, and the Philippines, which have invested heavily in fruit processing industries, have also become significant exporters of dried mango, mango puree, mango juice, and more (See Box 1).

Figure 8: Agricultural yield by product and regional benchmark, 2000-2018 (hg/ha)



SOURCE: FAO

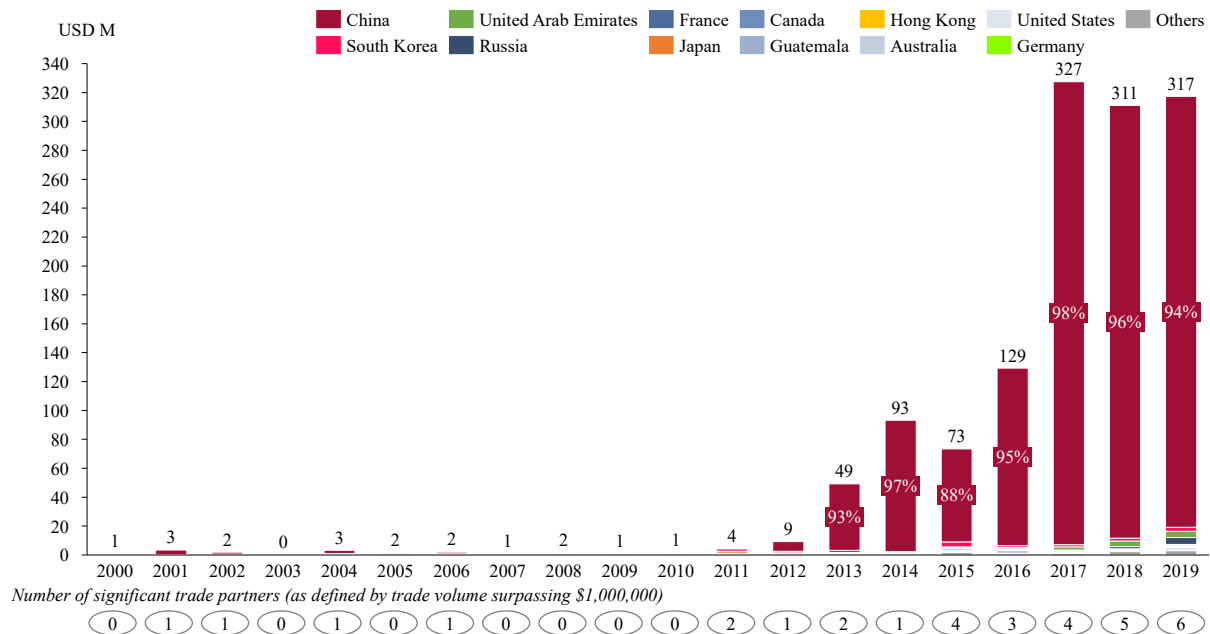
BOX 1: Vietnam’s growth as a mango exporter

The Vietnamese mango industry provides a view of what success might look like in Kenya. The structure of the mango value chains in both countries is similar, with smallholders accounting for much of the upstream production, brokers facilitating marketing and sales of fresh mangoes to packhouses and large purchasers. While the region around the Mekong River Delta accounts

for most of the production, actual farms are small and scattered across the region. Post-harvest losses are estimated at 15-25% of total production, lower than similar estimates for Kenya but still significant. Around 10% of production is estimated to be processed into value-added products like dried and frozen mango.¹⁷

Beginning in 2010, the Vietnamese government took two approaches to growing the domestic mango industry. First, fresh fruits were identified as a key policy priority through 2018's Vietnam Government Fruit Priority Program. The program introduced a set of fiscal policy measures with the intention of boosting production of mango in the country, including tax incentives and subsidies for investors, producers, and exporters. These measures have helped to formalize the organizing mechanisms in the Vietnamese mango industry, with local agents playing a large role in producing and marketing (including provision of equipment and tools necessary for production), local packhouses providing primary processing functions (including grading, washing, and packing), processors taking in products of adequate maturity and grade for drying. Importantly, enabling functions like financial teams and logistics infrastructure are critical to supporting this value chain. The results of these efforts have led to Vietnam becoming one of the top three global exporters of fresh and dried mango and one of the largest mango growers in the world.

Figure 9: Vietnam mango, mangosteen, and guava export value by destination, 2000-2019



SOURCE: UN Comtrade

In addition to fiscal policies supporting domestic production, the Vietnamese government employed trade policies to help farmers access larger markets. Vietnam signed the framework agreement to the ASEAN-China Free Trade Area, and in 2010 committed to decrease tariffs for the member countries on 90% of products. Since then, Vietnam's exports of mangoes have increased exponentially. This growth can be almost solely attributed to trade with China; Vietnam's mango export value to China in 2019 was more than \$298 million, marking a

¹⁷ Bahramalian, Duc Nguyen, Johnson, 2022

~12,000-fold increase from ten years prior. In 2016-8, Vietnam accounted for 60-80% of Chinese mango imports; the other large exporter of mangoes to the country is Thailand. Apart from favorable trade terms, China is also a natural export destination for Vietnam due to their geographic proximity and shared border, making it easy for mangoes to be transported by road (reducing risks of mishandling and spoilage and decreasing costs). China now accounts for ~95% of mango exports (Figure 9). Still, the growth in Vietnamese exports is not credited to the Chinese market alone; Vietnam now exports more than USD\$1M per year worth of mangoes to at least 6 trade partners, signaling growing international demand for Vietnamese mangoes.

Approximately 9% of mango production in Vietnam is processed today. The varieties of fresh mango cultivated in Vietnam (e.g., Ben Cat, Elephant, and Siamese) are not well known outside of Asia; so far, this has not been a challenge for Vietnamese producers given the relative attractiveness of these products with Chinese consumers.

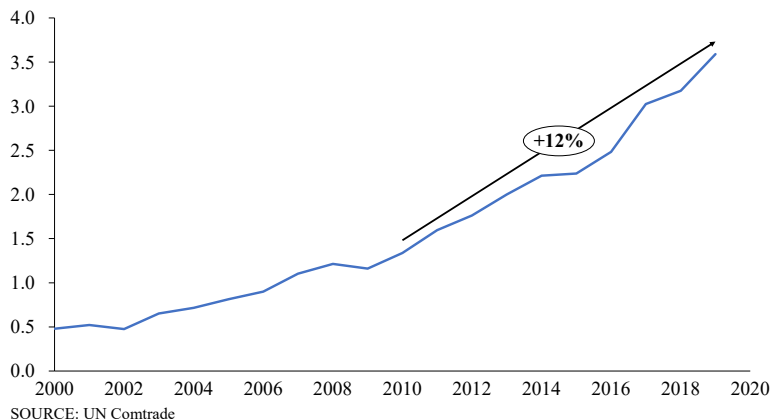
However, while trade with China has enabled growth of the domestic mango industry, it does not come without drawbacks. First, Chinese importers typically buy fresh mangoes from Vietnamese producers at low costs, repackage the produce, then re-export to higher value markets in Japan, Korea, and Europe, representing large potential value losses for Vietnamese producers. Second, while the Chinese market was demonstrably more attractive than others due to the minimal phytosanitary standards it imposed during early stages of the industry's development, importers are starting to require more stringent standards to be met for trade to continue. Finally, the overreliance on a single market is shown to create substantial risks for Vietnamese producers; in 2021, China significantly limited border crossings in an attempt to contain the spread of the COVID-19 virus. As a result, trucks carrying time-sensitive products like tropical fruits were stranded at the border for more than a month, leading much of the produce to go to waste.

For these reasons, the Vietnamese government has made it a priority to access other export markets in Japan, Korea, Australia, the US, and countries in Europe. Public workshops and forums have been organized to educate farmers on the phytosanitary standards they must adhere to meet foreign requirements. The government has also promoted investments in physical (e.g., vapor hot water treatment and irradiation to kill pests and diseases) and digital technology (e.g., mobile phone platforms for transparent tracing along the supply chain). In 2020, officials announced exemptions to income tax for activities related to agricultural cultivation.

Sources: “INSIGHT: Tax Incentives for Vietnam’s Agriculture Sector”, 2020; “Vietnam complains China’s border controls to stop coronavirus spreading are ‘overkill’”, 2022; “Vietnam truck jam as China tightens import rules for Covid”, 2022; “2018-21 ACIAR Improving smallholder farmer incomes through strategic market development in mango supply chains in southern Vietnam”, 2020

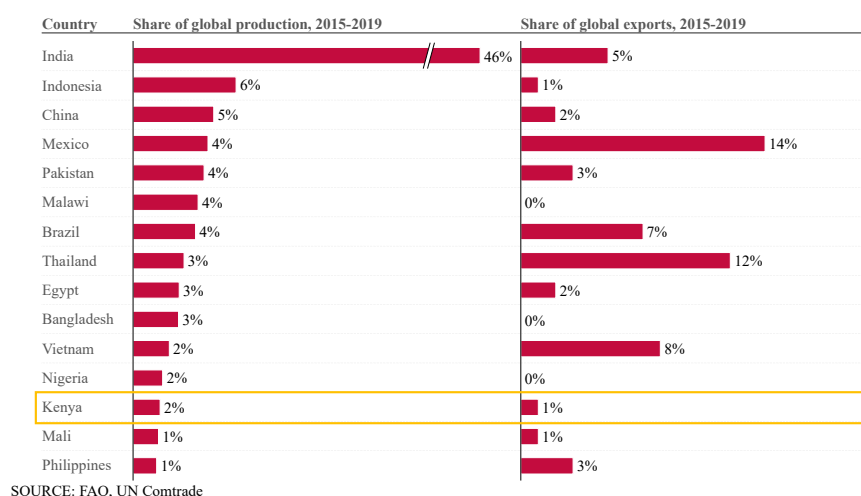
Although only 4-5% of Kenyan mango production reaches the export market, global trade of mango has increased significantly in recent years. Total exports of mangoes have increased more than 10% per year for the past ten years (Figure 10). Growth in the mango export market, in combination with a highly domestically focused mango industry, suggests that there could be significant value to be captured by reorientating the Kenyan mango sector toward exports.

Figure 10: Global export value of mangoes, mangosteens, and guavas, 2000-2019 (USD B)



Within the fresh and dried mango categories, Kenya is within the top 15 global producers. India accounts for the vast majority (>45%) of global production, but only 5% of exports (Figure 11). The top mango exporting countries are Mexico, Thailand, and Vietnam, which account for 14%, 12%, and 8% of global mango exports, respectively. Kenyan growers are responsible for 2% of global mango production, and 1% of mango exports.

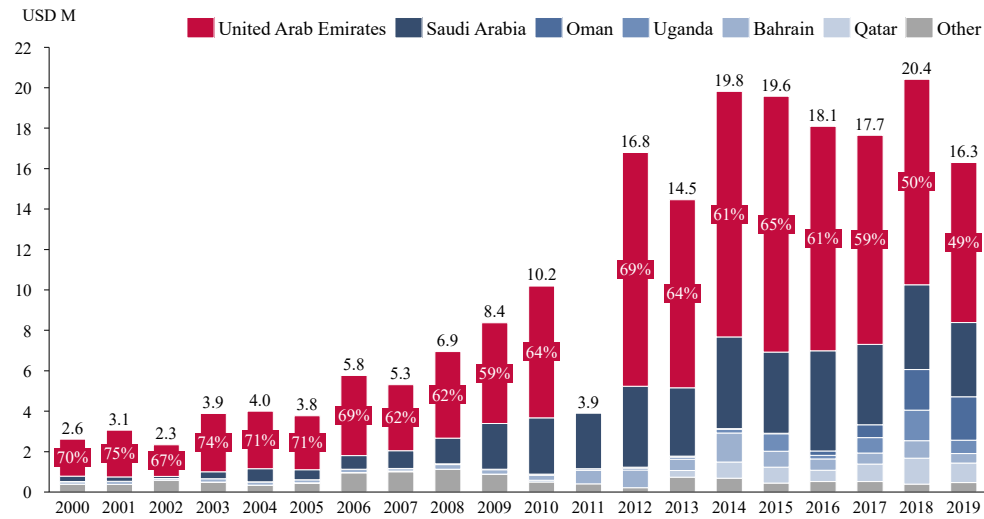
Figure 11: Share of global mango production and exports by country, 2015-9



