

SUSTAINABLE SOCIOECONOMIC DEVELOPMENT VIA MANGO FRUIT VALUE CHAIN: A COMPREHENSIVE REVIEW ON KENYA AND INDIA

CATHERINE MUENI PETER^{1*}, SUPRIYA¹, MWENJERI² AND PRATEEK KUMAR³

¹Department of Agricultural Economics, ANDUAT, Kumarganj, Ayodhya U.P - India

²Department of Agricultural Economics, Kenyatta University – Kenya

³Department of Extension Education, ANDUAT, Kumarganj, Ayodhya, U.P - India.

*Corresponding Author: mueni.peter2@gmail.com

Received: 19 March 2025; Revised: 21 April 2025;

Accepted 30 April 2025; Publication: 29 June 2025

Abstract: The mango fruit value chain plays an important role in driving sustainable socioeconomic development in both emerging and developing economies. This review explores the value chain of two major mango-fruit-producing countries Kenya and India, to assess its contribution to inclusive growth, rural livelihoods and environmental sustainability. By analysing each stage of the mango fruit value chain, from production and processing to marketing and export, the review identified shared challenges and context-specific opportunities for value addition, market access and smallholder farmer empowerment. The study highlighted the role of gender inclusivity, climate-resilience agricultural practices and public-private partnerships in enhancing value chain performance. Makeni which is the highest mango fruit producing county in Kenya relies on three business models in distributing their mango fruits while India is identified to utilise a well-structured value chain with strong institutional support however, both countries export a share of 2.1% of their mango fruit production. Drawing on comparative insights, the review underscores innovative practices in India's structured value chain to have potential that can inform strategies in Kenya, while also showcasing Kenya's emerging initiatives that promote sustainability and resilience. The review concludes with recommendations to policymakers, development agencies and mango fruit enterprise stakeholders that

To cite this paper:

Catherine Mueni Peter, Supriya & Mwenjeri Prateek Kumar (2025). Sustainable Socioeconomic Development Via Mango Fruit Value Chain: A Comprehensive Review on Kenya and India. *Journal of Applied Biology and Agriculture*. 2(1-2), 35-58.

can leverage mango sector as a strategic pathway toward sustainable development in both countries.

Keywords: Mango fruit, Value Chain Mapping, Socioeconomic, Sustainability

1. INTRODUCTION

Mango fruit (*Mangifera indica*) is hailed as the “King of Fruits” and stands as one of the most important tropical fruits in the world owing to its production, economic potential, nutritional and cultural significance both in Kenya and India. Mango fruit cultivation in Kenya and India is dominated by smallholder farmers with total contribution globally standing approximately at 2% and 45% respectively. However India is the world largest mango fruit producers, contributing over 45% of global output. The major producing states in India are Uttar Pradesh leading at 26.4% and Andhra Pradesh at 22.7% based on 2022/2023 mango production data, while in Kenya Makueni and Machakos leads with 30.4% and 23.2%.

Despite the dominance in the global arena, India's share on export remains modest due to high demand for domestic consumption, logistical challenges and strict world trade regulations, Varsha, (2022) with Kenya lagging behind due to unstructured marketing systems, United Nations Africa Renewal, (2018). India's mango yield is 9 tn/ha, which is at par with global average. However, the productivity is lower than major growing countries like Brazil (18 tn/ha) and Israel (23 tn/ha), according to Muthulakshmi *et al.*, (2022) and The Economic survey, (2017).

Kenya ranks 4th in Africa, and 13th globally contributing 1.7% of the total mango production in Africa whose global contribution stands at 10%, FAO. (2020). The increased production is attached to improvement in use of innovative technologies and adoption of new smart-farming methods. Makueni and Machakos Counties are leading producers of Mango fruits, due to the County's favourable climatic conditions, dedicated actors and the increasing demand locally and internationally. Since 2010, Kenya has progressively been producing on average about 650,000 metric tonnes of mango annually, Chege *et al.*, (2024) and Kang'ara *et al.*, (2023).

According to Uckert *et al.*, (2023) Mango producing counties in Kenya by value are Makueni leading with (30.4%), Machakos (23.2%), Kilifi (15.5%), Kwale (7.9%), Meru (4.5%), Embu (2.8%), Bungoma (2.1%) and

others (13.4%). The thriving mango industry not only generates income for the value chain actors but also addresses food security, creates employment and promotes sustainable agricultural practices, Ambuko and Owini, (2023); Muthini, (2015).

As demand for fresh and processed mango fruit products grows, particularly in international markets, the mango fruit value chain poses a strategic opportunity for sustainable socioeconomic development, World Bank. (2021). In regions like India which is the world's largest mango producer and Kenya, an emerging player in Africa's horticulture sector, the crop supports millions of livelihoods from smallholder farmers to traders to processors and exporters.

A rapid assessment of the mango fruit value chain identified three distribution models in Kenya with reference to Makueni county which are (i) a Farmer Cooperatives – Public Processor Business Model, (ii) a farmer groups – Private Processor Business Model, and (iii) the Conventional Business Model through wholesale market and brokers, Chege *et al.*, (2024). While the Agricultural sector governance in Kenya is collaborative between national and county government, support schemes are donor-backed, irrigation system still developing, market access is dominated by cooperatives, farmers groups and middlemen, with technology application focusing on mobile-agri-tech, India Agriculture is under central and state governance, support scheme are well established with extensive subsidies, Minimum Support Prices (MSP) and Crop Insurance, irrigation is also well developed in some areas, markets access is consolidated at Mandis and technology use having strong base like the growing digital tools such as eNAM and AgriStack, APEDA, (2022); Frontiers in Sustainable Food Systems. (2025); UNCTAD, (2021)

Improving market access for small-holder farmers, that has potential to raise rural incomes and mitigate poverty, a major UN Sustainable Development Goal since most of the poor are smallholder farmers living in rural areas of Africa and Asia. The Comprehensive Africa Agriculture Development Program (CAADP) prospects that, improving access to market for these farmers' bridges the gap towards poverty reduction. The long value chain, limited marketing options, restricted credit availability to low prices for their produce, lack of price transparency and poor infrastructure, marginalises smallholder farmers from the markets, Vamba *et al.*, (2023).

Both countries face challenges along their mango value chains which include low adoption rate of sustainable farming practices, postharvest losses, market information and market access, with India specifically having challenges of pest management, senile orchards and inadequate crop insurance schemes which affect farmer's welfare.

Consequently, mango fruit value chain faces systemic challenges in both countries, which include post-harvest losses, inadequate storage infrastructure, price volatility, limited access to finance and insufficient integration of smallholder farmers into high-value markets. At the same time, there are considerable opportunities from value addition, technology adoption, climate-resilience practices and inclusive policies that targets socio-economic equity and youth participation.

