
Review Status of Mango Production and Research in Ethiopia

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Abstract: Mango (*Mangifera indica* L.) is Ethiopia's second-most important fruit crop. It is, nevertheless, in its infancy when compared to the potential of the nation. The mango is a succulent stone fruit that is a member of the Panes *Mangifera* fruit family, which includes several tropical fruit trees of the Anacardiaceae flowering plant family. To examine the present status and potential future of mango in Ethiopian studies. Mango value chains also promote growth, introduce new technologies, provide jobs, and lessen poverty in communities. The mango fruit crop is also very important since it has the ability to be processed industrially and sold in both domestic and international markets. However, due to poor handling, insufficient transportation and storage facilities, disease issues, and susceptibility to low storage temperatures, mango fruit production, marketing, and consumption are constrained. There is a very low level of farmer information regarding orchard spacing, pruning, fertilizer application, availability of new varieties, and pest and disease control. Mango packaging and delivery fell well short of expectations. The main obstacles were pests, knowledge and skill gaps, and the availability of better cultivars. Other agricultural inputs included fertilizers and pesticides. A total of 76.9% of growers were similar, according to an assessment of commonalities in the off-farming system, mango production practices, harvest, post-harvest handling, marketing, and their restrictions. Thus, to develop the mango sector in Ethiopia, it will be essential to improve the pre- and post-production techniques, use and/or conservation of the identified cultivars, and address the constraints.

Keywords: Potential, Value Chain, Marketing, Fertilizer Mango Productivity

1. Introduction

In terms of production coverage and economic significance, the mango (*Mangifera indica* L.) is Ethiopia's second-most important fruit crop. It is, nevertheless, in its infancy when compared to the potential of the nation. The mango is a succulent stone fruit that is a member of the Panes *Mangifera* fruit family, which includes several tropical fruit trees of the Anacardiaceae flowering plant family. The mango originated in South Asia and spread throughout the world to become one of the most widely grown tropical fruits. One of the most extensively grown and sold tropical and subtropical fruits worldwide is the mango. The mango, one of the most adaptable and extensively cultivated fruit crops in tropical regions, is one of the 73 genera of the family

Anacardiaceae and orders Sapin dales [31].

Mangos are grown for family sustenance as well as for commercial purposes. When the dry season ends and the rainy one begins is when it ripens. For the people living in rural areas, mangos are an essential source of nutrition [28].

Mango fruit is an excellent dietary source of antioxidants such as ascorbic acid, carotenoids, and especially phenolic compounds. Mango fruits are highly valued due to their delicious and distinct flavour. They are also a great source of provitamin A, vitamin C, and dietary fiber. A fruit with a wide range of adaptable qualities has naturally found use in the production of various goods [12].

Millions of people live in the tropics, and mangos are a highly seasonal tropical fruit. This fruit is always in demand, however there can occasionally be a pre-harvest excess and a post-harvest shortage. The excess production needs to be

turned into a range of value-added goods in order to make this fruit more widely available all year round (Africa produced 13.6 million tons of mangoes in 2009 [14]. Growing both domesticated and wild fruit species on farms can significantly improve ecological, economic, and health outcomes while also providing small-scale farmers in Sub-Saharan Africa (SSA) with more crop production alternatives [1].

Ethiopia has a total area of 1.13 million km² with a varied range of agro-ecological conditions. It is possible to grow tropical, subtropical, or temperate fruits in many regions of the nation. For instance, a sizable portion of the country's southwest and south-central regions receive enough rainfall to sustain fruit varieties that are suited to the local climates. Numerous rivers and streams are also available for the cultivation of different fruits. With a net irrigation area of roughly 1.61 million hectares (ha), Ethiopia has a 3.5 million hectares (ha) of potential irrigable land, of which only 4.6% is currently used [4].

Mangos are grown in more than 85 countries worldwide, and they may be found in most tropical and subtropical regions without frost. Mango production spans over 3.69 million hectares worldwide. By 2009, the world's total mango production was estimated to be 35 million tons [14].

One of the most extensively grown and sold tropical and subtropical fruit trees worldwide is the mango [20].

Mango production is mostly conducted in the Oromia, SNNPR, Benishangul Gumuz, Amhara, Harari and Gambela regions of Ethiopia, where there is a vast expanse of appropriate land for this purpose. When it comes to total output and area coverage among fruit crops grown in Ethiopia during 2003–2004 and 2013–2014, mangoes came in second and third, respectively. Its overall production rose by 247% and its geographical coverage by 208.4%, respectively. Even though it has improved over the past ten years, Ethiopia only produces 72,187 tons of fresh mangos in 2013–14, with productivity at a very low 7 tons/ha [12].

Mangos make up around half of all tropical fruits produced globally. Over the past ten years, production of mangos has increased in tandem with the growing demand for them around the globe, particularly in the United States and Europe. In 2009, 13.6 million tons of mangoes were produced in [14]. Numerous Indigenous Fruit Tree Species (IFTs) are crucial for generating money and ensuring food and nutrition security in their local communities, despite being largely unknown in international markets.