Kenyan exports of fresh mango largely go to the Middle East. Currently, close to 50% of mango exports go to just one destination: the United Arab Emirates (Figure 12). Other Middle Eastern countries, like Saudi Arabia, Oman, and Qatar, also account for a large portion of Kenyan exports. In none of these Middle Eastern export destinations do Kenyan mangoes account for the country’s mango imports, signaling a low market presence for Kenyan producers, even in the countries where they export.¹⁸

¹⁸ UN Comtrade

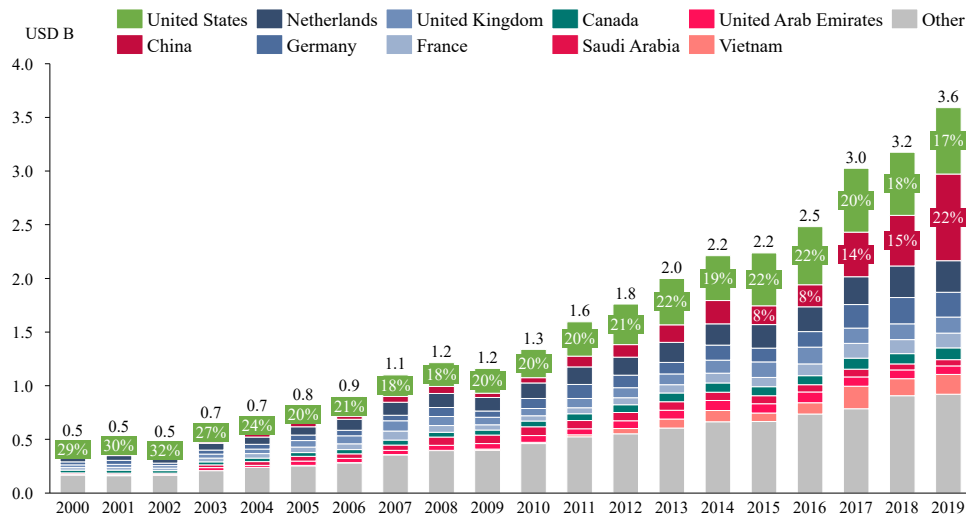
Figure 12: Kenyan mango export destinations, 2000-2019 (USD M)



SOURCE: UN Comtrade

Among the largest importers of mangoes, Kenya only exports with the United Arab Emirates and Saudi Arabia. Important import markets in the West (e.g. North America, Europe) do not currently import mangoes from Kenya (Figure 12, Figure 13). Potential reasons for Kenyan producers’ lacking presence in Western import markets are outlined in Chapter IV, and include misalignment between product type and quality, a self-imposed ban on mango exports, and a lack of phytosanitary certifications.

Figure 13: Major global importers of mangoes, 2000-2019 (USD B)

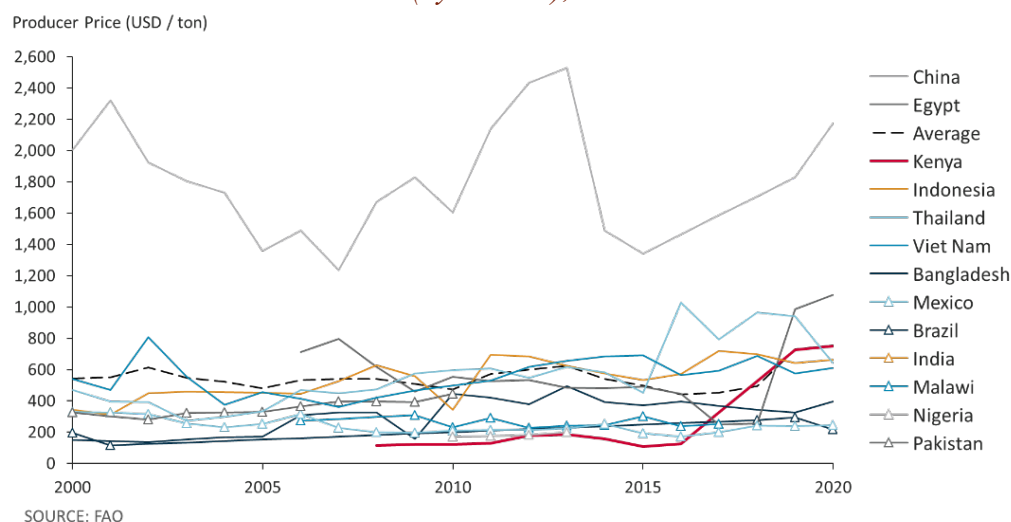


SOURCE: UN Comtrade

Although Kenya has been successful at cultivating more productive mango farms, it also faces significant operational and marketing challenges. Roughly 25-40% of mango

production in the country is lost post-harvest.¹⁹ Real prices for fresh mangoes are stagnant and significantly lower than other large global exporters in terms of USD / ton; despite these lower prices, Kenya is still only the 8th largest exporter of mango in the Africa region (Figure 14).

Figure 14: Average producer price per ton of mango in Kenya vs. 10 largest mango producing countries (by volume), 2000 – 2020



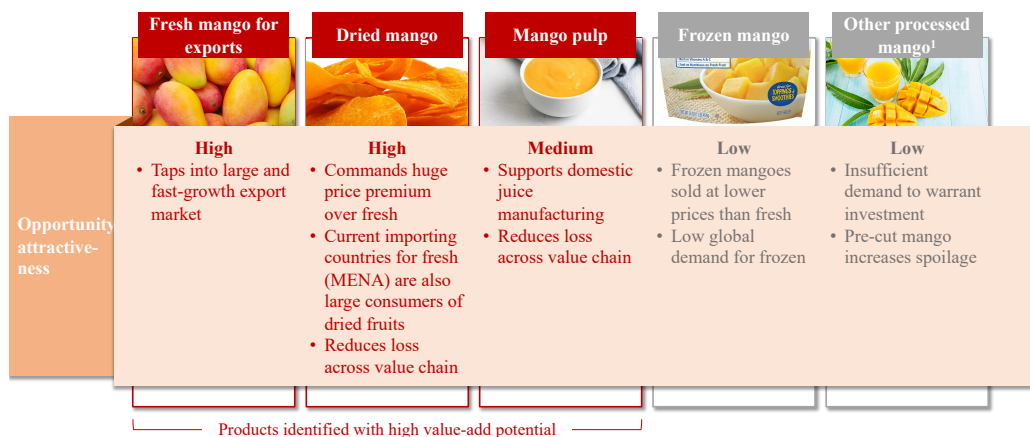
There is a wide range of products that the Kenyan mango industry can foster, but some opportunities are more lucrative than others. The industry currently consists mainly of fresh mangoes that are sold domestically; varieties that are more popular with local tastes (e.g., Apple and Ngowe) account for more than half of production, while export-oriented varieties account for only ~12% of production.²⁰ Currently, exports largely go to the Middle East (Figure 12), where phytosanitary standards are less stringent than other markets with higher value. Access to more lucrative export markets will be contingent on Kenyan farmers' ability to grow export-oriented varieties and comply with additional standards and audits. A closely related product could be freshly cut mangoes, though the processing potential for this would be minimal in Kenya; typically, processing of this kind would occur in the destination rather than the source country due to the high chance of spoilage that occurs once mangoes are cut. That said, corporations in West Africa, such as Blue Skies in Ghana, have been able to develop domestic winners that sell directly to retailers in Europe. Other types of mango processing – such as drying – can help to reduce spoilage in-country; currently there is little to no drying capacity in Kenya, despite growing for the product in Europe and North America. Frozen mangoes have historically

¹⁹ BCG KCDMS 2021; FSD Kenya, 2015; Owuor 2015; ProFound 2018; YieldWise, 2021

²⁰ International Trade Center, 2015

commanded lower prices than fresh mangoes, as smoothie and ice cream manufacturers in the West (the main buyers) typically still prefer to use second-grade fresh mangoes. Finally, mango pulp can be developed into an attractive export product given growing demand for end products (like fruit juice and ice cream) in the West and its potential to reduce domestic spoilage, though Kenyan producers would have to compete with established low-cost producers, like India.

Figure 15: Potential end products for the Kenyan mango industry



1. Includes: juice, jam, purees, freshly cut mango

Considering the characteristics and challenges of the value chain described above, we believe that value addition potential in this industry could lie in reorienting producers toward export-driven fresh mango and developing key processed mango products (specifically dried mango and mango pulp) (Figure 15).

1. The mango industry could prioritize planting of varieties better suited for global consumption or remove existing barriers for Kenyan mangoes to access export markets. Increased market research, as well as marketing of Kenyan varieties, could help to bridge the gap between what foreign consumers demand and what is grown domestically.
2. Processed mango products — including dried mango and mango puree — provide a dual benefit of commanding an outsized price multiple (especially for dried mango), while helping to manage losses in the value chain. A move from selling primarily fresh towards marketing processed products could also incentivize greater employment in value-added manufacturing industries and broader Kenyan industrialization.

BOX 2: How Del Monte Kenya built the domestic pineapple processing industry

A fully vertically integrated operation, Del Monte has been in Kenya since 1965, when it took over facilities from an existing fruit canner. Through large and long-term investments in

farmland and processing facilities, the company grew its presence exponentially in the first two decades of operation: employment grew from 691 in 1970 to ~6,000 in 1980, production from ~9,000 tons to ~53,000 tons. The company currently operates a 10,000 acre farm in Thika, near one of Kenya's largest commercial hubs. As a consolidated player, Del Monte Kenya produces a portfolio of pineapple and pineapple-related products to make use of their fresh production and minimize loss. This includes solid canned pineapple, fruit juice concentrate, mill juice sugar, and cattle feed. Importantly, Del Monte has also invested heavily in the enabling and adjacent industries to support their processed products, including their own can manufacturing facilities and machinery manufacturing and repair services. As a result of these investments and efforts to consolidate, Del Monte currently accounts for almost all of Kenya's pineapple exports.

Source: United Nations University Archives, 1995

IV. Challenges in the mango industry

Existing challenge in the Kenyan mango industry occur at every step of the value chain, indicating that there is a coordination failure. The following chapter summarizes the empirical evidence behind five categories of constraints to growth along the Kenyan mango value chain:

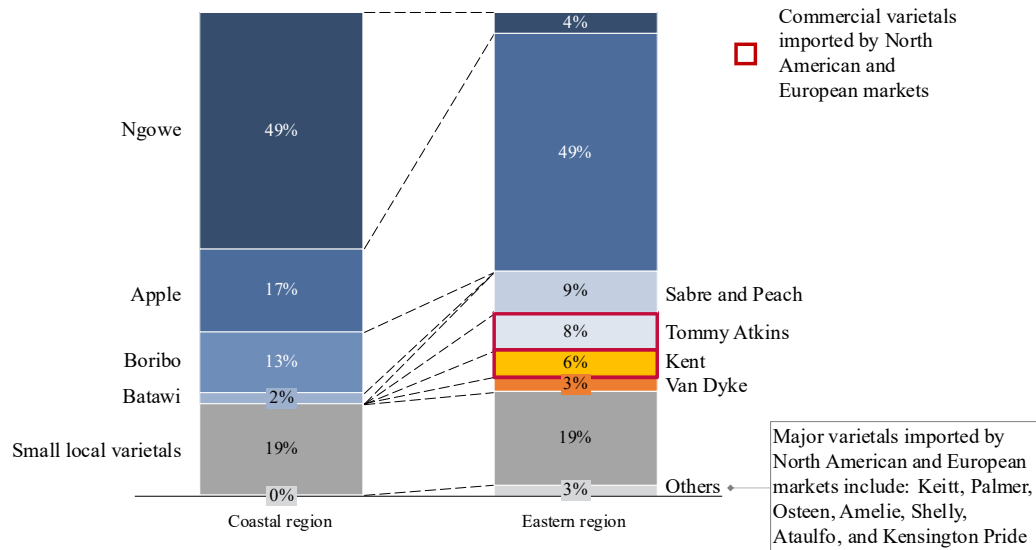
1. Product type and quality mismatch reduce access to export markets
2. Poor domestic infrastructure and storage lead to insufficient or inefficient aggregation
3. Political barriers between and within counties increase costs of aggregation
4. Limited capacity and know-how for processed fruits suppress value addition potential
5. Export barriers and lack of scale create matching frictions with international buyers

1. Product type and quality mismatch reduce access to export markets

Although Kenyan farmers control non-negligible quantities of global mango production, their products are not well suited to the demands of global consumers. Kenya accounts for 2% of global mango production, making it the third largest African producing country (Figure 11). However, the varieties grown reveal significant mismatches with products that are desired abroad. Different varieties of mangoes inform characteristics that ultimately affect their popularity with global consumers; for instance, varying sugar content (as measured by Brix values), size, or shelf life. Kenya's most commonly grown mango varieties, Ngowe and Apple, account for 66% and 53% of production in the Coastal and Eastern regions of the country (the largest mango growing regions, responsible for 90% of Kenyan production). In contrast, varieties that are most popular among North American and European markets, such as Tommy Atkins and

Kent, account for less than 15% of production in the Eastern region, and negligible amounts in the Coastal region (Figure 16).