Therefore, the review paper synthesises existing research on Mango fruit value chain from production to consumption in Kenya and India with focus on production practices, value addition, market dynamics and sustainability challenges in order to deliver sustainable socioeconomic outcomes, and the objective of the review are:

- Examine mango fruit production in terms of area, quantity and varieties in Kenya and India
- Map and analyse the stages and stakeholders of the mango fruit value chain in Kenya and India
- Identify challenges and constraints limiting value chain development
- Highlight innovative solutions and successful interventions
- Compare lessons learned between the two countries
- Offer actionable recommendations to enhance the chain's impact on rural development, income generation and sustainability.

By combining insights from two geographically and economically diverse countries, this review offers a refined understanding of how the mango fruit value chain can serve as a catalyst for inclusive and sustainable development.

2. METHODOLOGY

The study used Comprehensive-Narrative Literature Review Approach to establish the role of mango fruit value chain in enhancing sustainable socioeconomic development in Kenya and India. The review attempts to identify

how interventions in production, marketing, processing as well as exportation contributes to welfare, income generation, employment and sustainability in the two mango-producing countries. Therefore five databases we used to search for the literature between March and June, 2025. These are Web of Science, Google Scholar, Scopus, Science Direct and CAB Abstracts. Some Grey literature sources were also and includes FAO, World Bank, Ministry of Agriculture – Kenya, Indian Council of Agricultural Research and NGO publications (TechnoServe, SNV, GIZ). The key words used were; Kenya and India, mango value chain, socioeconomic development, farmers welfare and sustainability practices.

3.1. Mango Fruit Production in India

Mango fruit cultivation in India is fully diversified in different agro-ecological zones extending from Uttar Pradesh in the North to Andhra Pradesh and Maharashtra in the South. According to 2022-2023 mango fruit production data, India produced 21.97 MMT (million metric tonnes) contributing a global share of 45% of the world mango production, *CEIC Data, (2023)*.

Healthy and mature mango fruit tree in India aged 10 -15years old is said to yield around 200 – 300 pieces of mango against a potential of 500 – 1000 pieces per tree. Challenges range from illiterate and limited training among farmers who end up using traditional production methods, to unseasonal rainfalls and temperatures which affect flowering and fruit setting that requires dry weather, Antwi-Boasiako *et al.*, (2024) and ICAR, (2020). Below is the breakdown per state on area under cultivation of the fruit tree.

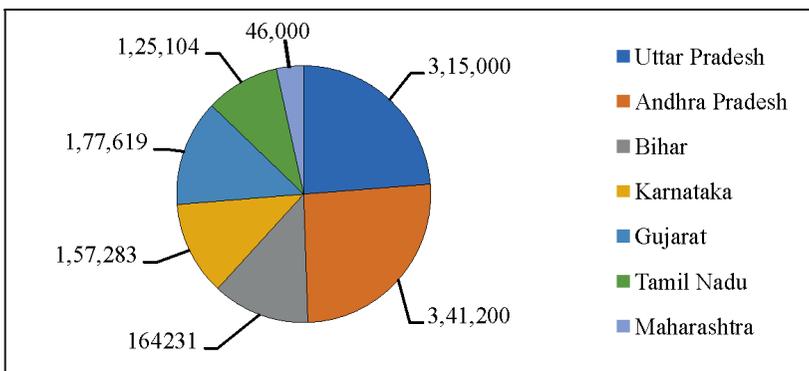


Figure 1.1 Area under mango fruit cultivation (ha) leading states in India

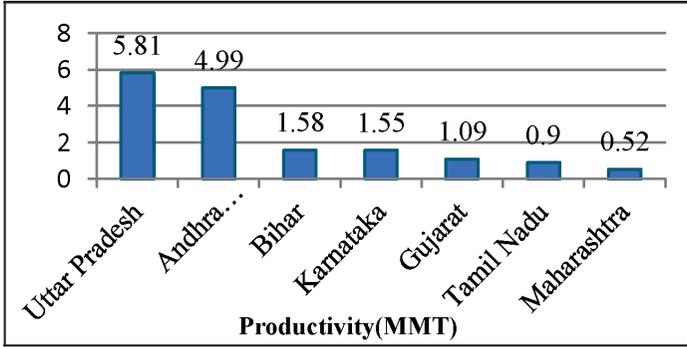


Figure 1.2: Mango Fruit Productivity by State in India

The national share contributed by each state is as shown by the doughnut chart below, where the figures are approximations based on available estimate according to CEIC Data, (2023).

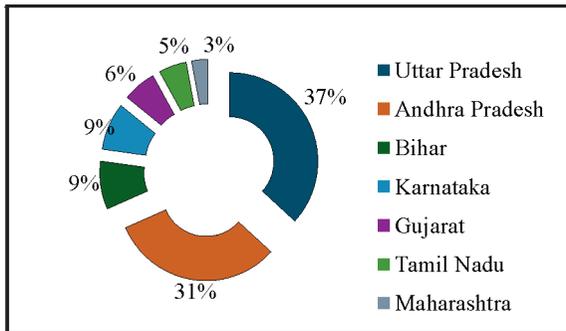


Figure 1.3: National share per state in Mango Production in India

India has over 1000 mango varieties however the major table and export varieties cultivated for socioeconomic development are featured in the table below.

<p>Uttar Pradesh: Dasheri, Langra, Chausa, Safade</p>	<p>Andhra Pradesh: Banganapalli, Totapuri, Neelum, Suvamarekha, Rasalu (juicy local variety), Dashehari, kesar, Himayath.</p>	<p>Bihar: Dudhia malda, Jardalu, Amrapali</p>	<p>Karnataka: Alphonso, Totapuri, Banganapalli, Neelum</p>
<p>Gujarat: Kesar (Gir Kesar), Alphonso, Rajapuri</p>	<p>Tamil Nadu: Totapuri, Banganapalli, Neelam, Imam Pasand, Alphonso</p>	<p>Maharashtra: Alphonso (Ratnagiri), Pairi</p>	

Figure 1.4: Major Mango Fruit Varieties grown in India by State

3.2. Mango Fruit Production in Kenya

The area under mango fruit cultivation in Kenya is not explicit by counties, however the area under production according to HCD, (2018) was 49,098 ha. By 2023 the area under mango cultivation has been increasing county wise as featured by Makueni County whose area is 65,453ha., Kang'ara *et al.*, (2023). The gap in Kenya mango production lies in the unavailable information about explicit area under mango cultivation for all major producing counties, to allow better planning towards government intervention for sustainable production.