Many wild fruit species from various African locations have a great potential for domestication and successful on-farm production, as demonstrated by [1]. Fruit markets in Sub-Saharan Africa are predicted to expand significantly as a result of rising rates of urbanization, economic growth, and population expansion. With a net irrigation area of roughly 1.61 million hectares, Ethiopia has a 3.5 million hectare potential for irrigation, of which only 4.6% is being used. Ethiopia produces 500 thousand tons of fruit in total. Fruits are important because they may be processed industrially and sold into both internal and foreign markets in Ethiopia. Bananas, citrus fruits, mangoes, avocados, papayas, and grape fruits are

the principal fruits grown and exported [20].

Mango production occurs primarily in the east and west of Oromo, SNNPR, Benishangul, and Amhara in Ethiopia [11]. Ethiopia's mango output is erratic due to a number of factors, including weather, disease outbreaks, and inadequate management [8]. Ethiopia has more than 47,000 hectares of fruit agricultural land. When compared to other fruits grown in the nation, mangoes accounted for 12.78% of fruit production and contributed roughly 12.61% of the area allotted for fruit production. The processing plant's annual consumption of mangoes at full production capacity is 8.6 tons, or just 1.8% of the current mango production [16].

But according to Joosten study, less than 2% of the produce is exported. However, according to cropping season data, mangoes accounted for 14.55% of all fruits produced in the nation and contributed roughly 14.21% of the land allotted for fruit cultivation [9, 19].

Therefore, the main objective of this study is to examine the present status and potential future of mango in Ethiopian studies.

2. Literature Review

2.1. Origin and Distribution of Mango (*Mangifera Indica*)

Mangifera indica is native to the Indo-Malesian area, which includes Myanmar and India. There are wild populations in Myanmar and the Indian states of Assam and Chittagong Hills. This plant has naturalized throughout the tropics and subtropics, and the rise in human population has been largely responsible for both its spread and naturalization. With hundreds of cultivars, *M. indica* is now both pan- and sub-tropical in climate. It is grown, among other places, in Hawaii, Australia, Malesia, North and South America, East and West Africa. The mango originates in South Asia and spreads throughout the world to become one of the most commonly grown and versatile fruit crops in tropical and subtropical areas. It is also one of the most cultivated fruits in the tropics.

Taxonomic of mango (*Mangifera indica*) production in Ethiopia

1. Domain: Eukaryota
2. Kingdom: Plantae
3. Phylum: Spermatophyta
4. Subphylum: Angiospermae
5. Class: Dicotyledonae
6. Order: Sapindales
7. Family: Anacardiaceae
8. Genus: *Mangifera*
9. Species: *Mangifera indica*

2.1.1. Mango Production in Ethiopia

One of Ethiopia's principal fruit crops that is grown and exported is the mango. Ethiopia's mango business is still quite young. Mangoes are farmed throughout the nation, nevertheless, particularly in the western and south-western regions and the Rift Valley. Although it has produced several variations, the national research system is not very popular.

Thus, international experiences with cultivating this crop will aid in the fruit's success and dissemination. The mango tree is a perennial that can live for over fifty years. It is the most widely produced fruit in most of eastern and southwest Ethiopia, both in terms of quantity and area covered.

Mango trees are also widely grown in gardens on farmer's properties across the nation. The sale of mango fruits significantly supplements the income of the majority of these farmers. In eastern Ethiopia, mangoes now occupy almost 35% of the total acreage set aside for fruit production [30].

Eight tons are produced on average per hectare [16]. The majority of this production originates in portions of Ethiopia that are in the south-western region, the Assossa zone, and upper Awash.

According to previous study there is a diminishing trend in mango production and quality due to old age, inadequate care, and the seedling-originated nature of the trees, even if the farmer's revenue from their mango trees greatly supplements their way of life. Still, there are some trees that yield extraordinarily well and have the greatest quality fruits [30]. In addition to its economic value, it is environmentally benign and forest-based, helping to fend off droughts and providing firewood and shade.

Fruit trees and perennial crops are significant in the context of boosting the high value production of agricultural

commodities. Tropical nuts, grapes, fruit trees, bananas, pineapple, papaya, mango, apples, passion fruits and other produce are included in this commodity group. With the exception of table bananas, most Ethiopians were unaware of and did not consider tropical fruit trees like avocado, mango, and the like to be part of their diet [31].

However, Yilma pointed out that the introduction of fruits as a business has been greatly aided by the growth of state farms under the previous command economy and the current expansion of private investors in various parts of the nation [29]. Otherwise, even along riverbanks where there is a plentiful supply of water for growth, places appropriate for fruit tree cultivation are inactive. Smallholders only cultivate bananas due to the lengthy establishment costs associated with fruit trees prior to fruit setting, knowledge gaps in food technology, and market information.

The estimates that Ethiopia only cultivates 12,000 hectares of mango fruits overall. With higher area coverage anticipated in the southwest and other regions of the nation owing to more hospitable climate conditions and other considerations, the greatest yearly production projection during the last five years is 180,000 Mt. Mango is one of Ethiopia's two potential fruit crops, after bananas, which are the country's first crop produced in significant quantities, according to [9, 19].