Figure 16: Estimated share of total mango production by varietal



SOURCE: International Trade Center, 2015

Given the strong domestic orientation of the Kenyan mango industry, the popularity of the Ngowe and Apple varieties are likely due to their seasonal availability. Smallholder farmers with limited resources typically approach mango farming with less appetite for risk and variability; thus, the ability to smooth income over a growing season becomes an important priority for growers. Ngowe and Apple mango varieties are estimated to be available for harvest 30 and 18 weeks out of the year, respectively, while more internationally popular varieties (in red) are only available for harvest 8 weeks out of the year (Figure 17). Despite other varieties having a higher sugar content and potentially yielding greater value for the farmer, domestic growers opt to plant “safer” varieties that stretch the harvesting season.

Figure 17: Weeks of availability of Kenyan mangoes by month and varietal

Varietal	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ngowe	4	2	4		4	4	4				4	4
Apple	4	2	4								4	4
Tommy Atkins	4											4
Van Dyke	4	4										
Haden	4	4										
Sabine	4	4										
Kent		4	4									

Source: International Trade Center, 2015

Beyond the shorter harvesting seasons of export-oriented varieties, another constraint that smallholder farmers may face in cultivating these products is a lack of technical know-how.

Varieties that are popular abroad are not currently grown on Kenyan soil because they require additional information and resources; mango farmers would have to employ more complex methods of cultivating these fruits. Some farmers have experimented with grafting — the process of taking branches from desirable varieties and appending to local trees — as a method of growing export varieties. While this method has shown some success in Kenya, the technical expertise is not widely shared among farmers, making it a less common way of growing mangoes. It is also estimated that grafted mango trees will only start bearing fruit three years after the procedure is complete, creating significant uncertainty for smallholder farmers who may not be willing to accept the risk.

Finally, other issues, such as pests, disease, and orchard management, could affect Kenyan farmers' ability to match the product type and quality that is demanded by consumers overseas. Experts point to key decisions around farm management, such as density and size of mango tree, input (e.g., fertilizer, pesticide, and herbicide) utilization, and investment in irrigation systems as key differentiators of farm output and profitability. In this regard, smallholder mango farmers face similar challenges as farmers of other crops; while these are critical elements to address to maximize agricultural value addition, this study will focus on aspects of the value chain more specifically pertaining to mango crops.

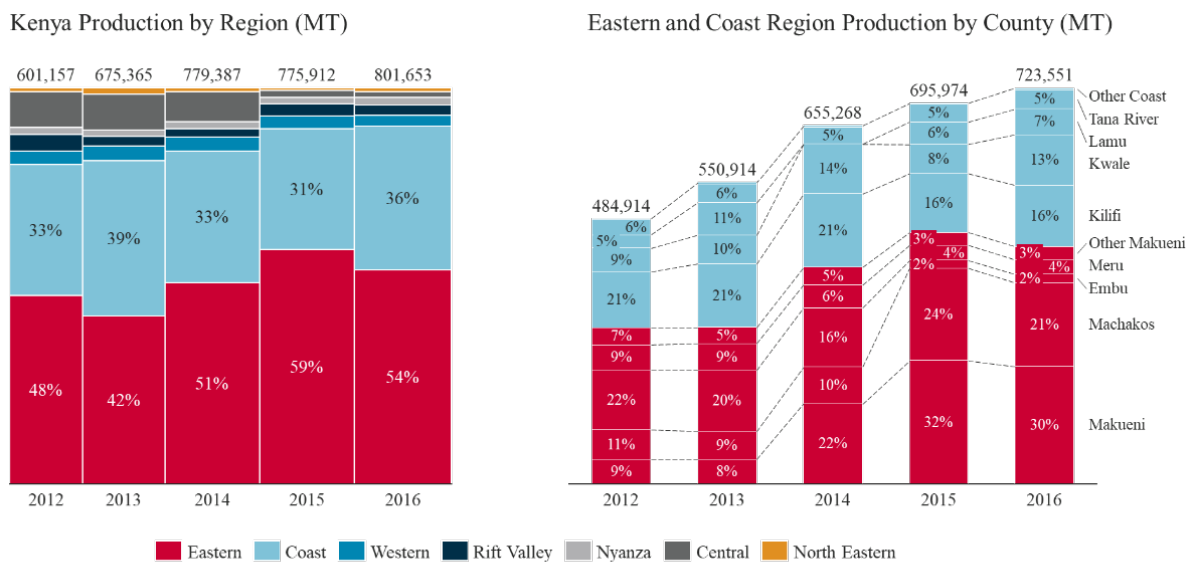
2. Poor domestic infrastructure and storage lead to insufficient or inefficient aggregation

While mango production is primarily concentrated within two regions, it is highly scattered between counties within those regions. 90% of Kenyan mango comes from the Eastern and Coastal regions (Figure 18). The Eastern region has 6.5M people, of which 62% are involved in agriculture and 15% in mango, while the Coastal region has 4.3M people, of which 32% are in agriculture and 8% in mango (see Appendix 2 for further macro-economic and agricultural indicators by region/county).²¹ In the Eastern region, production was initially fragmented but has begun concentrating since 2015 into Makueni and Machakos counties. Not only has production in these counties increased in recent years, but production in competing counties in the Eastern

²¹ KNBS, 2020

region, like Embu, has also decreased, potentially due to high levels of mango loss due to fruit flies and other pests.²² Within the Coastal region, however, production remains heavily fragmented across Kilifi, Kwale, Lamu and Lana River counties. While data is not available at the sub-county level, mango processors and retailers report that mango farmers are further disaggregated within the counties.

Figure 18: Mango production by region and county 2012-2016



Note: Potential source data discrepancy for Lamu production in 2014
 Source: Kenya MOALF, 2021

Even within a county, aggregating from multiple small farmers who cultivate a wide variety of crops is a prominent challenge. It is estimated that ~50-65% of mango farmers in Kenya are smallholders growing between 0-10 trees, relying on mango as only one of many crops cultivated due to heavy seasonality.²³ Depending on the region, the density of mango farmers varies significantly (Figure 19). The Eastern region has significantly higher densities than the Coastal region, although within the Coastal region mangoes are only grown in specific areas and therefore the average may obfuscate the reality on the ground. In the Eastern region, Machakos county has a farmer density of 12.5 / sq. km and Makueni county 8.6 / sq. km.²⁴

Creating a more efficient and integrated value chain remains a challenge in part due to scattered supply but also due to poor rural road infrastructure. For produce in Kenya,

²² Wangithi, et al., 2021; Kibira et al., 2015

²³ This may differ by region, e.g., the coastal province had only 18% of farmers between 0-10 with 65% having 0-50 in a 2010 census. Source: BCG USAID KCDMS, 2021; USAID-Kaves, 2015

²⁴ KNBS, 2020

transportation can range from 36 to 48% of the total cost of production, challenging large-scale facilities that attempt to expand their collection networks to capture more scattered supply.²⁵ Instead, brokers and intermediaries capitalize on the inefficiencies and can charge a significant margin on products that they collect, often at the expense of the farmer; brokerage fees can cost anywhere from 2-10% of the total cost of production for produce.²⁶

Figure 19: 2019 mango farmer density and 2016 mango production

Region	# of Mango farmers	Total Land Area (sq. km)	Average # of Mango farmers/sq km	2016 production (MT)
Eastern	249,435	153,328	0.6	433,441
Western	165,395	8,304	25.4	22,054
Nyanza	155,399	12,602	11.6	15,924
Coast	88,946	82,383	1.4	290,110
Central	73,755	13,152	6.5	11,901
Rift Valley	59,526	182,956	1.0	21,238
North Eastern	4,411	127,449	0.0	6,985
Nairobi (Province)	N/A	704	N/A	N/A
Kenya	796,867	580,876	1.4	801,653

Source: KNBS, 2020; Kenya MOALFC, 2021

Additionally, existing cold chain transportation and infrastructure is inadequate, and investing in new facilities is risky given fragmented supply. Limited cold chain or storage facilities is consistently reported as a major challenge, and even existing facilities – e.g., in Makueni and Tana River – face challenges aggregating enough supply. In Makueni County, the government-owned processing facility was forced to open more collection sites than originally anticipated to mitigate this challenge, incurring additional costs that hurt the profitability of the facility. Even then, it struggled to operate at capacity (see Box 3).

BOX 3: Makueni County government’s experience building a native mango industry

Within Kenya, Makueni County is the biggest mango producing locality (~215,000 MT/year in 2016), with more than ~70,000 households in 2019 growing mangos from 4.3M trees, contributing to ~40% of farm household income. Makueni County has faced all the challenges outlined in this paper – including price fluctuations due to high seasonality, limited processing capacity, fruit flies, and cold storage limitations – illustrated by 40% post-harvest losses reported.

²⁵ Kenya Markets Trust, 2016

²⁶ Kenya Markets Trust, 2016

A Processing Facility

In 2017, the Makueni County Government invested \$10M USD to establish the Makueni Fruit Processing Plant (MFPP), a county-owned processing facility that can process 5 metric tonnes of mango and 3,000 litres of puree per hour. Through consultations with the community, the site was chosen and the facility constructed to help mitigate production seasonality and therefore stabilize prices, increase the value-addition within the mango value chain, and create employment opportunities. The MFPP would purchase mangos at KES 21/kilo to stop the exploitation of farmers by brokers during peak season.

However, the creation of a central processing facility, while well-intentioned, did not solve some of the other systemic challenges in the value chain. The facility could not balance the heavy seasonality of production, faced challenges procuring from numerous small-scale farmers, and experienced frequent power outages. Since 2017, the facility has been able to absorb ~5% of production. Additionally, as the investment produced limited returns, the Makueni county government was unable to approve additional funds to aid in improvement and expansion.

To help MFPP survive, the county government diversified the plant's capacity to produce ready-to-drink juice as well as pulping tomatoes and other fruits. It also applied to create a direct power connection for the facility and increased the number of collection points for fruit. Furthermore, Makueni County engaged with community stakeholders extensively as well as USAID's Kenya Investment Mechanism (KIM) to assist in implementing changes to the Makueni County Investment Authority Act to better coordinate investment.

Looking to Export

In 2020, the Makueni and Kitui governments further invested in the potential export of mangos from Makueni county by announcing a "pest free area campaign" named Komesha: Zuia Fruit Fly Ufaidike. This campaign aims to enable Kenya to take full advantage of EU markets, recently unlocked as the self-imposed export ban was lifted by KEPHIS in 2021. The campaign will train, fund, and provide equipment to farmers to eliminate fruit flies, helping them meet European import standards. It is expected to increase mango export market share by 30% but results have not yet been reported.

This campaign will be implemented by the Mango Technical Working Group which includes the national government, KEPHIS, Makueni County government, Feed the Future Kenya Crops and Dairy Market Systems Activity, the Rockefeller Foundation, Technoserve, UNIDO, mango traders, researchers, development partners, and private sector actors, highlighting the importance of engaging the diverse stakeholders in mango.

Sources: "Agricultural Sector Transformation", 2019; Henning and Mbithi, 2021; Kenya MOALFC, 2021; Kenya National Bureau of Statistics, 2019; "Makueni Diversifies," 2021; "Mango production to increase," 2020; Maundu, 2020; McMullin, 2022; Muritu, 2020; Owino, 2020; Science Africa, 2020

Once storage and processing facilities are chosen, operating them at full potential with only mango is challenging due to seasonality. High seasonality of mango production has led processing facilities to fail to absorb supply in the high season and operate severely under capacity during the rest of the year. Despite attempts to create longer-lasting value-added

products such as dried mango, the Makueni county and Tana River facilities have been unable to operate exclusively on mango and make a return on investment, therefore requiring them to expand into different products (see Boxes 3 and 4). Some private production facilities have had success by processing a variety of different fruits as it does not require specialized equipment and it matches what smallholder farmers are growing and selling year-round.²⁷ Furthermore, most mango varieties grown ripen during the same months in Kenya; the possibility of diversifying varieties to smooth out the harvest season has not yet been explored on a large scale.