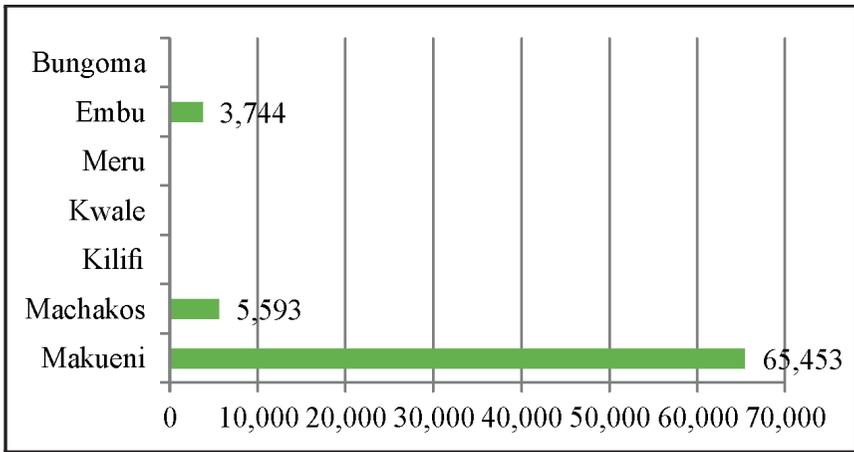


Figure 2.1: Area under mango fruit cultivation (ha) – leading Counties in Kenya

Mango fruit yield in Kenya Mango production in Kenya per tree (10 – 15 years old) stands at 180 – 200 pieces against potential quantity of 500 pieces per tree. With major confounding factors being climate variability, drought, access to finance, market, technology, ownership of land, pests, diseases and mango varieties, United Nations Africa Renewal, (2018). According to Kioko *et al.*, (2024), increased mango fruit productivity is not attached to sustainable agronomic practices but increased area of production. This calls for consolidated efforts among mango fruit stakeholders to identify strategies towards curbing effects of climate change, drought and market access through appropriate postharvest innovations in storage, transportation and increasing shelf-life among different mango varieties for enhanced performance.

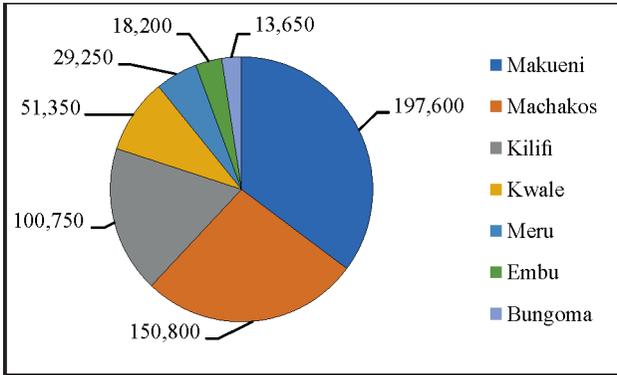


Figure 2.2: Mango Fruit Productivity by Major Producing Counties in Kenya

The major counties in mango fruit production contribute differently to the national share and it is as shown by the doughnut chart below in percentage.

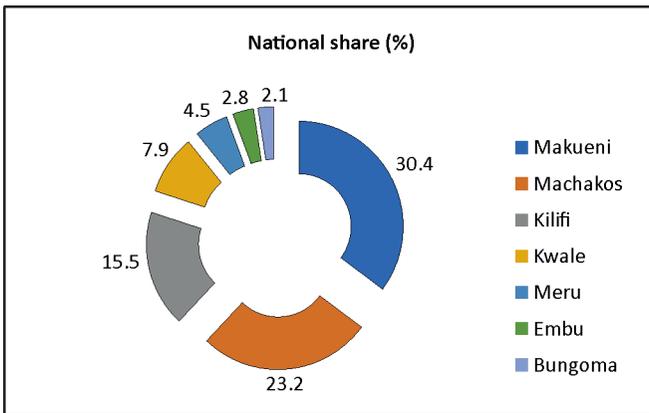


Figure 2.3: National Share per County in Mango fruit Production in Kenya

Kenya has diverse mango fruit varieties produced by mostly smallholder farmers who hold farmlands sizes of 1ha to 5ha. The figure below shows the major mango fruit varieties by major counties in Kenya, KALRO, (2019).

3.3. Value Chain Mapping and Actors

Value chain is a model that encompasses set of activities where value is created when availing a product to consumer by obtaining inputs to production, processing and distribution. The main concept here is increasing the value of mango fruit through enhanced methods that lead to higher profits to the

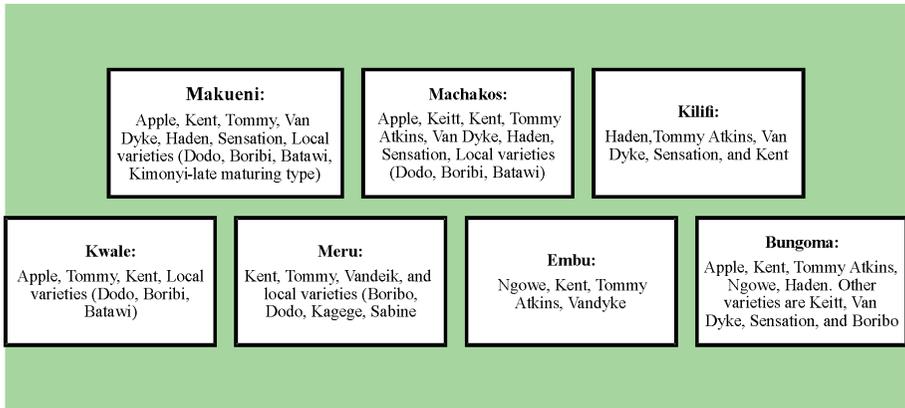


Figure 2.4: Major Mango Fruit Varieties in Kenya

farmers, ADB, (2021); World Bank. (2021). The model involves a number of intermediaries such as producer, processor, traders and distributors, Honja, (2014).

Mapping on the other hand is a concept that will visualize the flow of agricultural products and services from farmer to consumer indicating all the actors and activities. Therefore this review maps the mango fruit value chain showing the interconnected stages from input supply level to consumption end point and who influence the overall value generated. While the structure is generally similar across the two countries, the level of integration, institutional support and development vary between Kenya and India. The following is explanation of the stages.

Input Suppliers

They are actors who are engaged with supplying raw materials to mango growers, and they involve nurseries and agro-dealers. The main items supplied are saplings/ seedlings, manure, fertilizers, mango pesticides, tools and equipments. The source of these supplies will differ with farmer preferences and the region, making them experience different challenges in the process. Due to the informal system in Kenya, the quality of pesticides, saplings and farm tools and implements may lack consistency, compared to India where the input supply chain is formalised through government centre like Krishi Vigyan Kendras and certified government nurseries that facilitate subsidized high yielding varieties.