Table 1. An overview of the main fruit crops grown in Ethiopia during the 2012–2013 growing season.

NO	Fruit crop	Productivity (Quintal)	Production in quintal	Area in hectare
1	Avocado	28.68	256,331.64	8,938.24
2	Bananas	84.00	3,025,022.32	36,012.19
3	Lemons	73.14	55,167.50	754.23
4	Mangoes	79.18	697,507.30	8,808.64
5	Oranges	119.18	357,458.39	2,999.21
6	Pappayas	140.60	386,943.15	2,752.08
7	Pineapples	-----	-----	215.69

Source: [9]: Results of the Agricultural Sample Survey

Area, Production and Yield of Mango at Regional Level

Table 2. An overview of the production of mangoes in Ethiopia's regional states.

NO	Region	Productivity	Production in quintal	Area in Hectare
1	Tigiray	-----	-----	118.20
2	Affar	-----	-----	-----
3	Amara	42.17	10,408.67	246.85
4	Oromia	74.96	284,065.79	3,789.47
5	Somail	112.66	3,776.26	33.52
6	B/Gumuz	78.78	51,411.10	652.56
7	S.N.N.P	101.87	343,910.27	3,375.89
8	Gambela	-----	-----	180.41
9	Harari	0.90	331.69	367.24

Source [9]: Results of the Sample Survey

Among the fruit crops grown in Ethiopia, mangos were in second and third place, respectively, in terms of total production and area covered. Its area coverage and total production increased by 247% and 208.4%, respectively, between 2003–14 and 2013–14.

Ethiopia produced just 72,187 tons of fresh mangoes in 2013–14, despite a ten-year boost in production to 7 tons/ha

(CSA, 2014). As a result, its potential has not yet been completely realized, and markets across the nation do not receive a sufficient supply of mangoes in the quantity and quality that consumer's desire. In a similar vein, the Amhara region boasts a sizable landmass with an ideal climate and abundant irrigation water resources for the cultivation of mangos. However, the Amhara region's total yearly output and

area coverage for mangoes in 2013–14 were just 800 hectares and 2826.3 tons, respectively [9].

The Amhara region supplied just 3.8% and 3.9% of the nation's total fruit and mango production in 2013–14, respectively, and only 5.4% and 7.7% of the nation's total fruit producing areas. Furthermore, the national average mango production of 7 tons/ha is significantly higher than the regional average of 3.5 tons/ha [9].

2.1.2. Ethiopian Methods of Mango Production

Ethiopian farmers typically paid little attention to spacing. Because of their age, the majority of farmers did not know much about spacing, which resulted in an uneven development pattern with some orchards growing closer to one another and others farthest from one another. All operations depend heavily on space, and improper spacing might cause productivity issues [24].

Nonetheless, it seems that tree spacing plays a significant role in mango yield. Irrigation is used by smallholder farmers to grow mangos. The source and the volume of water, however, differ. On the other hand, a considerable proportion of Ethiopian mango growers utilize river water, whereas only a tiny percentage of smallholders use pond water. When crops are watered using river water as opposed to pond water, the yield is higher. One of the elements influencing yield is the amount and quality of water available. Irrigation requirements vary depending on a number of factors, including soil type, property, climate, and others [24].

According to the same study, the smallholder farmers in the area use wind breaks, pruning, pest and disease control, irrigation with either pond or river water, and fertilizer application, either organic or inorganic. However, it is uncommon to utilize inorganic fertilizer and both organic and inorganic fertilizer though some creative farmers do use organic fertilizer for the goal of producing mangos.

Found in a similar study that FYM was primarily carried from the homestead to the field during the dry season and disseminated in a circular pattern at the base of each tree. The assessment demonstrated that while treating pests or fertilizing, chemical inputs were totally avoided. Because of this, its FYM rate of application is low to increase soil fertility while having a favorable environmental impact—that is, lowering soil pollution and reducing pollution in the air and water. According to the same study, early intercropping of mango with maize, taro, ginger, chat, cabbage, and banana is practiced by smallholder farmers in the region [5].

2.2. Mango Harvesting in Ethiopia

In Ethiopia, there are three stages involved in mango harvesting: fully ripe fruit, partially ripened fruit, and unripe fruit. Fruit that was harvested after it reached its full maturity had a shorter shelf life and quickly degraded. Rosals showed that fruit loss increases significantly after harvest as fruit maturity increases, which lend support to this. Ethiopian smallholder farmers harvest using three different methods: by hand, with scissors, and with a stick. The hand-picking method of gathering food helps preserve fruit quality and

shield it from mechanical harm [23].

According to a report, hand picking can result in fruit with a stem and lessen fruit bruising and damage, however stick structures cause fruit to fall and leave the fruit without a stem, which makes fruit bruising and mechanical damage easier [24].