3. Political barriers between and within counties increase costs of aggregation

Mango production usually features only on the periphery in national agricultural agendas, but often has a stronger focus at the county-level. Broadly, MOALFC priorities as outlined in the Agriculture Sector Transformation and Growth Strategy (ASTGS) 2019-2029 align with the challenges faced in the mango industry. Relevant priorities include improving road infrastructure, developing farmer-facing SMEs to help provide inputs, irrigation, reducing post-harvest handling losses, investing in 6 new agro-processing projects, assisting in tax incentives, and increasing fruit crop production by ~35%.²⁸ Within this report, however, mango does not feature except for where it is highlighted as an opportunity by the Machakos, Makueni, and Tana River County governments. Within the Kenya Vision 2030 and the LAPSSSET corridor²⁹ development strategy, a large investment to increase mango supply to the Galole Integrated Fruit Processing Supply in Tana River (see Box 4) has been highlighted as an area for investment.³⁰

BOX 4: Tana River County and the Galole Integrated Fruit Processing Plant

Tana River produces ~5% of Kenya's mango and ~13% of the Coastal region's production (Figure 18). It also falls within the LAPSSSET corridor and was identified as a potentially ideal place to build a major processing facility targeted at export out of Lamu port. The investment presented in 2013 by the CEO of LAPSSSET at the time, Silvester Kasuku, was a nucleus/outgrower model over 350 ha in the Tana River Delta that could supply fruit to the Galole Integrated Fruit Processing Supply, a ~\$600,000 facility financed jointly by the Coast Development Authority (CDA) and Constituency Development Fund (CDF) and completed in April 2014.

²⁷ McMullan, 2022

²⁸ "Agricultural Sector Transformation", 2019

²⁹ Lamu Port, South Sudan, Ethiopia Transport Corridor. LAPSSSET is a mega project of seven infrastructure investments in ports, roads, pipelines, railways, and airports to connect Kenya, South Sudan and Ethiopia.

³⁰ Kasuku, 2013

This facility promised to buy from 10,000 mango farmers in Tana River and support over 20,000 farmers in Kilifi and Lamu counties to produce mango pulp as well as other fruits. It would guarantee a price of Ksh 20/kg as opposed to a common price from brokers of Ksh 2/fruit (~Ksh 3-12/kg). It also aimed to train 2,000 farmers on Good Agricultural Practices (GAPS) and provide services to exporters. The processing capacity was 12,000 tonnes per year and aimed to extend the shelf life of mangos and smooth the heavily seasonal fruit supply.

However, after one year, the facility was shut down due to mismanagement. The project site was reportedly built in an area that had poor water and electricity access, making it untenable to run and was eventually abandoned by the staff. According to an interview with the Tana River Governor at the time, Major Dr. Dhadho Godhana, politics between the national and county governments were to blame. Furthermore, the Tana River Mango Marketing Cooperative Society reported that the facility was unable to absorb the full mango supply in high season.

In 2018, the processing was revamped at a cost of ~\$1.5M to have increased capacity and become fully automated. The CDA director stated that the plant originally failed because of the manual machines affecting quality and decreasing revenues, although most sources indicate that mismanagement is at fault. In 2020, CDA announced that it would convert part of the facility into a water bottling plant to supplement fruit production in the off-season.

Source: “Coast Development Authority (CDA) has launched”, 2020; “Farmers to reap more”, 2021; “Kenya: USD 116k”, 2019; Mengistu, 2021; “Tana River fruit factory turns”, n.d.

County-level projects have faced significant political and economic challenges, underscoring the lack of supporting institutions required to build a modernized value chain. Both Makueni County and Tana River County built processing plants that promised to convert fresh mango into higher-value and longer-lasting pulp (see Box 3 and 4). However, failure to create sufficient collection networks, challenges with poor rural infrastructure, a lack of extension and coordination to help smooth mango production through different varieties or modern farming techniques, and insufficient funding and project governance led to massively underperforming facilities and eventual shutdown. Both projects ultimately re-opened, but with portions redirected to process other products. Furthermore, coordination mechanisms at the county-level aimed at extension support for export orientation (e.g., assistance with new varieties, planting schedules, and modern cultivation techniques) are virtually nonexistent.³¹

County-level regulations and taxation schemes are non-harmonized, increasing the cost of doing business for producers and creating barriers to entry for private sector farms and processors. Cess fees, in particular, are levied on produce for the purpose of maintaining infrastructure and extension services for production. These fees can be charged either at the point

³¹ Langat, 2020

of production or during transit within a county, but also when produce crosses county lines. The 2022 posted cess fee, according to the Ministry of Industrialization, Trade and Enterprise Development (MoITED) is 20Ksh per basket of mango.³² These cess fees are an important part of local government finances; they are among the top ten sources of revenue by county governments, accounting for 4% of total county generated receipts in 2017-8.³³ As producers aggregate mango from farms, these fees are incurred but rarely re-invested back into the infrastructure and extension services promised. Additionally, counties often change their cess rates without notice and produce is frequently double taxed at production and in transit across county lines because counties do not recognize each other's permits. Finally, cess collection can cause significant delays during transportation, generating logistic concerns.³⁴ The cumulative effect are not only higher costs of production, but also high levels of uncertainty on what those costs are. This increases the barriers for private sector players to grow and scale.

4. Limited capacity and know-how for processed fruits suppress value addition potential

Some primary processing capacity already exists in Kenya, largely controlled by farmer cooperatives or intermediate buyers. Primary processing typically occurs where production from multiple smallholder farmers is aggregated in a centralized packhouse. In these contexts, mangoes (often along with a variety of fruits such as pawpaw and avocado that ripen in different seasons throughout the year) are washed, graded, and sorted according to size and quality metrics before being sold and delivered to retailers in the cities or exporters. As an intermediate step of the fresh mango value chain, primary processing adds limited value by reducing inconsistency in product specifications. Due to the low technological requirements, investment barriers to create these primary processing facilities are typically lower than other types of processing.

However, value-added processing capacity is extremely limited in Kenya, representing a constraint for the country to produce and export higher value mango products. Significant investments in specialized technology are required for Kenya to produce value-added products, including freshly cut mangoes, dried mangoes, frozen mangoes, and mango pulp (Figure 20). Crude estimates place the current capacity for value-added mango processing at ~70,000 tons per

³² Ministry of Industrialization, Trade and Enterprise Cess Requirements & Rates, 2022

³³ The National Treasury of Kenya, 2019

³⁴ Kenya Markets Trust, 2016

year.³⁵ In addition to the capital expenditures required to build out a robust value-added processing facility, large ongoing expenses will also need to be incurred to operate this machinery. For instance, commercial dehydrators utilize high levels of electricity for long periods of time (>10 hours per batch) to produce dried mango.³⁶ While individual quick freeze machines are able to freeze mangoes in as quickly as 5 minutes, additional investments in cold chain storage would be required to maintain consistency of the product.³⁷ Value-added processing often leads to isolation and creation of byproducts (e.g., mango pits, skin) that may require additional technology for disposal.

Figure 20: Processing technology requirements of select mango products

Mango end product	Technology requirement	Representative cost per machine (entry-level machines, before any applicable taxes, tariffs, and charges)
Freshly cut mango	Commercial choppers	\$9,900 – 12,000 / machine
Dried mango	Commercial dehydrators	Starting at ~\$7,000 / machine
Frozen mango	Individual quick freeze (IQF) machines	\$60,000 – 80,000 / machine
Mango pulp	Aseptic drums	Starting at ~\$30,000 / machine

Source: Alibaba, 2022

As a result, decisions to invest in value-added processing capacity are extremely sensitive to the economics of the final product. Several factors affect the economics of each of the products listed above, and therefore inform the attractiveness for Kenyan producers to invest in the associated technologies. Firstly, most value-added products increase the shelf life of the fruit by reducing its susceptibility to natural conditions (for reference, fresh mangoes typically must be stored in a narrow range of 8-9 degrees Celsius to remain fresh). In contrast, freshly cut mangoes, if processed domestically for consumption abroad, could reduce shelf life by increasing exposure to the air. Secondly, virtually all processed mango products provide the benefit of reducing spoilage by allowing products that would otherwise be thrown or sold at below-market prices to be used for other purposes. In some cases, even fruits with visible damages can be partially repurposed as processed products as imperfections become less conspicuous. Third, certain mango products, such as freshly cut and dried mangoes, command

³⁵ McMullan, 2022; BCG KCDMS 2021

³⁶ Alibaba, 2022

³⁷ Alibaba, 2022

price premiums over unprocessed mangoes; a recent report estimated the cost of dried mango in Kenya to be \$25/kg, compared to the cost of fresh mango at \$0.80/kg.³⁸ In contrast, frozen mangoes are typically sold at even cheaper prices than fresh mangoes given that they are mostly sold to ice cream and juice manufacturers. Finally, mango processing may lead to additional logistics considerations. For dried mango and mango pulp, the processed product is more easily packed and transported as the sensitivity to natural conditions is reduced. On the other hand, frozen and freshly cut mango require cold chain storage to maintain product consistency.

Segregation of mango (and more broadly fruit) production exacerbates this constraint by disincentivizing capital expenditure. As mentioned above, production of fresh mango (and other fruits grown by smallholders) are scattered across multiple counties in the Eastern and Coastal regions of the country, making it difficult for products to be aggregated in centralized facilities. Given that fruit processors benefit from and rely on economies of scale, the decentralization of mango production significantly reduces the incentive to invest in processing technology. In certain mango products, Kenya might already be shown to be a cost-ineffective producer; recent estimates priced Kenyan mango pulp at ~0.70/kg, compared to Indian mango pulp, which was priced at ~0.25/kg.³⁹ The coordination problem of aggregating sufficient produce to reach economies of scale can be partially addressed by expanding use cases of processing facilities to other products; the technologies used for value-added processing mango can also be applied to fruits like avocados, bananas, and citruses.

5. Export barriers and lack of scale increase matching friction between Kenyan producers and buyers abroad

To date, the self-imposed export ban represents the most significant barrier to trade with potential importing markets. In 2013, KEPHIS imposed a ban on exports of domestic mangoes to the European Union. At the time, the export ban originated due to fear of the fruit's susceptibility to fruit flies, and the potential that more produce might be blacklisted by EU importers if the disease were discovered. As a result, EU importers are noticeably absent from

³⁸ BCG USAID KCDMS, 2021

³⁹ BCG USAID KCDMS, 2021

Kenya's top destinations for mango exports, even if Kenya exports other tropical fruits to countries like the Netherlands, France, Spain, and the United Kingdom (Figure 12).

Kenya's lack of presence in the global mango market even before the export ban suggests other barriers might be relevant. Countries outside of the Middle East and North Africa made up a minority of Kenya's mango exports even before the ban was enacted in 2013, suggesting that the ban itself may have had little impact on exports (Figure 12). Importantly, the mango growing season in Kenya, concentrated in November to January, represents a competitive advantage against other mango producing countries, as it coincides with typically "low" seasons in global mango supply; however, export barriers today prohibit domestic producers from realizing this opportunity. As we look toward Kenya's plans to remove the export ban (first announced in 2021), it would be overly optimistic to think that this action alone will dramatically increase the country's presence in the global mango market. Kenya's lack of access to higher value markets in the West also has important price implications for domestic producers, who report some of the lowest mango prices among other large mango-growing countries. Prices have increased in recent years, potentially due to the regionalization of global mango value chains (Figure 14).

Adherence to strict phytosanitary protocols is an important requirement for access to export markets. Most importing countries in the West require exporting companies to show compliance with phytosanitary standards, but these standards are often decentralized and costly. Standards typically prohibit fruits with detected presence of specific pests and diseases, as well as informing appropriate amounts of detected chemicals. While some markets accept global certifications such as the Food Safety System Certification 22000 (FSSC 22000), others prefer to utilize certifications specifically designed for the importing country or buyer. For instance, mango producers hoping to export to Tesco in the United Kingdom would at minimum have to show certifications for the British Retail Consortium Global Standards (BRCGS) and Tesco Nurtures; other retail buyers would require additional certifications. Adherence to these standards can be costly and complex; one estimate placed the average number of audits that a Kenyan farm would have to pass to retain access to important export markets at 5 per year.⁴⁰

⁴⁰ Ahmed, 2021

Familiarity with Kenyan mango products is likely low among international buyers. This is most clearly evidenced by the mismatch between varieties grown by Kenyan farmers and varieties preferred in importing countries (Figure 16); while that mismatch is partially informed by the biological characteristics of the Kenyan mango (e.g., size, sugar content), it is just as likely that importers are simply unfamiliar with the varieties offered by Kenyan producers. The lack of awareness is further exacerbated by a continuous period of low trade resulting from the self-imposed export bans. As a result, expanding access to lucrative importing markets would require not only adherence to phytosanitary regulations, but also a concerted marketing effort to increase awareness of the Kenyan fruit.