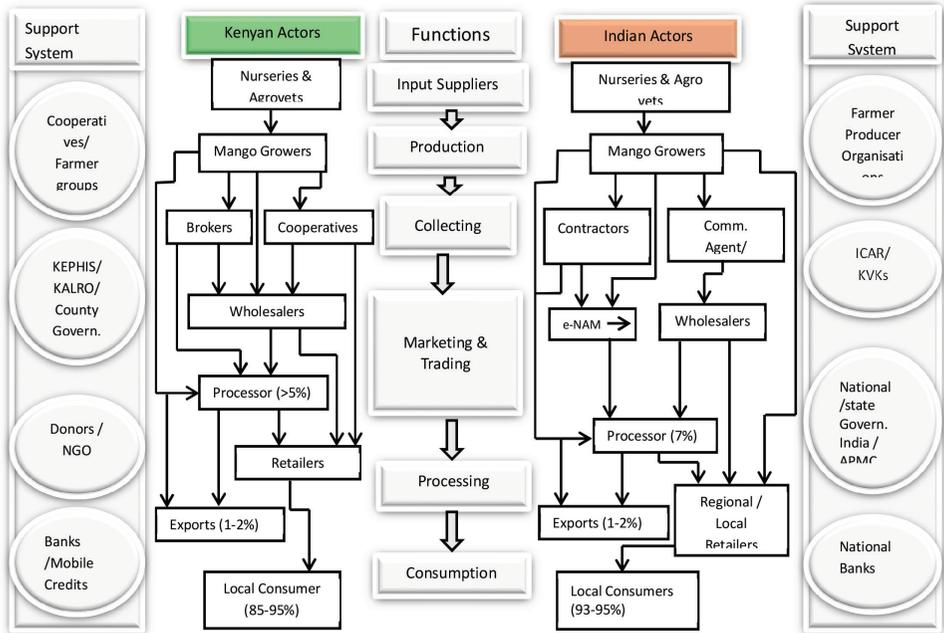


Figure 3.1: Mango fruit Value Chain Mapping on Kenya and India

Mango Growers

This is characterised by farmers who cultivate, manage and maintain quality of the mango fruit orchards through pest and disease control. They handle harvesting and other on-farm practices such as grading, sorting, washing and packing. Kenya is dominated by smallholder farmers, who rely on rain-fed production and encounter high postharvest losses due to insufficient training and poor infrastructure. India has mixed small, medium and large-scale farmers who has access to irrigation via drip or boreholes and participates in farmer producer organizations.

Contract Farmers

This actor buy mango fruits directly from the mango growers in bulk, and then segregates them through sorting and grading for further processing. However for Contract farming which is practiced widely in India, the farmers and traders carry out agricultural production based on a signed agreement, Shree and Vaishnavi, (2022) and Mishra and Sharma (2017). Based on ICAR definition, it is “an agreement between farmers and processors or marketing firms about

production and supply of agricultural products including Mango fruits, under pre-agreed production term.” The agreement entails mandatory pre-determined production terms, who to bear the costs involved in management of the orchard and the fixed prices for the output whether the produce exceeds or subceeds the stated quantity. This reduces market risk for farmers due to assured procurement.

Aggregators, Commission Agents and Cooperatives

They also buy mango fruits directly from farmers whereby in Kenya there are a few cooperatives and aggregation centres but the collection in rural areas is majorly dominated by brokers who end up exploiting the farmers due to lack of price transparency. Whereas in India FPOs and Cooperatives plays the role of aggregating the mango fruits enhancing the bargaining power of farmers on price due to collective market.

Wholesalers / Traders

They buy large quantities from aggregators or farmers and either transports to different markets or processors. They are also involved in setting prices especially in uncontrolled markets, especially in Kenya where the networks are informal with limited infrastructural capacity compared to India where they operate under Mandis (regulated markets) and licensed commission agents which shows some formal setup.

Processors

These are the actors who convert mango fruits in to other products like pulp, candy, juices, jam, concentrates, pickles and dried mango etc. and later grade them based on quality for export and local market. This adds value and shelf-life, thus reducing postharvest losses to the perishable products, Bien, and Soehn, (2022). In Kenya there are cottage industries that deals with value addition which accounts for less than 5% of total mango produced but they have limited capacity Musyoka, (2020), with NGO-led innovative initiatives playing a key role in women empowerment toward income generation. However, follow-up studies shows that those involved in grading are minimal thus the export-grade processing is still developing, Swibe, (2023). On the other hand, India has strong presence of mango processing industries which accounts for 7% of total

mango produced especially in Andhra Pradesh and Maharashtra serving both export and domestic markets, **Patil, et al., (2025) and APEDA, (2021).**

Retailers

They sell fresh mango fruits or processed products directly to the consumers either packaged or direct display with promotion price offers. They provide conduit for consumer feedback. In Kenya they are mostly found in open-air markets and as road-side vendors, with supermarkets handling high quality mangoes and processed products. While in India it's mostly dominated by road-side vendors and wholesale markets, with online delivery platforms emerging in urban centres.

Exporters

They engage with contract farmers and producers, handling compliance to international standards like Global GAP and SPS in terms of packaging, quality certification and logistics for international trade as well as HACCP (Hazard Analysis Critical Control Points) in food safety. Kenya exports about 1-2% of total mango fruit production whose markets are mainly UAE, Saudi Arabia and Europe with strict SPS standards posing great challenges, but practices like hot water treatment and established pest free areas are used to control fruit-fly, Turley *et al.*, (2022) while India exports 1-2% of total mango production to markets in UAE, UK, Qatar, Kuwait, Oman and USA among others, whereby they use vapour heat treatment and irradiation for export compliance purposes, according to Patil *et al.*, (2025); APEDA, (2021).

Transporters

They are involved with moving the mango fruits from farmers to market or processing centres and making sure they minimize the spoilage through careful handling. In Kenya the sector is dominated by youth with poor roads affecting timely delivery of mango fruits and inadequate cold-chains reduces their shelf-life. The better road connectivity in India and availability of cold-chain transport has lowered the spoilage during movement especially in export corridor.

Support Service Providers

These are responsible for provision of extension services to farmers, training, market information, offer financial credits, insurances, capacity building

and improvement of quality. Kenya gains support from national and county government agricultural officials, Agwu, (2023) as well as NGOs like SNV and TechnoServe, while India offers their services through ICAR centres called KVKs, NARBAD and state horticulture departments, larger farmer outreach and well-funded schemes, ICAR, (2020).

Policy Makers and Regulatory Bodies

They are tasked with formulating and enforcing policies on quality standards on inputs, food safety and trade. They also regulate export standards, subsidies, promotion of innovation and link farmers with market. Ministry of Agriculture is key in both countries, with Kenya SPS standards under KEPHIS and horticultural crop directorate, while India has APEDA for exports, state horticulture mission and FSSAI for food safety.