Found in another study that harvesting often begins after fruit drops, which is the primary ripeness index. Producers harvest after the maturity index in order to assent to this line. Because of this, farmers are able to hang their fruit on the tree longer before harvesting it, which helps them find markets where the prices are higher. The assessment also showed that children work primarily by climbing trees to collect crops. However, albeit less frequently, using wooden sticks to knock down fruits, shaking trees, and plucking hooks are also practiced in the study areas. The latter methods result in fruit droppings that could potentially hurt someone physically at any time [5].

According to a report, bruising, punctures, and cuts enhanced the generation of ethylene, accelerated the softening of fruit, and eventually resulted in mechanical damage and deterioration [14].

2.3. Limitations on Ethiopia's Mango Production

The main obstacle impeding the growth of Ethiopia's mango industry is the absence of a cooperative or farmer organization among mango growers. Mango producing is often viewed as a supplemental activity to other farming methods, rather as the primary source of income for most farmers because to its extremely seasonal nature and the tendency to prioritize food security with grain crops [18].

The main potential and obstacles in mango production were determined by SNV working with consultants from Global Development Solutions. The main obstacles to Ethiopia's mango production are: inadequate facilities, expertise, and knowledge for planting, harvesting, and handling mangoes after harvest. Mango fruit diseases and pests are common; there are few mango varieties available, as well as insufficient capability and extension services to support the introduction of better and commercially viable mango varieties [26].

A study found that the main constraints affecting Ethiopia's mango output are limited technology, insect and disease problems, and a shortage of irrigation water [24].

2.4. Main Reasons for Loss of Mango Products

Mango produce loss in Ethiopia is primarily caused by birds, wind, injury, pathogens, and maturity stage.

According to Seid and Zeru study, birds pose a greater challenge during the maturity stage of produce, and wind is a significant issue from the point of fruiting to harvesting [24].

Mango harvesting techniques, maturation stage, wind, and birds all add to significant mango loss both during and prior to harvesting. Mango produce can also be lost during the harvesting and storage process due to improper harvesting tools and inadequate storage facilities.

2.5. Features of Ethiopia's Mango Market

According to a study done in southern Ethiopia by Tigist

et.al, investments in larger private and state firms are gradually improving the region, although there is still little relevance for the local and regional (Middle East and Djibouti) markets. Only a portion of the smallholder farmers' output is sold in the nearby fresh fruit markets. Fresh or (semi)processed, there is great potential in both domestic and international markets. However, there are many variables pertaining to quality, supply, and institutional setups throughout the value chain, which raises the risk of transactions and associated expenses [25].

Because of this, there are very few institutional arrangements in the oligopsomic wholesale market places and only a small percentage of small farmers participate in organized marketing. Mango's marketing organization is dominated by a small number of buyers. A limited group of fruit wholesalers in Addis Ababa determines the pricing and, in turn, the quantity of fruit supplied to the retail stores in Addis Ababa. To their own advantage, they employ middlemen to affect farm gate pricing and the state of the market. Producer organizations have not been able to confront this problem due to a lack of institutional strength [26].

Another study revealed that although the value chain is relatively basic at the production level, it mostly uses subsistence-level gardening, harvesting, and post-handling practices that restrict the fruit's quality. Upstream problems include the fact that the majority of fruit grading and packaging is done after a tiresome road trip to the capital, which compromises both the fruit's quality and the potential value that farmers may provide [18].

In Addis Ababa, market traders control the majority of the wholesale market and operate in a way that makes it difficult for new players to enter the space. Strong ties exist between Addis wholesalers and Assosa-based traders, and the majority of the final retail price is determined by these two stages of the value chain. There are chances to improve farmer level value capture in the chain because of the responsibilities that they perform, which seem to indicate that there is not a proportionate addition of value in the chain.

2.5.1. Marketing of Mango, Market Locations, and Modes of Transportation

The majority of mango growers in Ethiopia often sell their goods at the local market that is close by. Mango growers typically sell their produce to consumers, though occasionally they sell to stores due to market volatility and a lack of marketing infrastructure. The other factor is the similarity in the mango fruit's development stage and harvesting time. Due to this circumstance, there is a greater supply than there is demand at that particular moment. Due to the declining fruit price in this scenario, farmers are forced to sell their goods in the local market [24].

Mango farm gate sales are also typical in Ethiopia in addition to this. According to James study the primary channels for selling mangoes in Ethiopia are direct sales to consumers, hotels, big-box stores, supermarkets, wholesalers, small merchants, and kiosks [18].

2.5.2. Mango's Spatial Market Share in Ethiopia

Mango marketing involves the use of carts, cars, human backs, and pack animals by smallholder farmers to convey their produce to the point of sale. Ethiopian mango growers pack their fruits in baskets, cans, plastic boxes, and wooden boxes to prevent postharvest loss and ensure the safety of the fruit throughout transit [24].