Finally, establishment of significant trading relationships with importers will likely take time. The emergence of Vietnam as a global leading mango exporter provides potential lessons for Kenya (Box 1). Vietnamese exports of mangoes rose 12,000-fold in the period of 2009-2019, largely supported by a significant increase in Chinese imports of mangoes (Figure 9). In the years preceding this reliance on Chinese imports, Vietnamese authorities made its mango industry a strategic priority, and ratified a regional free trade agreement with neighboring countries in 2010. In the early years of the agreement, Vietnam's significant mango trade partners (defined as exports exceeding \$1,000,000) were limited to only China and South Korea, and the number of significant importers did not increase until five years after the agreement was ratified. Today, while Chinese imports still account for ~95% of Vietnamese mango exports, Vietnamese producers also export significant volume to countries like South Korea, the United Arab Emirates, Russia, France, and Japan. As Kenya begins to open trade of its mangoes to a greater set of destinations, exports will likely only begin to increase years from now.

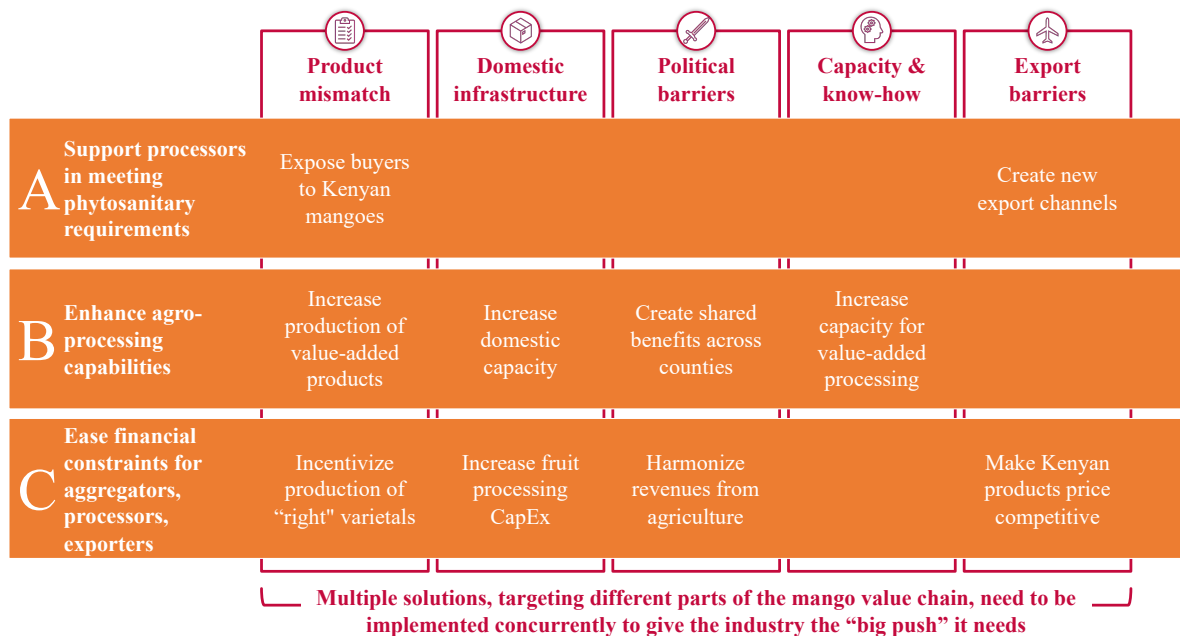
The five barriers to industry growth discussed occur from farmgate all the way to end consumer; this indicates that there is a coordination challenge faced by the Kenyan mango industry, where no single stakeholder is incentivized to invest in necessary improvements. The following section will describe potential policy interventions to help alleviate this market failure.

V. Policy solutions

To address the coordination problem affecting all parts of the mango value chain identified in the preceding chapter, we recommend a “big push”-style set of policies that support

phytosanitary certifications, creation of new (and improvements to existing) agro-processing centers, and reduced financial constraints for aggregators, processors, and exporters. Individually, each of these policy alternatives are likely able to address certain constraints in the Kenyan mango value chain today, but a coordinated effort across these solutions is critical to tackle all five of the identified challenges (Figure 22). This chapter describes the requirements for each policy proposal in further detail.

Figure 22: Relevance of policy alternatives to identified challenges



Source: Authors' analysis

(A) Support producers and processors in meeting phytosanitary requirements

Mango quality cannot be perfectly observed by buyers and sellers; as a result, second-best mechanisms have been employed to signal quality. Because only the most conspicuous characteristics of the fruit (e.g., size and color) are readily observed at the time of transaction, alternative mechanisms or second-best solutions need to be employed to signal and observe quality. One example is the Kenyan government's self-imposed export ban on mangoes to reduce the risk of further losses due to some bad quality fruits affecting the country's ability to export other agricultural products to important markets. Another example is the role of phytosanitary certification bodies, which provide indicators of quality by imposing strict standards that are tested through thorough audits and data collection, reducing information asymmetry between buyers and sellers. Importantly, the success of these solutions depends on their ability to

profitably signal quality and impact buyers' beliefs; in cases of “sticky” beliefs, even additional investments in technologies that signal quality may not meaningfully change the economics.⁴¹

Removal of pre-existing export bans opens opportunities for producers to access global markets, but more barriers need to be overcome before opportunities can be realized. Most export markets in Europe and the United States (unlike current export markets in the Middle East) require some form of phytosanitary certification to clear customs in the respective markets. In addition, for producers hoping to access multiple export markets, this could result in frequent audits and parallel efforts to establish credibility among buyers new to Kenyan mangoes.

Phytosanitary standards typically control aspects of the entire value chain – from cultivation and procurement of mangoes to further processing – and require collaboration between stakeholders. Leading phytosanitary standards, like the FSSC 22000, impose restrictions on water quality, utilization of chemicals in the growing process, pest and disease incidence, and more. Among federal government bodies, these areas would affect operations of at least three ministries: the Ministry of Water and Sanitation (MoWSI), the MOALFC, and the MoITED. Beyond these federal offices, partners in county governments and in the private sector would need to provide support for producers to obtain certifications. Some of these collaborative networks exist today; for instance, in removing the self-imposed export ban, KEPHIS worked with investors and private sector players to co-invest in a hot water treatment plant that reduced risks of pests and diseases in mangoes. However, even with the existence of cross-disciplinary agricultural networks, one might expect to see changes in the mango value chain as phytosanitary certifications become the norm in the industry. For example, one private sector player transformed its procurement strategy by shifting the majority of sourcing from brokers to dealing with farmers directly.⁴² This move allowed the company to have greater control over the characteristics under which the produce was grown, as well as improved communication of information to facilitate improvements in growing practices.

The process of obtaining certification is often long and costly. Due to the large amount of data that the certification process requires – and limited ability of Kenyan producers and adjacent stakeholders currently to address those data needs – it is estimated that obtaining a single license

⁴¹ Bai, 2016

⁴² McMillan, 2022

could take more than two years and \$10,000.⁴³ Once an application for phytosanitary certification is approved, further resources are required to maintain it; producers would need access to independent laboratories to process test samples and ongoing human resources to manage data requirements. It is estimated that retaining a phytosanitary license could cost at least \$3,000 per year.⁴⁴ These cost estimates assume that producers already meet the standards that European and American certifications may require; those who don't, would need to incur additional costs to upgrade existing facilities.

As a result, the government can induce the export orientation of the domestic mango industry by providing financial and political support to mango processors and exporters to obtain phytosanitary certifications. Kenyan exporters have already exhausted the opportunity to access markets with relatively lower phytosanitary requirements, like countries in the Middle East and North Africa (Figure 12). At the same time, the global trend across mango importing countries is to increase transparency in food value chains, which has led to previously lenient importing countries (like China) to impose further restrictions on phytosanitary standards (Box 1). Financial support can take the form of specialized subsidies that compensate processors and exporters for the initial certification process to increase incentives to invest in production standards and capabilities that adhere to phytosanitary protocols. Political support can align the strategic priorities across all levels and ministries of the government toward increasing mango exports through phytosanitary certifications. Additional initiatives can include exploring the use of technology to monitor practices such as drones and satellite imaging; these technologies are already used by a variety of large-scale agricultural and food companies to monitor farming practices (e.g., deforestation and use of deforested land in the Amazon) that are difficult to monitor otherwise due to their disaggregated supply.⁴⁵ Public sector players and funds can also be deployed to invest in county-wide improvements to water sanitation systems such that a greater scope of farmers can more readily meet requirements specified by phytosanitary certifications. While most of this support is directed at downstream players like processors and exporters, we expect that these interventions will have indirect effects on upstream producers by reducing the information barrier between what is demanded abroad and what is produced

⁴³ McMillan, 2022

⁴⁴ McMillan, 2022

⁴⁵ Reinhardt, et. al., 2020

domestically. As a result, we also expect this support to partially address the issue of mismatched products between domestic producers and international buyers by increasing awareness of Kenyan mango varieties, like the Apple Mango.

(B) Enhance agro-processing capabilities

The mango value chain is plagued by dispersed production, high post-harvest losses, a short shelf-life, and heavy seasonality. During the high season, buyers are overwhelmed with production, prices plummet, and mangos are left to rot on the side of the road; during the low season, mangos are difficult to source, and mango prices can triple. Furthermore, dispersed production makes sourcing sufficient mango to consistently run a processing center costly, especially as road and cold chain infrastructure are poor. Drying and pulping are critical ways to address these challenges: they increase the shelf-life from a few weeks to a few months to years and they can add value to the product, resulting in higher profits for farmers.

Well-functioning processing hubs can offer a solution to current challenges. They can provide numerous collection sites to help brokers and farmers offload production at a known price point, they can convert excess production into high-value, long-life products, and they can more easily access export markets that require a minimum product quantity and quality due to their ability to aggregate at scale and meet phytosanitary standards. Processors can also partner with or supplement government extension services to increase knowledge of export-grade varieties (e.g., Apple Mango), to help farmers diversify varieties to extend the production season (see Figure 17), and to provide a clear incentive for farmers to implement fruit-fly traps as part of the “pest free area” campaigns through exclusive purchase of quality produce. Eradication of fruit-flies only works at a regional level and so ensuring a steady off-take for quality products can provide a broad incentive for all farmers to implement.

However, locating a processing facility, choosing what and how to process, and maintaining processing facilities are critical factors to their success. Dispersed demand presents two issues for collection: if there are too few centers, creating a sufficient collection network is almost impossible due to the cost of transport and the durability of mango in the absence of an expensive cold chain network. If there are too many centers, each center would not be able to source and process sufficient mango to make a return on large capital investments of the machinery. Therefore, the location of a facility must be carefully selected around the aggregation

area. Furthermore, seasonality and small-scale producers make it impossible for larger-scale processors to be profitable exclusively processing mangos. Examples of Makueni County and Tana River County (see Boxes 3 and 4) indicate that mango processing is not sustainable by itself and that a center must have a more diverse set of operations. Private sector processors (e.g., Best Tropical Fruits in Machakos) have taken a more supply-driven strategy with success: they process, dry, and pulp whatever fruits that farmers grow and are able to profitably operate and export year-round, supplying steady income to the numerous smallholder farmers.⁴⁶ Finally, the model of operation is important. Government-led processing facilities have been affected by corruption and political constraints with funding, forcing them to shut down or operate at loss-making sub-scale capacity. Cooperative-led processing facilities have faced challenges as most farmers are smallholders with limited knowledge of the full ecosystem or skills required to make a facility a success, and limited time to dedicate to running it versus farming.⁴⁷ The most successful operations have had a professional team running them, indicating that private-sector development or a private-public partnership have the highest chance of success.

(C) Ease financial constraints for aggregators, processors, and exporters

The Kenyan mango industry is currently caught in a suboptimal vicious cycle. Low levels of export orientation and an overreliance on domestic consumption create disincentives to invest in aggregation facilities, processing capacity, or improvements to existing practices. However, low levels of investment lead to a persistent lack of awareness of the Kenyan mango, reinforcing the country's position as an insignificant exporter of the fruit.