Consumers

They are the final actors in the mango value chain and they buy mango fruit either as fruit or processed from the retailer, processor or farmers. They prefer physically fit and unbruised fresh mango for their consumption

3.4. Challenges and Mitigation Strategies in the Mango Fruit Value Chain

Despite the economic potential of the mango value chain in both Kenya and India, several systemic and context-specific challenges hinder its performance, efficiency, inclusiveness and sustainability. These constraints exist across all stages of the chain and impact the ability of smallholder farmers and other actors to realizing the full value of their produce hence derailing development, Nyamongo and Muturi, (2021).

A key mitigation strategy to enhance production in India is seen in Andhra Pradesh state through use of fruit covers to protect the mango fruits from pests and extreme weather to enhance export market and maintain the export-quality increasing presence in the international market. Moreover, sustainable practices like high-density planting, canopy management, integrated nutrition and pest management, technologies to conserve water such as drip irrigation and best soil preparation methods are being used to increase mango fruit productivity, Suman *et al.*, (2022) and Mohan *et al.*, (2024)

Summary of Major Challenges and Mitigation Measures Specific to Kenya and India

Value chain Stage	Major Constraints	Interventions Proposed	Kenya	India
Input supplies & Farm Production	<ul style="list-style-type: none"> . Low quality seedlings / saplings . Pests & diseases . Climate variability (erratic rainfalls, monsoons, drought) 	<ul style="list-style-type: none"> . Promote improved & resilient mango varieties. . Training farmers on IPM for control pests & diseases 	<ul style="list-style-type: none"> . Initial stages into adoption of climate smart practices e.g. IPM 	<ul style="list-style-type: none"> . Advanced stages in adoption of climate smart practices .eg. High density planting, IPM & drip irrigation
Postharvest handling	<ul style="list-style-type: none"> . High postharvest losses . Inadequate storage infrastructure . Lack of widespread aggregation centres 	<ul style="list-style-type: none"> . Investment in cold-chain. . Farmer empowerment on postharvest handling practices. . Installation of aggregation centres 	<ul style="list-style-type: none"> . PHLW between 30%–45%. . Lacks adequate storage infrastructure and aggregation centres 	<ul style="list-style-type: none"> . PHLW between 20%-30% . More established cold storage chains & pack houses. . Inadequate aggregation centres
Processing	<ul style="list-style-type: none"> . Seasonal glut . Inadequate processing infrastructure 	<ul style="list-style-type: none"> . Train SMEs & agro-processing sector on value addition. . Encourage private-public investment for local processing units. . Design off-season supply models 	<ul style="list-style-type: none"> . The sector is growing through donor supported programs . Most mango is sold while fresh . Low capacity for value addition 	<ul style="list-style-type: none"> . Well-developed processing industry . Value added products for export channel
Distribution / Marketing	<ul style="list-style-type: none"> . Long channels . Farmers rely on middlemen . Limited market information on price . Limited exports 	<ul style="list-style-type: none"> . Promoting digital market platform . Formation of strong cooperatives & FPOs . Export facilitation programs to train farmers on SPS&GAP standards 	<ul style="list-style-type: none"> . Heavy reliance on informal markets and brokers . Low farm-gate prices to farmers . Low adoption of M-Farm digital market 	<ul style="list-style-type: none"> . Well-organised markets. . Smallholder farmers lack direct market linkage. . High adoption of e-NAM digital market
Financial & Institutional Support	<ul style="list-style-type: none"> . Limited access to finances . Weak infrastructure and logistics 	<ul style="list-style-type: none"> . Agri-Fintech and mobile services i.e. Mobile-based loan apps and credit scoring . Warehousing and storage receiving systems . Enhancing extension services 	<ul style="list-style-type: none"> . Smallholder farmers struggle to access affordable credits . Safaricom's DigiFarm 	<ul style="list-style-type: none"> . Smallholder farmers struggle to access affordable credits . Kisan Credit card to support input-supplies to registered farmers
Policy Strategies & inclusiveness	<ul style="list-style-type: none"> . Land & resources access . Feeble supportive policies . Marginalization of women and youth 	<ul style="list-style-type: none"> . Mango-specific policies . Advocate for land tenure reform . Inclusive credit schemes . Training and empowerment programs 	<ul style="list-style-type: none"> . Agricultural Sector transformation & growth strategy (ASTGS) . Climate-Smart Agriculture strategy (2017-2026) . The Youth Agribusiness Strategy (2018-2022) . Land Reforms & Tenure Security 	<ul style="list-style-type: none"> . National mission on sustainable Agriculture . Agricultural Infrastructure development . Technology and Digital Agriculture mission . FDI in Agriculture

In Kenya there are donor supported interventions like ICIPE-led IPM package such as male-annihilation and auto-dissemination capable of reducing postharvest losses by 27.2% and increasing income by ksh. 42,960/acre, Otieno, (2023) and Korir *et al.*, (2015). Other measures in the control of Fruit fly is use of baits like protein baits, methyl eugenol traps, biological controls like *Fopius arisanus* or parasitoids as well as regular field sanitation by removing fallen fruits to break pest cycles, Muriithi *et al* (2024) and Gichungi, (2021).

ICAR promotes IPM kits in India such as pheromone traps, neem-based bio-pesticides, biological controls for mango hopper, mealybug and powdery mildew and copper oxychloride and sulphur sprays for the control of fungal infections, Balasubramaniam, (2022).

For sustainable farming practices, Kenya has adopted drought tolerant varieties like Apple and Ngowe varieties, micro-catchment and mulching practices while in India drip irrigation, rain water harvesting and intercropping are major practices towards resilience in production. However both countries, practice regular pruning, adoption of high density planting and use of growth regulators in induction of flowering uniformity, Onyango *et al.*, (2023) and Bastia *et al.*, (2025).

Post-Harvest Losses due to poor handling, lack of cold storage facilities and inadequate infrastructure, can be curbed via development of Cold Chain through Investment in solar-powered cold storage units, especially at aggregation point, Jarman *et al.*, (2023) According to GIZ, (2020), training Farmers on Post-Harvest Handling to enhance their understanding on sorting, grading and packaging hygiene techniques can reduce spoilage and improve quality to meeting export standards, Reddy and Murthy, (2023). Decentralized Aggregation Centres can reduce perishability if the stakeholders can establish rural collection hubs equipped with basic processing and storage infrastructure to aggregate mango fruits during harvesting, ICAR, (2020).