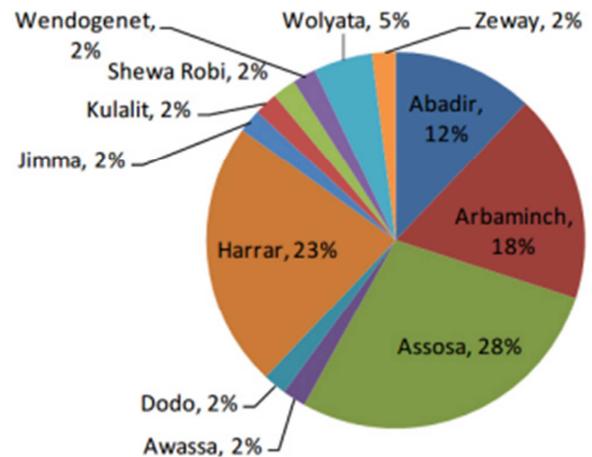


Figure 1. Mango market share in terms of space in Ethiopia's Addis Ababa wholesale market.

2.5.3. Mango Marketing Limitations in Ethiopia

Mango production, marketing, and consumption are limited because of disease outbreaks, poor transportation and storage infrastructure, inappropriate handling, and susceptibility to low storage temperatures [6].

Ethiopian postharvest losses in terms of quantity and quality between harvest and consumption hamper the cultivation and selling of fresh fruits like mangos. Fresh fruit quality is influenced by postharvest treatment, storage, transportation, and harvesting practices. Due to their perishable nature, tropical and subtropical fruits, such mangos, are now more difficult to store and transport than other temperate fruits [6].

The following are the main obstacles to Ethiopian mango commercialization: insufficient markets to take in the output, Cheap prices for the goods, a lot of intermediaries in the marketing chain, Absence of marketing organizations defending farmers' rights and interests over their marketable products, Insufficient cooperation among producers to enhance their negotiating leverage Inadequate packing and product handling Inadequate pricing structure primarily in the export market, a lack of openness in the market information system dominating informal trade in the export market [3].

2.6. Value Chain of Mango in Ethiopia

The idea of a value chain includes the organization and coordination problems, the strategies, and the power dynamics among the many chain participants. The term "value chain" describes the entire set of operations needed to take a good (or service) from its inception through all the stages of production, delivery to customers, and eventual disposal. Moreover, a value chain is present when all of its participants act in a way

that optimizes value creation along the chain [20].

There are two ways to interpret this definition: narrowly and broadly. A value chain, in its narrowest sense, refers to the variety of tasks carried out inside an organization in order to generate a specific result. This could involve the following: the ideation and design phase, the input acquisition procedure, the production process, the marketing and distribution efforts, the provision of post-purchase services, etc.

The "broad" approach to value chains examines the intricate web of actions taken by different players (dealers, primary producers, processors, retailers, service providers, etc.) in order to get a raw material to the point of sale of the finished good. The "broad" value chain begins with the raw material manufacturing system and progresses through connections with other businesses that are involved in trading, assembling, and processing [20].

2.6.1. Sources of Input Supply, Mango Production Inputs

Inputs from agriculture play a significant role on output and productivity. Hence, labor, land, compost/manure, and seed or seedlings were the usual inputs used in the production of mangos. Markets, agricultural offices, and farmers' own initiatives are the main suppliers of inputs for the cultivation of mangoes in Ethiopia. Agricultural development offices, markets, agricultural research institutes, own stocks, IPMS, and other farmers are the main sources of inputs for mango production in Ethiopia [5].

A survey conducted by Timoteos revealed that the majority of growers plant two kinds of unnamed local cultivars. These regional types feature big kernels relative to the amount of fruit flesh and are fibrous [26].

The most popular mango kinds found in Ethiopia, according to a 2010 FAO survey, include Apple, Tommy Atkins, Kent, and Keitt.

Mango cultivars in Ethiopia can be broadly divided into two categories: endemic and alien. According to Tommy Atkins, state farms and recently established private commercial farms typically utilize exotic kinds, but small farmers are primarily limited to using local or traditional varieties (such kent, keitt, etc.) [12].

Below is a description of the primary problems this stage of the chain is experiencing, as illustrated by the analysis of identifiable, non-commercial hybrid types, inadequate methods and procedures for cultivation, harvesting, and post-harvest handling, Mango production is hindered by underfunded Agricultural Research Institutes and a lack of agricultural extension support. Inadequate market information feedback loops that provide farmers with little knowledge or motivation to increase the quantity or quality of their output, There are no for-profit nurseries providing better cultivars [18].

2.6.2. Mango Fruit Exports

Only 4 tons of mangos were exported from Ethiopia in 2006, valued at less than US\$1000, according to the previous study. Mango exports are now extremely rare from Ethiopia. Compared to 2002, when 811 tons were shipped for US\$675,000 (US\$832 a ton), this indicates a considerable

decrease. On the other hand, the longer term average price for mango exports has been roughly US\$323 per ton, suggesting that this has been an exceptionally high value year [9]. The inconsistent quality of Ethiopian mango exports when they arrive in other countries has been one of the primary causes of the decline in mango exports. According to reports, Et-Fruit, the government-owned Ethiopian Fruit Marketing Agency, had been shipping mangoes to the UAE, Saudi Arabia, and Djibouti, but had lost some of those contracts as a result of the shipments' subpar quality upon arrival. This scenario demonstrates the main obstacles encountered in attempting to expand the Ethiopian mango export market: inadequate cold chain and packaging for exporting, expensive freight to foreign nations, rival products from South Africa and Egypt, and little commercial variety production [14].