A combination of fiscal measures can not only catalyze growth in investment in the industry, but also communicate the strategic imperative of developing a native mango industry:

- **State-led research effort into mango export market.** Stakeholders along the mango value chain need an intimate understanding of the type, quality, and phytosanitary standards of mangoes that are demanded abroad; farmers need to know which varieties to plant and cultivate, packhouse operators need to know what quality to look for and

⁴⁶ McMullin, 2022

⁴⁷ Kibaara, 2022

whether to employ hot water treatments or irradiation, and exporters need to know how to market and brand their products. However, this is a classic coordination failure: no single player has the incentive to incur the cost of market research. The Kenyan government can play the role of the information gatherer and disseminate crucial knowledge to relevant stakeholders in the value chain. They can also identify potential future initiatives to support the implementation of these ideas. In Vietnam, the information dissemination process took the form of public workshops and forums, which also encouraged collaboration between stakeholders at the county level (Box 1).

- **Subsidized loans for the improvement of existing aggregation and processing facilities and the creation of new strategically located facilities.** There are two challenges that this can solve: first, exporters struggle to aggregate sufficient fruit and second, there is room to grow processing capacity especially as channels for export continue to open. The absolute processing capacity of Kenya is currently ~10% of total production; however, the true processing capacity is closer to ~3% as most facilities operate subscale.⁴⁸ There is significant room to both invest in making existing facilities more efficient as well as increase the topline processing capacity of the country. One example of this is ensuring that all production facilities can process the various types of fruit farmers are growing year-round, even if the highest potential product is mango. County-level government have struggled to continue funding their processing facilities (e.g., Makueni county) on their own. As mentioned in the prior policy solution, the ideal investment must involve the private sector: either 1) private companies are subsidized to build and run facilities or 2) government actors lead a public private partnership where they own the physical facility, but private actors are contracted to operate it. This helps avoid the challenges faced in Tana and Makueni counties (Boxes 3 and 4).
- **Tariff reduction for imports of equipment critical for value-added fruit processing.** Kenya's heavy manufacturing industry is limited, with industry accounting for only 7.4% of employment in 2020.⁴⁹ As a result, technical equipment needed for value-added processing – dryers, freezers, tanks, etc. – cannot be produced domestically and must be imported. Machinery with less complex parts are typically sourced from China, whereas

⁴⁸ BCG KCDMS, 2021

⁴⁹ Statista data 2020

more specialized machinery are sourced from Italy or Germany. Cost of these machines can already be significant on their own (Figure 20), but import tariffs charged by the Kenyan government can increase the cost burden for starting a processing business by up to 16%.⁵⁰ By providing temporary relief on these tariffs in target industries, the Kenyan government can create more incentives for entrants in the fruit processing business.

- **Increased harmonization and enforcement of cess fee schedules across counties.** Cess fees are determined and charged by individual counties, and while they are not supposed to charge cess for a shipment that has already paid it in the originating county, this is often not the case. By harmonizing the fee schedule and better enforcing only single charges, as well as ensuring that cess fees are earmarked in county-level budgets to be invested back into the road and other infrastructure critical for agricultural products, the cost of production can be decreased for potential entrants. Given the large dependence of local government revenues on cess, and its potential externalities to other agricultural products, we expect this to be an especially politically challenging challenge to tackle and may not be an immediate priority in the national reform agenda. Our recommendation of a “big push” set of policy solutions is not reliant on cess reform.

Collectively, these fiscal measures affect players across different stages of the mango value chain in Kenya. As a result, they also help to address each of the five constraints identified in the previous chapter. For instance, product mismatch is addressed through improved market research, domestic infrastructure is empowered through loans that enable investments, county-level political barriers are overcome through harmonization of cess fees, value-added processing capacity is increased by lowering costs of importing required machinery, and export barriers are lowered by increasing marketing of Kenyan mangoes.

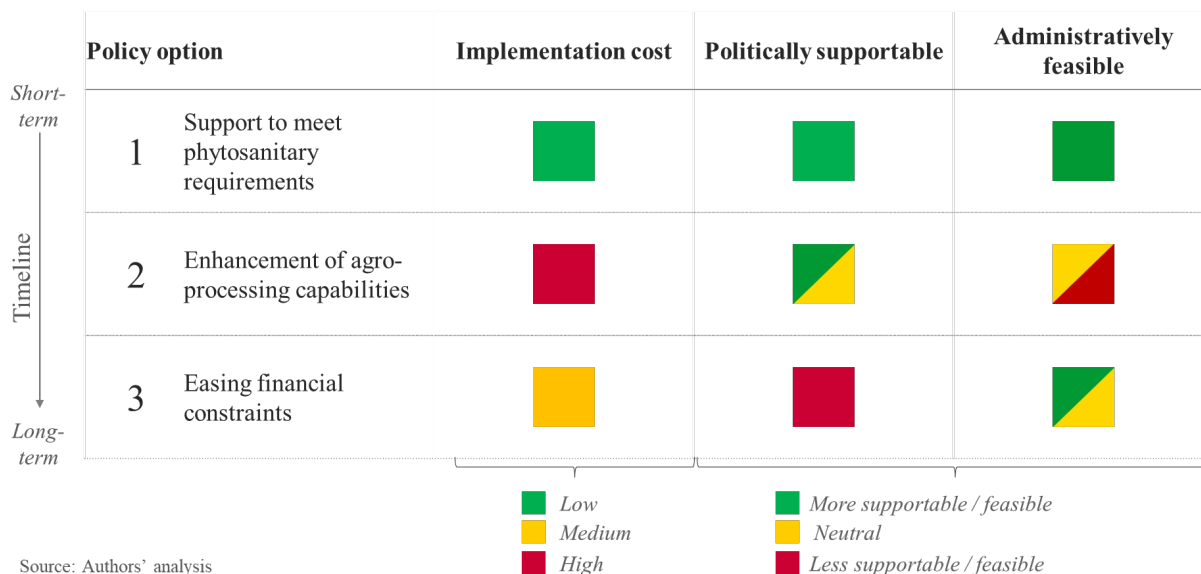
VI. Recommendation

While the constraints identified can only be addressed through a combination of the three policy solutions recommended, some consideration must be paid to the timing and operations of implementing these policy alternatives. The three policy solutions identified vary in terms of timeline of impact, financial cost, supportability among existing and new

⁵⁰ International Trade Administration, 2021

stakeholders of the value chain, and ease of implementation. Although ultimately some variation of these three solutions will have to be in place for Kenya’s mango industry to flourish, prioritization is also key to ensuring requisite policies are implemented at the right time. Figure 23 describes a schematic analysis of the three proposed policy alternatives. The rest of this chapter describes what implementation of these options will look like in greater detail.

Figure 23: Relevance of policy alternatives to identified challenges



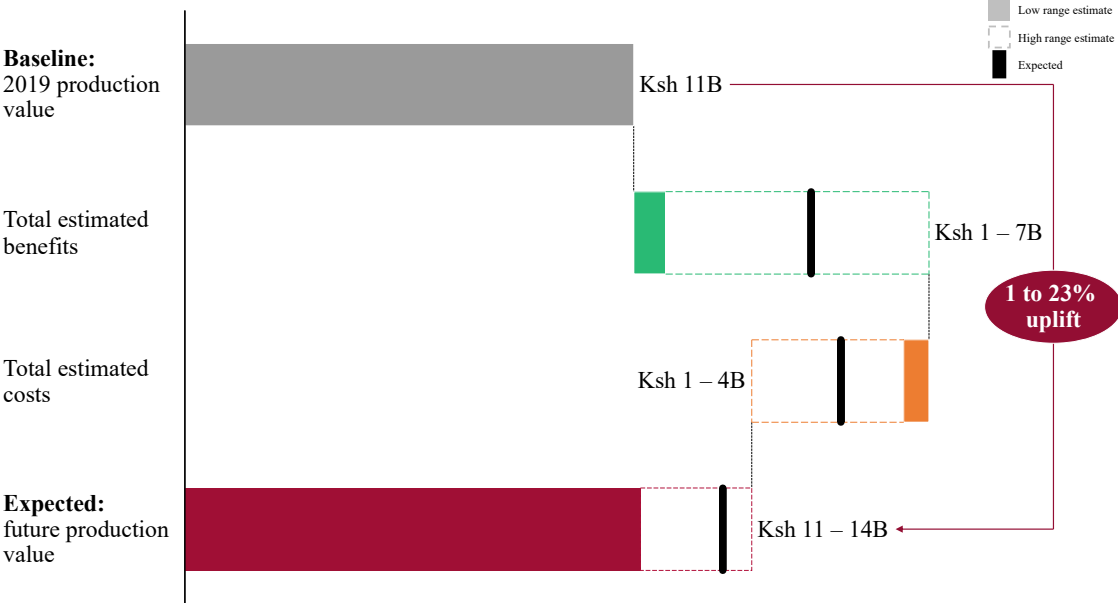
The nearest term impact exists in supporting mango players in obtaining phytosanitary certifications, which opens the door to other opportunities in the middle- to long-term. In the short run, support for phytosanitary certifications can be positioned as an extension to the government’s current efforts to remove bans of its mango exports. Together, these two action options communicate the strategic importance of mango exports and allow existing producers to generate trade relationships with mango importers. In the medium term, these relationships can be leveraged to generate demand for value-added processed mango products and justify enhancements to the country’s agro-processing capabilities. Finally, measures that ease financial constraints for industry players will have to cut across multiple stakeholders; as a result, we expect the timeline for these measures to extend to the long-term.

Together, we expect these policy solutions to yield up to 7B in additional yearly value for the Kenyan mango industry, but this will require an investment of Ksh 1 to 4B. Some value will be unlocked with new phytosanitary licenses for Kenyan producers, but the bulk of value addition will come from enhancing the industry’s agro-processing capabilities and empowering

all stakeholders across the value chain to make necessary investments. We expect that these policies will contribute to development of the mango industry across three important product categories: exports of fresh mango, dried mango, and mango pulp. See Appendices 6 and 7 for a full description of the methodology and assumptions used to calculate the potential benefits and costs associated with this policy program.

In aggregate, this program is expected to at least pay for itself in the long run, with significant upside of up to 23% increase in yearly value for the mango industry (Figure 24).

Figure 24: Policy recommendation Cost-Benefit analysis



SOURCE: Authors' analysis; detailed assumptions and calculations outlined in Appendix 6

While most of the proposed policy measures are aligned with existing priorities, there are several key political risks that must be considered. These include:

- 1) **Opposition to allocating budget items specifically to mango (and potentially away from stronger priorities such as maize).** Nationally, mango has been a secondary priority next to staple crops such as maize. Any new investments or budget allocations to a crop that has historically not been priority will garner some opposition, especially as staple products often have coordinated lobbying groups. However, there is a strong argument in upgrading mango specifically as a smallholder farmer initiative, given its production landscape. Additionally, the recent export ban lift and the LAPSSETT corridor project provide additional platforms on which to launch initiatives successfully.

- 2) **Incongruencies between national- and county-level policies.** As noted throughout this paper, most mango-related investments and projects are led at the county level, even if there is national funding support. It is more easily defensible that phytosanitary certifications and fiscal support should be nationally led, as consistency is key, and the inputs and outcomes heavily involve international trade. However, the second proposal to re-purpose existing aggregation and processing facilities and to build new ones is potentially better led at the county level in part because it has historically been implemented that way, but also because local governments may be better able to assess the geographic needs of farmers as well as implement the local construction and management efforts. Policy initiatives should leverage existing mechanisms to coordinate between these bodies, such as the Joint Agriculture Sector Steering Committee (JASSCOM) and the technical Sector Working Agriculture Groups (SWAGs) established by MOALFC in 2016 to connect national and county stakeholders (see Figure 25).⁵¹
- 3) **Tensions between MOALFC and the MoITED in terms of who is sponsoring, implementing, and taking credit for policy success or failure.** While the majority of our policy proposals sit within the mandate of the MOALFC (core functions include formulating policy and regulation, promoting technology delivery, and implementing and coordinating programs in the agricultural sector), MoITED has the “Promotion of Value Addition and Agro-Processing” under its mandate (see Appendix 4 and 5 for full MOALFC and MoITED Mandates). This potential overlap makes it critical to establish which body is responsible to fund and implement policies such as subsidizing certifications aimed at trade and easing tariffs on industrial processing equipment.