Processing and value addition practices can be strengthened through Public-Private Partnerships (PPPs), a strategy that encourages investment in small-scale processing facilities through tax incentives and subsidies, Abdulsamad, *et al.*, (2015). Support for Agro-processing SMEs provides technical training, business incubation and access to affordable equipment can improve the value chain expansion through value added products, APEDA. (2022) therefore increased income and employment. Off-season Processing Models such as contract-based buying agreements which ensures supply continuity for the processors is a major sustainable practice that can ensure all-year-round supply of mango products, FSD Kenya, (2021).

Market access and pricing due to informal markets, poor bargaining power and export limitations can be improved through Digital Market Platforms that promote mobile-based business models like M-Farm in Kenya and e-NAM in India to provide real-time price information and directly connect farmers to

buyers. Encouraging Farmer Producer Organizations (FPOs) and Cooperatives will strengthen marketing by enhancing negotiating power and quality control. Moreover, Export Facilitation Programs can assist farmers to meet Sanitary and Phyto-Sanitary (SPS) standards, packaging norms and certifications to access premium markets, Deuss and Laget, (2023) and M-Farm Kenya. (2021).

To expand financial and institutional support in terms of limited access to credit and weak policies, interventions such as Agri-fintech Solutions are major solution. They are Mobile-based loan apps and credit scoring models that provide farmers with fast and affordable credits to allow them meet their farm requirements. In Kenya we have Safaricom's DigiFarm and are seen to ease financial strains among smallholders. In India there is an organised subsidy plan called Kisan Credit Card which provides the smallholder farmers with input subsidies in terms of cash 6,000 rupees per year per registered household, Sharma *et al.*, (2025). Additionally, Warehouse Receipt Systems has potential to enable farmers store mangoes and use them as collateral for credit facilitation, Narayanan *et al.*, (2024) and Bayudan-Dacuycuy, *et al.*, (2022).

Policy Reforms is advisable to develop mango-specific strategies at national and county/state levels in the coordination of interventions and investments. Policies that promote gender equity and youth inclusivity are important to target Women and Youth trainings for skills development focusing on value addition, agribusiness and entrepreneurship. Inclusive Financing Models like friendly loan schemes for women and youth which has less collateral demands and financial literacy support are seen as gateway to credit access. Finally, Policy reforms and community advocacy to promote equitable land rights and leasing models for Land Access will enable women and youth acquire land for agricultural productivity without being marginalised.

3.5. Innovations in Mango Fruit Value Chain

Kenya and India have implemented innovative models, technologies and programs, which offer replicable examples that combine sustainability, profitability and inclusivity.

India has **modelled FPOs and Cooperative Marketing** such as Sahyadri Farmers Producer Company (Maharashtra) aggregates mangoes from over 10,000 farmers who have invested in sorting, grading, ripening chambers and export logistics. This has enabled farmers to bypass middlemen and access premium from domestic and export markets, hence increasing farmer income

by 30–40%, improved traceability and reduced post-harvest losses, Shree and Vaishnavi, (2022) and Narayanan, (2021).

On the other hand, Kenya has **modelled Solar-Powered Cold Storage Solutions** like EcoZen and SokoFresh pilot projects that provide mobile-solar-powered cold storage for mango farmers in rural Kenya. They operate on basis of pay-as-you-store and are linked to digital traceability, which has potential to reduce post-harvest losses on users up to 50%, improving shelf life, thus its accessible to formal buyers.

India has **export-oriented mango farms** in Andhra Pradesh and Gujarat which benefits from contract farming with exporters providing inputs, training and guaranteed prices, while Kenya has **exporters** like Mace Foods and Selina Wamucii who link smallholders to European Union markets under compliance schemes such as Global G.A.P certification, which has led to more stable incomes, improved product quality and better access to finance through pre-financing models.

India has an **advanced digital market platform e-NAM** (National Agricultural Market) connecting farmers to buyers across states, promoting transparency and competition, with Kenya having an emerging **M-Farm** that allows farmers to access real-time market prices, inputs and sell collectively enabling farmers to receive better prices and reduce dependence on middlemen, M-Farm Kenya. (2021).

In Kenya **women's cooperatives** in Machakos and Makueni counties produce dried mango, juice and chutneys using locally sourced fruit, while India has **Self-help groups** (SHGs) in Tamil Nadu and Kerala engaging in mango pickle and pulp production for regional markets. This has led to women empowerment, value addition at community level and increased household incomes.

Mobile-Based Extension Services such as **Avaaj Otalo** in India and **iShamba** Kenya offer audio-based advisory services via phone, including tips on disease control, pruning, and post-harvest practices. This has led to greater retention of farmers knowledge and real-time problem-solving in rural areas with limited extension coverage, GIZ. (2020).

3.6. Case Study

The review identified major effective mango fruit value chain (MFVC) interventions by comparing Kenya and India, focusing on value addition, market access and smallholder farmers' empowerment.

Case Study 1: Sahyadri Farmers Producer Company (India)

Sahyadri Farmers Producer Company is located in Nashik, Maharashtra state in India. It is one of India's largest FPOs, operating with over 10,000 fruit and vegetable growers, including mango fruit farmers. The FPO has invested in shared infrastructure for post-harvest handling, which includes pack-houses, ripening chambers, cold storage and export-quality processing units. The company offers traceability, collective bargaining as well as international markets access. Through this intervention point, farmers are able to retain 85% of the final market price which is more than traditional means which offers between 40–50%. It also reduces losses and wastage in a drastic way, and farmers are empowered via ownership and equity in the FPO.

Case Study 2: Makueni Mango Processing Plant (Kenya)

Makueni Mango Processing Plant is located in Makueni County, Kenya. It was launched by the county government of Makueni in partnership with SNV (single nucleotide variant) a Netherland Development Organisation and private actors. It is involved with processing of mangoes fruits into puree, juice and dried slices, obtained from over 7,000 smallholder farmers. The facility also offers services like cold storage and grading as well as connecting farmers with local and regional buyers. The facility has led to seasonal glut mitigation; enhanced market access and off-season income creation through value addition, local cooperatives empowerment and improvement in rural employment, SNV Netherlands Development Organisation, (2019).

3.7. Conclusion

The mango fruit value chain in both Kenya and India is occasioned by important opportunities that drive socioeconomic development sustainably, especially in rural communities relying more in Agriculture. The review has indicated key intervention point that can aid in unlocking greater value, reducing losses and enhance livelihoods along the mango fruit value chain.

India has a strong farmer-led institutions and export-oriented processing, that provides worthwhile lessons for Kenya, whose infrastructure and market capacity are expanding steadily. Conversely, Innovations in Kenya are decentralized with climate-resilient solutions and therefore can offer adaptable models for underserved communities of India.