2.6.3. Mango Consumption in Ethiopia

The bulk of Ethiopian consumers, who are low-income, cannot afford the increased costs associated with processing and packing, hence the majority of products consumed in Ethiopia are consumed mostly in their freshest form. Nonetheless, since 1997, Ethiopia's demand for canned fruits has grown by 7%, indicating that there is a sizable domestic market for the production of canned mangoes [27].

Considering how much fruit is grown in Ethiopia, the country's mango fruit processing industry is incredibly underdeveloped. One of the causes of this is that other nations' highly established processing businesses are able to export to Ethiopia and charge a low price for the finished well. In fact, there were several imported brands of long-lasting mango juice available all over Ethiopia, which will undoubtedly serve as a competitive barrier to entrance for indigenous juice producers [18].

2.6.4. Participants in the Mango Value Chain and Their Roles

According to a study there are several obstacles facing Ethiopia's fruit processing industry development. These are lack of technical expertise in processing, a lack of technical support for maintenance, and a lack of funds to engage in numerous low-cost imports of mango juice [18].

Market participants along the mango value chain in the research areas include producers, local collectors, wholesalers, retailers, processors, and end consumers, according to a 2011 study conducted in Ethiopia's Jimma zone by Ayelech. The main players, or initial link, in the cultivation and market supply of mangos are producers. Mango from farmers in village marketplaces is collected by local collectors, who are either part-time traders or farmers in assembly markets, with the intention of reselling it to consumers, retailers, and wholesalers.

A research by James on the value chain of mangoes in Ethiopia identified the following actors: retailers, processors like hotels, wholesalers (local and regional mango collectors/bulkers), mango producers/growers, and consumers [18].

The producers, merchants, and consumers are the main participants in the mango value chain, according to [7]. Smallholder farmers make up the majority of the producers,

and they provide the goods to local cooperatives, shops, traders, and consumers. The merchants sell to consumers, retailers, wholesalers, and Ethiopian Fruit.

2.6.5. Value Addition to Mango in Ethiopia

Mango fruits are prized for their delectable flavor and unique taste. They are also a great source of pro-vitamin A, pro-vitamin C, and dietary fiber. A fruit with a wide range of adaptable qualities has naturally found use in the production of many goods. Mangos can be processed into a very broad range of goods. There are two phases of maturity for mango processing. Chutney, pickles, slices, and dehydrated goods are made from green fruits. Ripe mangoes are processed into a variety of dried goods, nectar, juices, jelly, jam, and frozen and canned slices [12].

3. Mango's Current Condition and Potential Future in Ethiopian Research

More than a thousand variations have been found worldwide, with South East Asia thought to be its birthplace [22].

Mango cultivation spans around 3.7 million hectares globally, ranking second among tropical fruit crops and fifth globally among fruit crops, following citrus, banana, grape, and apple [10].

The majority of world output is shared by Asian nations (77%), Americans (13%), and African nations (10%), in that order. In terms of economic importance; the mango is the fruit crop that is planted most commonly in Ethiopia, with banana coming in first [31].

The mango is referred to as the "king fruit" because of its superb flavor, mouthwatering taste, and high nutritional content [10]. These qualities make the crop valuable for ensuring both food and nutritional security, particularly in developing nations like Ethiopia where achieving these goals is still difficult. 12,799 acres of land are used to produce 69,743.39 tons of mangoes [9].

Furthermore, between 2003 and 2013, the area covered by mangos and their production climbed by 247% and 2084.4%, respectively. It is cultivated throughout the nation, with the main producing regions of western and eastern Ethiopia accounting for more than half of all mango output in Ethiopia [9].

Although the crop has the potential to improve Ethiopian society's nutritional condition and health, the average national production yield is only approximately 7 tons/ha, and in other regions, such as Amhara, it is predicted to be only 3.5 tons/ha [22].

Despite the fact that a variety of factors, including genetic and/or environmental variables influence agricultural yield, the nation's productivity is only 20 to 30 tons per hectare, far lower than its potential [22].

Improved commercial mango varieties are gradually displacing farmers' native cultivars under the government's recently implemented export-oriented horticulture policy. A limited number of studies have previously documented the

methods and limitations associated with mango cultivation in Ethiopia [22].

Nevertheless, none of them were able to identify the mango cultivars grown by the farmers, and the breadth of information produced about pre- and post-production procedures as well as marketing, particularly in eastern and western Ethiopia, was insufficient to address the problems. Apart from conservation, locally adapted cultivars typically yield stable yields, so a thorough understanding of the crop's current diversity and the traditional production system is necessary to develop conservation strategies for a given crop species at the national level [29].