The potential political challenges highlight that upgrading the mango value chain is an adaptive challenge, which requires embracing early experimentation and high levels of stakeholder engagement across the entire value chain:

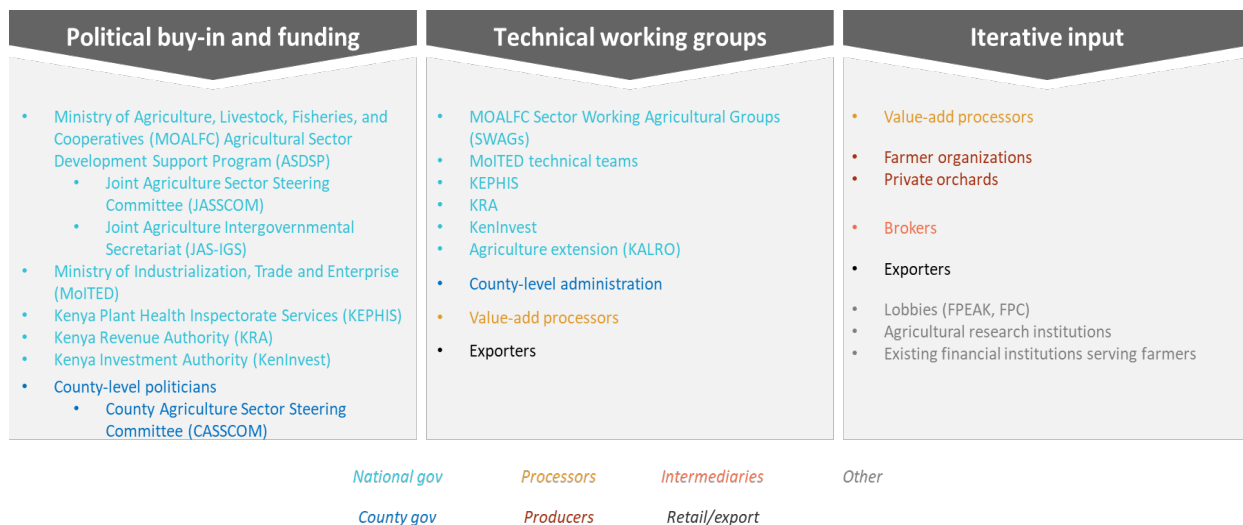
- 1) **Authorizers:** Stakeholders who authorize initiatives, mobilize political will, and who have responsibility for outcomes. This most critically involves MOALFC, MoITED, and county-level politicians. Within MOALFC, the likely owners of these initiatives would sit in the Agricultural Sector Development Support Program, specifically in their priority

⁵¹ Kenya MOALFC, n.d., “Initiatives for establishment”

to improve access to markets by value chain actors. Additionally, existing coordination mechanisms between national and county actors should be leveraged, including the JASSCOM, which oversees the Joint Agriculture Intergovernmental Secretariat (JAS-IGS), and the County Agriculture Sector Steering Committee (CASSCOM).⁵² Funding mechanisms are also incorporated into this group, including the Kenya Revenue Authority (KRA), responsible for any adjustments to subsidies and tariffs, as well as the Kenya Investment Authority (KenInvest) that promotes investment into Kenya. Finally, regulatory stakeholders such as KEPHIS are required for success.

- 2) Technical working groups: Stakeholders responsible for the design, oversight, and implementation of initiatives. Existing Sector Working Agricultural Groups (SWAGS) are the likely place begin, but critical thought must be given to including all relevant stakeholders that have a critical voice in ensuring initiatives are sustainable and meeting the needs of all stakeholders (e.g., processors, exporters, see Figure 25).
- 3) Input providers: Stakeholders impacted by initiatives or with specific knowledge that can provide critical information, feedback, and partnerships. This includes a broad variety of stakeholders (Figure 25) but critically includes farmer organizations, brokers, and lobbies. These stakeholders must be incorporated into iterative feedback loops as initiatives are implemented to ensure that they are accomplishing what they set out to.

Figure 25: Key stakeholders in the Kenyan mango value chain



⁵² Kenya MOALFC, n.d., “Initiatives for establishment”

With the right willingness to experiment and refine the ideas presented in this paper, Kenya can harness the strength and potential in its native industry to increase its global position in mango. By embracing an approach that engages with the various stakeholders to test, refine, pilot, and implement the ideas presented in this paper, these set of policies can help Kenya move towards this opportunity.

Appendices

Appendix 1: Key stakeholders in the Kenyan mango value chain

Stakeholder	Key actions
Smallholder farmers (0-10 trees)	<ul style="list-style-type: none"> • ~55% of farmers⁵³ • Usually growing other crops and mango is a supplementary crop that provides extra income during mango season • Mango trees at these farms are usually local varieties with limited or no irrigation and minimal use of inputs • Use of brokers to buy mangos at farmgate
Medium to large-scale farmers (11-500 trees)_	<ul style="list-style-type: none"> • ~44% of farmers⁵⁴ • May be growing mango as supplemental income or may be a primary source as one of several crops • The larger scale producers often tied to processors or exporters, so export varieties more common • Irrigation and use of inputs more common than for smallholders • Use of brokers to buy mangos at farmgate or participation in cooperatives or local processing (e.g., Makueni or Tana county, see Box 3 and 4)
Private business orchards	<ul style="list-style-type: none"> • ~1% of farmers⁵⁵ • Growing mango for processing or for export • Can have own land or contracted farm labor and may also purchase from surrounding farmers/brokers • Usually has own packhouse and may have own processing facility or use county-level one
Brokers	<ul style="list-style-type: none"> • Purchase mangos from farm gate and re-sell to market sellers, kiosks, supermarkets, processors and exporters • Farmgate price can range from ~10-65% of re-sale price⁵⁶
Local market sellers	<ul style="list-style-type: none"> • Less quality or varietal differentiation with mangos often in a large pile at a kiosk or open market • Can have high spoilage rates without cold storage⁵⁷
Cooperatives	<ul style="list-style-type: none"> • Farmer cooperative society that offtake mangos from a member farmers (ranging from 10 to several hundred) and sell on at markets or to processing facilities or exporters • Cooperatives will often provide access to inputs at subsidized prices and training, and some do limited processing such as drying • Mango cooperatives have historically been small-scale in Kenya due to the disaggregated nature of the farmers and that they are not exclusively focused in mango

⁵³ BCG USAID KCDMS, 2021

⁵⁴ USAID-KAVES, 2015; BCG USAID KCDMS, 2021

⁵⁵ USAID-KAVES, 2015; BCG USAID KCDMS, 2021

⁵⁶ "Kenya: USD 116k mango", 2019; Kibaara, 2022

⁵⁷ Kibaara, 2022

Supermarkets / high-end grocers	<ul style="list-style-type: none"> • Large supermarkets such as Zucchini usually source from multiple brokers and/or large-scale farms (less common) • Will only accept high quality and specific varieties (usually Apple) • Can source mango year-round but adjust prices accordingly during off-season
Basic processors (packhouses)	<ul style="list-style-type: none"> • Either buy mangos from brokers or farmers or charge a fee to use basic machinery to sort, grade, and pack mangos to be sold at market
Value-add processors	<ul style="list-style-type: none"> • Take lower quality fruits to pulp (majority) or dry for sale in markets or use by juice and baking companies
Downstream value-addition	<ul style="list-style-type: none"> • Juicers or bakeries that buy mango pulp as inputs into further value-add products such as juice or baked goods
Exporters	<ul style="list-style-type: none"> • Require high quality mangos with certain certifications • Apple mango is Kenya's most exportable indigenous varietal

Appendix 2: select characteristics of mango-producing counties

Region / County	2019				2016	
	Population ('000s)	% of hh in crop production	% of hh in mango	% of farmers irrigating	Mango Production (MT)	Avg price (Ksh/MT)
Coastal Region	4,329	32%	8%	6%	290,110	13,355
Kilifi	1,454	50%	13%	4%	112,542	15,704
Kwale	867	58%	17%	2%	92,259	16,440
Lamu	144	40%	20%	6%	47,226	848
Tana River	316	25%	10%	13%	34,416	6,140
Taita/Taveta	341	50%	7%	18%	3,634	20,393
Mombasa	1,208	2%	0%	8%	33	20,606
Eastern Region	6,553	62%	15%	9%	433,441	18,857
Makueni	988	74%	29%	8%	214,702	15,621
Machakos	1,422	54%	19%	7%	152,496	15,440
Meru	1,546	59%	6%	19%	26,459	19,463
Embu	609	67%	15%	9%	15,600	18,500
Kitui	1,136	76%	13%	3%	13,978	9,724
Tharaka-Nithi	393	72%	13%	9%	9,877	13,247
Marsabit	460	3%	0%	0%	329	40,000
Kenya	47,564	46%	7%	6%	723,551	16,318

Source: KNBS, 2020; Kenya MOALFC, 2021

Appendix 3: distribution of mango farm sizes in Eastern and Central provinces

Table 10: Distribution of Mango Trees in Eastern Province

Farm size	Number of farms/farmers		Population of trees	
	Number	Percent	Number	Percent
Up to 10 trees	52,442	56.6%	240,678	7.9%
11 – 20 trees	14,994	16.2%	231,502	7.6%
21 – 50 trees	13,670	14.7%	456,317	15.0%
51 – 100 trees	6,079	6.6%	443,423	14.5%
101 – 200 trees	3,228	3.5%	461,964	15.2%
201 – 500 trees	1,667	1.8%	501,694	16.5%
501 + trees	570	0.6%	713,563	23.3%
Total	92,650	100%	3,049,141	100%

Source: ABD/IDM Baseline Survey, April – June 2010

Table 11: Distribution of Mango Trees in Coast Province

Farm size (number trees)	Number of farms/farmers		Population of trees	
	Number	Percent	Number	Percent
Up to 5	23,564	29.1	71,410	5.4
6 – 10	21,215	26.2	166,624	12.6
11 – 20	19,515	24.1	293,576	22.2
21 – 50	13,199	16.3	411,271	31.1
51 – 100	2,753	3.4	185,138	14
101 – 200	567	0.7	80,667	6.1
201 – 500	162	0.2	46,285	3.5
501+	81	0.1	67,443	5.1
Total	80,975	100	1,309,922	100

Source: ABD/IDM, April 2009

Appendix 4: MOALFC strategic objectives and functions

Strategic Objectives

The Strategic Objectives for the Ministry are to:

1. To create an enabling environment for Agricultural development
2. To increase productivity and outputs in agricultural sector
3. To enhance national food security
4. To improve market access and trade
5. To strengthen Institutional capacity

Functions of the Ministry

The Ministry's core functions include:

- i) Formulation, implementation and monitoring of agricultural legislations, regulations and policies
- ii) Supporting agricultural research and promoting technology delivery
- iii) Facilitating and representing agricultural state corporations in the government
- iv) Development, implementation and coordination of programmes in the agricultural sector
- v) Regulating and quality control of inputs, produce and products from the agricultural sector
- vi) Management and control of pests and diseases
- vii) Collecting, maintaining and managing information on agricultural sector

Source: Kenya MOALFC, 2022 (<https://kilimo.go.ke/about-us/>)

Appendix 5: MoITED mandate

“The mandate of the Ministry is to promote Industrialization through:

- Industrial Policy and Planning;
- SME Policy; SME Financing Policy;
- SME/ Biashara Financing Policy;
- Buy Kenya – Build Kenya Policy and Strategy;
- To Promote Standardization in Industry and Quality Control; Promotion and Development of Micro and Small Enterprises;
- To Promote and Facilitate Domestic and Foreign Investments;
- Promotion and Oversight of the Development of Special Economic Zones and Industrial Parks;
- Kenya Property Rights Policy (Patents, Trade Marks, Service Marks, and Innovation);
- Promotion of Value Addition and Agro-Processing; Textile Sector Development;
- Business Innovation and Incubation; Promotion and Development of the Cottage Industry;
- Oversight and Regulation of the Scrap Metal Industry; Industrial Training and Capacity Development;”

Source: Kenya MoITED, 2022 (<https://www.industrialization.go.ke/index.php/about-us/mandate>)

Appendix 6: Cost-benefit analysis assumptions and methodology

Note: Appendix 7 details the assumptions and calculations made to arrive at the estimated costs and benefits listed.