Notwithstanding, the success of these attempts relies on the systemic support from inclusive policies, strategic infrastructural investments, climate-resilient innovations and the empowerment of marginalized rural poor, especially women and youth. Therefore, to scale the impact, a multi-stakeholder platform encompassing farmer cooperatives, government institutions, processors, distributors and NGO's is critical.

Through the alignment of Mango Fruit Value Chain development to sustainability and equity objectives, the sector can expand beyond a fruit economy to a driving force for food security, rural transformation and climate resilience.

3.8. Policy Implications and Recommendations

The transformation of mango fruit value chain into a sustainable engine for socioeconomic development requires coordinated policy actions across various sectors. Insights from Kenya and India suggest that enabling environments anchored on inclusive policies, strategic investment and institutional capacity are critical in unlocking the chain's full potential. Some of the key policies and their implications capable of addressing government strategic plans, private investments and NGO programs are as indicated below:

Strengthen Farmer Organization and Collective Marketing

Major implication is driven by the strong Farmer Producer Organizations (FPOs) and cooperatives which will mitigate exploitative middlemen and ultimately enhance the economies of scale and competitive advantage on inputs supplies. Thus the review recommends provision of legal and financial support to Cooperatives, farmer groups and FPOs like tax incentives and matching grants by the governments, as well as promoting peer-learning platforms and national federations of FPOs to enhance collaboration.

Invest in Post-Harvest Infrastructure

The implication of the investment is anchored on the importance of addressing food security and increase income of smallholder farmers through reduction of postharvest losses. Thus the review recommends Public-Private Partnerships (PPPs) which will work together towards providing accessible rural cold storage facilities, processing units and logistics hubs to ensure that farmers can

increase shelf-life of their produce as well as add value for easy transportation. Additionally, pricing mechanism on decentralized storage and solar-powered technologies for the farmers should be provided.

Facilitate Access to Finance and Insurance

Through access to finance by smallholder farmers, women and youth, financial exclusion which is a major constraint can be mitigated. Therefore the review recommends development and scaling-up of agri-fintech models and digital credit scoring systems, expanding weather-indexed crop insurance specific to mango production seasons and offering blended finance options to processing units and SMEs.

Promote Market Linkages and Export Readiness

The implication is associated with quality standards and logistics which determine the efficiency in Marketing systems and global competitiveness. The review recommends strengthening the traceability systems and promoting compliance to SPS (Sanitary and Phyto-Sanitary measures) and Global G.A.P (Good Agricultural Practices) standards, as well as investing in export facility desks and logistics support at county/state levels; and support on digital platforms to connect farmers to high-value buyers.

Mainstream Climate Resilience and Sustainability

The implication here lies in the threats posed by climate change hence affecting the long-term viability of mango fruit production. Thus the review recommends adoption of climate-resilient practices such as agroforestry, drip irrigation, organic inputs, protective gear, promoting research on drought resistant and pest resistant mango varieties and incorporating mango fruit value chain resilience into national climate adaptation goals.

Ensure Inclusivity and Gender Equity

The implication is that, mango fruit value chain potential and sustainability can be enhanced through women and youth inclusion. The review recommends creation of gender-responsive policies in agriculture and agro-processing; provide frameworks on how to lease land, training programs on finance and business incubation for women and youth as well as full representation in decision-making bodies such as FPO boards and value chain councils.

References

- Abdulsamad, A., Stokes, S., & Gereffi, G. (2015). Public-private partnerships in global value chains: Can they actually benefit the poor?. *United States Agency for International Development-Leveraging Economic Opportunities Report*, (8).
- ADB. (2021). Improving agricultural value chains in Uttar Pradesh. Asian Development Bank.
- Agricultural and Processed Food Products Export Development Authority (APEDA). (2021). India export statistics – Fresh mangoes. In *Agri-Exchange: India export analytical report*. <https://agriexchange.apeda.gov.in/>
- Agwu, A. E., Suvedi, M., Chanza, C., Davis, K., Oywaya-Nkurumwa, A., Najjingo Mangheni, M., & Sasidhar, P. V. K. (2023). Agricultural extension and advisory services in nigeria, malawi, south africa, uganda, and kenya. *Partnerships for Innovative Research in Africa (PIRA) Research Report*. East Lansing, Michigan, USA: Alliance for African Partnership, Michigan State University.
- Antwi-Boasiako, A., Amponsah, P., Opoku, J. A., Coulibaly, D., & Mintah, P. (2024). Increasing Mango Production Efficiency under the Fast-Changing Climate. In *Abiotic Stress in Crop Plants-Ecophysiological Responses and Molecular Approaches*. IntechOpen.
- APEDA. (2022). Mango Export Statistics and Value Chain Support Programs. Agricultural and Processed Food Products Export Development Authority, Government of India. <https://agriexchange.apeda.gov.in/>
- Balasubramaniam, M. (2022). Evaluation of frontline demonstrations on integrated pest and disease management (IPDM) practices in paddy.
- Bastia, D. K., Behera, S. K., Tripathy, S., Nanda, A., Rath, S., & Srivastava, R. K. (2025). Building Resilience: Climate Adaptation Practices in Indian Rainfed Farming. In *Mitigation and Adaptation Strategies Against Climate Change in Natural Systems* (pp. 109-147). Cham: Springer Nature Switzerland.
- Bayudan-Dacuycuy, C., Magno-Ballesteros, M., Baje, L. K. C., & Ancheta, J. A. (2022). Sustainable value chain financing for smallholder agricultural production in the Philippines. *Philippine Journal of Development*, 46(1), 19-40.
- Bien, J., & Soehn, I. (2022). Reducing post-harvest losses for mango farmers in Kenya (SYPA Thesis). Harvard Kennedy School.
- CEIC Data. (2023). Production of horticulture crops in major states – Fruits (Mango) [Database table]. India Premium Database: Agriculture Sector (Table IN.RIP021).