Nevertheless, under ideal circumstances, their yield is typically lower than that of "improved" cultivars which are ideal for low input needs, pest- and drought-tolerant [29].

The market for mangoes in Ethiopia is substantial and expanding, according to James et al.'s 2008 research, which also showed that the mango sub-sector is a suitable place to start when addressing poverty. The mango value chain may promote development, introduce new technology, generate jobs, and lessen poverty in local communities, according to the same study.

In order to determine the primary mango cultivars, production methods, and limitations in east and western Ethiopia in 2016, this study was carried out.

The harvest of mango fruits is very important since it can be processed industrially and sold into both domestic and international markets. For a technical evaluation of the potential of developing a new product from other fruit crops, the mango was chosen. Mangoes are currently seen as prospective export and local market crops. The Ministry of Agriculture and Rural Development (MoARD)'s Fruit and Vegetables and Horticulture Development Department and The Netherlands Development Organization (NDO) are promoting the crop as part of their program to support Business Organizations and their Access to Market (BOAM). Additionally, two primary criteria—"potential market opportunity" and "outreach to small holder farms"—were used to choose the mango crop as a possible commodity for investment [12].

Furthermore, at the moment, Ethiopian mangoes have the following qualities: High market value with high added value from knowledge or agro processing- Long-term edge over competitors SNV's BOAM program is supporting the adoption of new and faster technology (top-working) to turn the old mango trees into improved and marketable varieties. - Improved group activities and the role of women -Social acceptability and support by government policies [26].

The Ministry of Agriculture and Rural Development (MoARD) stated that the goal of expanding the area under mango production to exceed 12,000 hectares in the designated regions of Oromia, SNNPR, Amhara, and Tigray is that mangos are one of the fruits and vegetable products with potential for export.

An estimated 3000 hectare currently covered with mangoes in Ethiopia; 9, 835 ha will be planted in the near future to

progressively replace the aging mango stock. Three Florida Research Center varieties—Tommy Atkins, Kent, and Keitt—have been modified by the Awash Melkasa Agriculture Research Institute (AMARI) [2].

4. Conclusions

After bananas, which are the first fruit crop grown in significant quantities in Ethiopia and are primarily grown in the west and east of the regional states of Oromia, SNNPR, Benishangul, and Amhara, mango is among the country's second-most promising fruit crops. The market for mangoes in Ethiopia is sizable and expanding, and the mango sub-sector is currently an excellent place to start when addressing poverty. Mango value chains also promote growth, introduce new technologies, provide jobs, and lessen poverty in communities.

The mango fruit crop is also very important since it has the ability to be processed industrially and sold in both domestic and international markets. However, due to poor handling, insufficient transportation and storage facilities, disease issues, and susceptibility to low storage temperatures, mango fruit production, marketing, and consumption are constrained. There is a very low level of farmer information regarding orchard spacing, pruning, fertilizer application, availability of new varieties, and pest and disease control. The Ministry of Agriculture and Rural Development (MoARD) stated that the goal of expanding the area under mango production to exceed 12,000 hectares in the designated regions of Oromia, SNNPR, Amhara, and Tigray is that mangos are one of the fruits and vegetable products with potential for export. An estimated 3000 ha are currently covered with mangoes in Ethiopia; 9, 835 ha will be planted in the near future to progressively replace the aging mango stock. Three kinds, Tommy Atkins, Kent, and Keitt, were brought from the Florida Research Center and modified by the Awash Melkasa Agriculture Research Institute (AMARI).

5. Recommendation

Numerous steps need to be taken in order to boost mango output. To boost mango yield, training on agronomic practices is essential. These practices include proper spacing, when to prune, how and when to apply fertilizer, how to identify pests and diseases and how to treat them, when and how to harvest, what sort of packaging materials to use, and more.

Distributing early maturing cultivars and pest and disease resistance is another way to boost output potential. Road, canal, and transportation system infrastructure should be upgraded for added dimension and to lessen loss. To boost the amount of sales in the official markets and raise the income of smallholder producers, structured market arrangements and enhanced local market actors—producers' organizations—are essential.

Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] Aithal. A and Wangila. J., 2006: Rapid Assessment of fruit markets in Ethiopia based on research in Addis Ababa, Mekele and Awassa: Final report for Improving Productivity and Market Successes (IPMS) for Ethiopian Farmer Project, Addis Ababa. World Agro-forestry Centre (ICRAF), Nairobi.
- [2] Akinnifesi, F. k., Leakey, R. R. B., Ajayi, O. C., Sileshi, G., Tchoundjeu, z., Matakala, P., and kwesiga, F. R., 2008 Indigenous fruit trees in the tropics: domestication, utilization and commercialization, CAB International, Wallingford, U k, in association with the World Agro-forestry Centre, Nairobi, Kenya.
- [3] Alizar. A., 2007. Horticultural Marketing in Ethiopia, Faculty of Business and Economics, Master of Business Administration, Addis Ababa University.
- [4] Amur. M. H., 2002 Ethiopia, the Sudan, the Libyan Arab Jamahiriya and Somalia: Status of irrigation and drainage, future developments and capacity building needs in drainage. In International Programme for Technology and Research in Irrigation and Drainage (IIPTRID): Capacity Building for Drainage in North Africa. IIPTRID capacity building report. FAO, Rome, 121-143.
- [5] Ayelech. T., 2011: market chain analysis of fruits for Goma woreda, Jimma zone, Oromia regional state; A Thesis Submitted to School of Graduate Studies of Haramaya University.
- [6] Baldwin. E. and Mitra. S., 1997 Post harvest physiology and storage of tropical and subtropical fruits. International Wallingford, UK 85-122.
- [7] Bezabih. E., 2010. Market Assessment and Value Chain Analysis in Benishangul Gumuz Regional State, Ethiopia; Final Report, SID-Consult-Support Integrated Development, June, 2010; Addis Ababa.
- [8] CSA., 2009. Agricultural sample survey: report on area and production for major crops, statistical bulletin 427. Addis Ababa, Ethiopia.
- [9] CSA., 2013. Agricultural Sample Survey 2012 / 2013; Report on Area and Production of Major Crops, Statistical Bulletin Addis Ababa, Ethiopia.
- [10] Department of Agriculture., 1996. Development Guideline for Mango Production in the 8th National Economic and Social Development Plan (1997-2001) (translated from Thailand original), Bangkok.
- [11] Desta. H., 2005. Export potential of Ethiopia processed fruit and vegetables, export promotion department of English, P., S. Jaffee and J. J. Okello. "Exporting out of Africa: The Kenya.
- [12] Elias. A., 2007. Technical Assessment on Viability of Integrated Fruits Processing in Ethiopia; Master of sciences Thesis, Addis Ababa, Ethiopia.
- [13] FAO, (Food and Agricultural Organization)., 2005. Addressing Marketing and Processing Constraints those Inhibit Agric-food exports, guide for Policy Analysts and Planners. Agricultural Service Bulletin Rome, Italy.
- [14] FAO., 2009 Utilization of tropical foods: fruit and leaves. Food and nutrition paper, via delle terme dicaracalla, Rome, Italy.

- [15] FAO., 2010. Technical guidelines on tropical fruit tree management in Ethiopia; Giuseppe De Bac Project GCP/ETH/073/ITA.
- [16] FAO., 2009. Food and Agriculture Organization, STAT accessed July 2009.
- [17] Haidar. J. and Demisse. T., 1999. Malnutrition and xerophthalmia in rural communities of Ethiopia. *East African Medical Journal*. 10: 590-593.
- [18] James. S, Chris. R and Joseph. K. K., 2008A nalysis of the Mango Value Chain from Homosha-Assosa to Addis Ababa; The Semwanga Centre for Agriculture and Food, World Vision Australia, Go Mango, September.
- [19] Joosten. F., 2007. Development Strategy for Export Oriented Horticulture in Ethiopia <http://library.wur.nl/way/bestanden>.
- [20] Kaplinsky. R and M. Morris., 2001. A Handbook for Value Chain Research Brighton, United Kingdom Institute of Development Studies, University of Sussex.
- [21] Ma, X.; Wu, H.; Liu, L.; Yao, Q.; Wang, S.; Zhan, R.; Xing, S. and Zhou, Y., 2011. Poly phenolic comp.
- [22] Olaniyan, A. O., 2004, General information about mango and citrus production in Nigeria *Oec*. 2004.
- [23] Rosals. C. A., 2005. Skin color and pigment change during ripening and related post-harvest management of fruit. *National Inc, USA*. 321-345.
- [24] Seid. H and Zeru. Y., 2013: Assessment of production potentials and constraints of mango (*Mangifera indica*) at Bati, Oromia zone, Ethiopia, *International Journal of Sciences: Basic and Applied Research (IJSBAR)*, 2307-4531.
- [25] Tigist. D, Timoteos. H and Piet. V., 2009. A Bright Future for Small Fruit Farmers in Southern Ethiopia, SNV Netherlands Development Organization, Case Studies.
- [26] Timoteos. H., 2009. Challenging Impossible-Looking Hurdles; SNV Netherlands Development Organization, Case Studies.
- [27] Tiruneh. D, 2009. Value chain development of mango and highland fruits production, SNV Ethiopia.
- [28] Vayssières J. F., Sinzogan A. A. C., Adandonon A., Coulibaly O and Bokonon Ganta A., 2012. In: (Eds.).
- [29] Weinberger, k., Lumpkin, T. A., 2005 Horticulture for poverty alleviation – the un-funded revolution, Working Paper No. 15, AVRDC (The World Vegetable Center), Shanhua, N Taiwan.
- [30] Yeshitela, TB and T. Nessel, 2004. Characterization and Classification of Mango Ecotypes Grown in Eastern Hararghe (Ethiopia). *Sarhad Journal of Agriculture*, 19(2): 179-180.
- [31] Yilma Tewodros, 2009. United Nations Conference on Trade and Development.