Potential increased revenues

Exports of fresh mango present the largest area of growth. A combination of a large and growing market for fresh mango trade and the higher prices commanded by foreign vs. buyers, leads to an estimated Ksh 0.8 – 7 billion in increased value captured by Kenyan producers (see Appendix 7 for detailed assumptions and calculations). Growing Kenya’s dried mango sector presents a triple opportunity of increasing throughput of underutilized capacity, reducing spoilage in the domestic mango value chain, and creating products that command a higher price point. Similarly, the pulp industry helps to reduce spoilage by making use of typically unsold fruit. As a result, we expect development of the value-added mango processing industry to account for an additional ~Ksh 17 – 67 M in value. Together, we expect development of the Kenyan mango industry across these product categories to yield up to an additional Ksh 7.5B in annual value.

Benefits were estimated for three product opportunity areas: increased exports of fresh mango, increased dried mango production, and increased mango pulp production:

- For increased exports, benefits are estimated to come from an increase in share of production that is exported, from 5% today to up to 20% in the future (high range of our estimates). 15% was a relevant target tested in interviews with experts in the fresh mango trade business. Other assumptions used in this calculation include:
 - Current production of 867,951 tons / year (from FAO, most recent year available)
 - Spoilage rate of 40% for fresh mango (validated with experts as high-end of spoilage estimates)
 - Domestic mango retail price of 75 Ksh / kg, export mango price of 151 Ksh / kg (from BCG / KCDMS)
- For increased dried mango production, benefits are estimated to come from increased processing capacity and utilization rate. We estimate that four new processing facilities will be built as part of our solution design, each with the capacity to process 10,000 tons of mango per year (this is the average size of extant processing facilities in Kenya). We also target an increase in utilization rate from 15% to 65%. Other assumptions used in this calculation include:
 - Dried mango accounting for 30% of all processed mango
 - Reduction in fruit weight of 65% from drying (as validated by scientific studies)
 - Spoilage rate of 10% for dried mango
 - Dried mango retail price of 2,500 Ksh / kg (from BCG / KCDMS)
- For increased mango pulp production, benefits are similarly estimate to come from increased and improved processing capacity. The above assumptions regarding processing capacity continue to apply here

Costs to achieve potential impact

These opportunities will not come without additional costs and investments. For instance, an estimated Ksh 3 – 11 M will be required to support the certification process for existing and new producers to obtain phytosanitary licenses. This amount is expected to cover the cost of the initial investments associated with attainment of the license, while the ongoing maintenance costs of the license is expect to be met by the profits earned by processing facilities. Similarly, enhancement of Kenya’s agro-processing capabilities is estimated to increase the government’s cost burden by Ksh 0.2 – 1.7 B. This amount is budgeted to upgrade 4 facilities, and build 4 additional new facilities, which together should meet the demands of both value-added processed mango products from abroad, and fruit offtake from domestic producers. Finally, the set of fiscal measures is estimated to account for Ksh 0.4 – 2.8 B in additional spent from the government.

Costs were estimated for three recommended policy solutions: support for phytosanitary certifications, enhanced agro-processing capability, and eased financial constraints:

- For phytosanitary certifications, costs are estimated based on the number of licenses sponsored. We estimated 10 additional licenses to require sponsorship from the government. The upfront cost of getting a license is estimated to be \$10,000 (based on findings from interviews with experts). We target 50% cost sharing between the processor and the government. Finally, we estimate an additional 20% additional investment to improve the phytosanitary standards of facilities
- For enhancement of agro-processing capability, we assume that 4 facilities will need to be upgraded, and 4 additional new facilities will be built. We estimate that the cost of upgrading a facility to be Ksh 78.3M (based on case studies in Makueni) and the cost of building a new facility to be Ksh 200M (based on case studies in Tana River)
- For additional financial constraints to be eased, we further segmented the solution to target areas of: new efforts for market research, loans for aggregation and processing facilities, regulation of cess fees, and tariff reduction
 - For creation of market research efforts, we estimated a 20% R&D reinvestment on MOALFC’s budget allocation of Ksh 1.5B
 - For loan subsidies, we assumed 50 loans to be subsidized at 50% of the loan value. Loan value is estimate at Ksh 100,000 / month, for 18 months
 - For cess fees, we estimate a 50% reduction in all cess fees charged (to remove instances of double taxation that currently occurs). The current cess fees of Ksh 20 per basket is used as a benchmark. We additionally assume that 70% of mangoes are consumed within county today and do not cross county lines as a result
 - For tariff reductions on imported equipment, we assume that 50 new machines will need to be imported. Based on a study of machine prices today, we estimate the average price to be \$75,000. We apply a 16% tariff rate (as published by Kenyan authorities) to estimate potentially foregone internal revenue

Appendix 7: Cost-benefit analysis detailed calculations

Unlocking Kenya's mango value chain - cost benefit analysis

Item	Units	Value (expected)	Value (low range)	Value (high range)	Source	Authors' notes
Benefits						
1. Increase exports of fresh mango						
Current total production	tons	867,951.00	867,951.00	867,951.00	FAOSTAT	
Assumed spoilage rate (for fresh)	%	33%	40%	25%	Interviews	
Current export rate	%	5%	5%	5%	Interviews	
Future export rate	%	15%	7%	20%	Assumption	
Increase in export volume	tons	58,586.69	10,415.41	97,644.49	Calculation	Assumes production holds steady
Current domestic mango retail price	Ksh / kg	75.00	75.00	75.00	BCG / USAID / KCDMS 2021	
Current export mango retail price	Ksh / kg	151.00	151.00	151.00	BCG / USAID / KCDMS 2021	
Total benefit value of increased exports of fresh mango	Ksh	4,452,588,630	791,571,312	7,420,981,050	Calculation	
		99%				
2. Increase exports of dried mango						
Current processing capacity	tons	70,000.00	70,000.00	70,000.00	Interviews / BCG	
Expected new processing capacity	tons	40,000.00	10,000.00	80,000.00	Calculation	Assumes 4 new facilities at 10,000 tons each
Total expected processing capacity	tons	110,000.00	80,000.00	150,000.00	Calculation	
Current operating rate	%	15%	15%	15%	Interviews/BCG/other sources I can find	
Future operating rate	%	65%	45%	75%	Assumption	
Increase in processing output	tons	61,000.00	25,500.00	102,000.00	Calculation	
Dried share of total processed mango	%	30%	30%	30%	Assumption	
Increase in dried mango volume	tons	18,300.00	7,650.00	30,600.00	Calculation	
Current domestic mango retail price	Ksh / kg	75.00	75.00	75.00	BCG / USAID / KCDMS 2021	
Current dried mango retail price	Ksh / kg	2,500.00	2,500.00	2,500.00	BCG / USAID / KCDMS 2021	
Reduction in weight due to drying	%	65%	65%	65%	Healthy Canning (2020)	
Assumed spoilage rate (for fresh -> dried)	%	10%	10%	10%	Interviews	
Assumed spoilage rate (for fresh)	%	33%	25%	40%	Interviews	
Counterfactual amount of fresh mango used for drying	tons	28153.85	11769.23	47076.92	Calculation	
Total benefit value of increased exports of dried mango	Ksh	39,749,712	16,550,481	66,731,538	Calculation	
3. Increase exports of mango pulp						
Increase in processing output	tons	61,000.00	25,500.00	102,000.00	Calculation	
Pulp share of total processed mango	%	70%	70%	70%	Assumption	
Increase in mango pulp volume	tons	42,700.00	17,850.00	71,400.00	Calculation	
Current domestic mango retail price	Ksh / kg	75.00	75.00	75.00	BCG / USAID / KCDMS 2021	
Current domestic mango pulp price	Ksh / kg	75.00	75.00	75.00	BCG / USAID Estimated to be similarly priced to fresh mango; additional value comes from reduced spoilage	
Assumed spoilage rate (for fresh -> pulp)	%	10%	10%	10%	Interviews	
Total benefit value of increased exports of mango pulp	Ksh	320,250	133,875	535,500	Calculation	
Total benefits across all product opportunities	Ksh	4,492,658,592	808,255,668	7,488,248,088	Calculation	

Unlocking Kenya's mango value chain - cost benefit analysis

Item	Units	Value (expected)	Value (low range)	Value (high range)	Source	Authors' notes
Costs						
(A) Support phytosanitary certifications process						
Number of licenses sponsored	#	8.00	6.00	10.00	Assumption	Assuming that there is a plant and certification required for each large-production county
Upfront cost of getting license	USD	10,000.00	10,000.00	10,000.00	Interviews	
Total cost of getting licenses until run-rate reached	USD	80,000.00	60,000.00	100,000.00	Calculation	
FX	Ksh / USD	113.65	113.65	113.65	XE.com (as of Jan 27, 2022)	
Total cost of getting licenses until run-rate reached	Ksh	9,092,000.00	6,819,000.00	11,365,000.00	Calculation	
Amount of government subsidy	%	50%	30%	75%	Assumption	
Additional % for investments in phytosanitary improvements	%	20%	20%	20%	Assumption	
Total cost for supporting phytosanitary certifications process	Ksh	6,364,400	3,409,500	10,796,750	Calculation	
(B) Enhancement of agro-processing capability						
Number of facilities to upgrade	#	4.00	-	4.00	Assumption	
Number of facilities to build	#	4.00	1.00	7.00	Assumption	
Cost of upgrading	Ksh	78,333,333	78,333,333	78,333,333	Makueni County Government (2018); The Saturday Standard (2019)	
Cost of building	Ksh	200,000,000	200,000,000	200,000,000	The Star (2021)	
Total cost for upgrading	Ksh	313,333,333	-	313,333,333	Calculation	
Total cost for building	Ksh	800,000,000	200,000,000	1,400,000,000	Calculation	
Total cost for upgrading/building	Ksh	1,113,333,333	200,000,000	1,713,333,333	Calculation	
(C) Ease financial constraints						
(i) Market research						
MOALF standard budget allocation for ag project	Ksh	1,500,000,000	1,500,000,000	1,500,000,000	2020/2021 Kenya Government Budget	
R&D re-investment %	%	20%	20%	30%	Assumption	
Cost of market research	Ksh	300,000,000	300,000,000	450,000,000	Calculation	
(ii) Subsidized loans						
Number of loans subsidized	#	50.00	50.00	50.00	Assumption	
Average monthly rent for new facility	Ksh / month	100,000.00	100,000.00	100,000.00	Interviews	
Subsidy percentage	%	50%	50%	50%	Assumption	
Months of subsidy provided	Months	18.00	18.00	18.00	Assumption	
Additional cost of subsidy	Ksh	45,000,000	45,000,000	45,000,000	Calculation	
(iii) Regulating cess fees						
Current cess fees per basket of mango	Ksh	20.00	20.00	20.00	Kenyan government	
Weight of basket of mango	kg	30.00	30.00	30.00	Assumption	
Reduction in cess fees	%	50%	50%	50%	Assumption	
Reduction in cess fees per kg	Ksh	0.33	0.33	0.33	Calculation	
Total production of mango	tons	867,951.00	867,951.00	867,951.00	FAOSTAT	
Assumed spoilage rate	%	33%	40%	25%	Interviews	
Total non-spoiled fresh mango volume	tons	585,866.93	520,770.60	650,963.25	Calculation	
Assumed export rate	%	15%	7%	20%	Assumption	
Total domestic fresh mango volume	tons	497,986.89	484,316.66	520,770.60	Calculation	
Total processing capacity	tons	45,500.00	31,500.00	52,500.00	Calculation	
Total domestic sales of fresh mangoes	tons	452,486.89	452,816.66	468,270.60	Calculation	
Share of mangoes consumed within-county	%	70%	70%	70%	FAO (2017)	
Total domestic sales of fresh mangoes across county lines	tons	135,746.07	135,845.00	140,481.18	Calculation	
Forgone internal revenue from cess regulation	Ksh	45,248,689	45,281,666	46,827,060	Calculation	
(iv) Tariff reduction						
Number of machines to be imported	#	80.00	20.00	140.00	Interviews	
Price of all machines + shipping/handling	USD	500,000.00	125,000.00	875,000.00	Assumption	Based on representative avg (50K) + 30% for shipping and handling
Import tariff in Kenya	%	16%	16%	16%	Trade.gov	
Forgone internal revenue from tariff reduction	USD	6,400,000.00	400,000.00	19,600,000.00	Calculation	
FX	Ksh / USD	113.65	113.65	113.65	XE.com (as of Jan 27, 2022)	
Forgone internal revenue from tariff reduction	Ksh	727,360,000	45,460,000	2,227,540,000	Calculation	
Total cost to ease financial constraints	Ksh	1,117,608,689	435,741,666	2,769,367,060	Calculation	
Total costs across all initiatives	Ksh	2,237,306,422	639,151,166	4,493,497,143	Calculation	

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