- Chege, C. G. K., Onyango, K., Bolo, P., Ndiwa, A. M., & Wanyama, R. (2024). Agroecological mango business models in Kenya: A report of the assessment of the mango business models in Makueni Agroecological Living Landscapes (ALLs), Kenya.
- Deuss, A., & Laget, E. (2023). Sanitary and phytosanitary approval procedures: Key issues, their impact on trade, and ways to address them.
- FAO. (2020). Developing Sustainable Value Chains for Smallholder Farmers: Mango Case technology
- Frontiers in Sustainable Food Systems. (2025). Strengthening agricultural extension systems through digital innovations in India. *Frontiers in Sustainable Food Systems*, 1430336. <https://www.frontiersin.org/articles/10.3389/fsufs.2025.1430336/full>
- FSD Kenya. (2021). Mango value chain report for Kenya. Food Security and Nutrition Working Group.
- Gichungi, H. M. (2021). Impact Assessment of Integrated Pest Management Strategy for Control of Mango Fruit Fly on Women Decision Making Among Smallholder Mango Producers in Machakos County, Kenya (Doctoral dissertation, UON).
- GIZ. (2020). Scaling Sustainable Agriculture: Value Chain Approaches in East Africa. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.
- Honja, T. (2014). Review of mango value chain in Ethiopia. *Journal of Biology, Agriculture and Healthcare*, 4(25), 230-239.
- ICAR. (2020). Innovations in Mango Production and Post-Harvest Management. Indian Council of Agricultural Research. <http://www.icar.org.in>
- Jarman, A., Thompson, J., McGuire, E., Reid, M., Rubsam, S., Becker, K., & Mitcham, E. (2023). Postharvest technologies for small-scale farmers in low-and middle-income countries: A call to action. *Postharvest Biology and Technology*, 206, 112491.
- KALRO. (2019). Mango Production Manual for Smallholder Farmers in Kenya. Kenya Agricultural and Livestock Research Organization. <http://www.kalro.org>
- Kang'ara, J. N., Nzioka, C., & Wambua, J. (2023). Socio-economic and physical factors affecting mango performance and productivity in Makueni County, Kenya. *International Journal of Research and Innovation in Social Science (IJRISS)*, 7(8), 1–9.
- Kioko, D., Benards, P., Timamy, P., & Mohamed, K. (2024). Socio-Economic and Physical Factors Affecting Mango Performance and Productivity in Makueni

- County, Kenya. *International Journal of Research and Innovation in Social Science*, 8(12), 4456-4468.
- M-Farm Kenya. (2021). *Digital Market Platforms and Value Chain Efficiency: The Case of Mango Farmers in Eastern Kenya*. M-Farm Insights Report.
- Mishra, S., & Sharma, S. (2017). *Contract farming in India: Opportunities and challenges*. *International Journal of Agricultural Sciences*, 9(2), 5192–5197.
- Mohan, G., Perarapu, L. N., Chapagain, S. K., Reddy, A. A., Melts, I., Mishra, R., ... & Fukushi, K. (2024). Assessing determinants, challenges and perceptions to adopting water-saving technologies among agricultural households in semi-arid states of India. *Current Research in Environmental Sustainability*, 7, 100255.
- Muriithi, B., Franchini, R., Kolhoff, P., Seekman, V., Grossman, L., Mulungu, K., ... & Khamis, F. M. (2024). Gendered barriers and opportunities for scaling integrated pest management practices along the mango value chain in Kenya. *Journal of Integrated Pest Management*, 15(1), 5.
- Musyoka, J. K. (2020). *Farm-level supply and value addition of mangoes among small-scale producers in Machakos County* (Masters dissertation, University of Embu).
- Muthini, D. N. (2015). An assessment of mango farmer's choice of marketing channels in Makueni, Kenya.
- Muthulakshmi, K., Thilagavathi, M., Shivakumar, K. M., Duraisamy, M. R., Kavino, M., & Uma Gowri, M. (2022). Determination of growth and export performance of mango in India. *Journal of Experimental Agriculture International*, 44(10), 163–169. <https://doi.org/10.9734/jeai/2022/v44i1030889>
- Narayanan, S. (2021). *Farmer Producer Companies in India: Progress, Challenges and Policy Issues*. IGIDR Working Paper WP-2021-012.
- Narayanan, S., Hussain, S., & Rashid, S. (2024). *Feasibility of nationwide warehouse receipt system: An assessment of the potential for a nationwide warehouse receipt system and recommendation for the requisite legal and regulatory framework*. Intl Food Policy Res Inst.
- Nyamongo, M., & Muturi, G. M. (2021). Value chain analysis and upgrading strategies in mango production in Kenya. *Agriculture*, 11(7), 623.
- Onyango, K., Bolo, P., Ndiwa, A., Wanyama, R., & Chege, C. G. (2023). A rapid agroecological mango value chain analysis in Kenya.
- Patil, N. A., Reddy, N. R. K., & Ganapthy, M. S. (2025). *Analyzing the export value chain and competitive dynamics of India's fresh mango market*. *Journal of Scientific Research and Reports*, 31(3), 129–136. <https://doi.org/10.9734/jsrr/2025/v31i32885>

- Reddy, A. A., & Murthy, D. S. (2023). Post-harvest management of fruits in India: A review. ResearchGate.https://www.researchgate.net/publication/381829685_Post-Harvest_Management_of_Fruits_in_India_A_Review
- Sharma, K., Kumar, A., & Agrawal, R. C. (2025). Kisan credit card and smallholder farmers' economic performance in eastern India: A panel data analysis.
- Shree, D. N., & Vaishnavi, P. (2022). Challenges faced by farmer producer organisations (FPOs)-A review. *Journal of Agricultural Extension Management*, 23(1), 131-138.
- SNV Netherlands Development Organisation. (2019). Inclusive Value Chains: The Makueni Mango Project. SNV Kenya Publications. <https://snv.org/project/makueni-mango>
- Studies in Africa and Asia. Food and Agriculture Organization of the United Nations. <http://www.fao.org>
- Suman, J., Shekhawat, P. S., Jain, S., & Verma, D. K. (2022). Performance of growth, instability and comparative advantage in export of fruits and vegetables from India.
- Swibe, J. M. (2023). *An Assessment of Effects of Mango Value Addition Activities on Women Economic Empowerment in Tana Delta Sub-county, Kenya* (Doctoral dissertation, University of Nairobi).
- Turley, L., Bermúdez, S., Voora, V., Wilkings, A., & Elder, S. (2022). Voluntary Sustainability Standards in East Africa.
- Uckert, G., Cavicchi, A., Soika, J., Matavel, C., Mule, M., Lerantilei, S., ... & Sieber, S. (2023). Consumer preferences and willingness to pay for dried traditional mangos from Kitui—A marketing analysis for Kenya and Germany. *Frontiers in Sustainable Food Systems*, 7, 1113930.
- UNCTAD. (2021). *Commodities at a Glance – Mango Sector Review*. United Nations Conference on Trade and Development.<https://unctad.org>
- United Nations Africa Renewal. (2018). Mango farmers in Kenya get access to new technology to counter post-harvest losses
- Vamba, M., Kibutu, T., & Musau, J. (2023). Devolution of Agriculture and its Effects on Mango Marketing by Small-Scale Farmers in Makueni County, Kenya.
- Varsha, M. R. (2022). Mango export and processing opportunities in India. *Journal of Scientific and Research Reviews*, 14(9),1–8.
- World Bank. (2021). *Transforming Agri-Food Systems in Africa: Value Chain Development and Inclusive Growth*. World Bank Agriculture Global Practice. <https://www.worldbank.org>