

Review Article

Opportunities and Challenges of Fruits Industry Development in Ethiopia - from Subsistence to Specialized Commodity Commercialization: The Case of Avocado Fruit

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Abstract

This paper explores the detail opportunities and challenges of avocado production system. Avocado fruits production has multiple opportunities and has recently production and use is rocketed up, involving many actors along the value chain in Ethiopia. Although the avocado has extreme opportunities, the industry development has multitude of challenges and bottle necks that hinder the development, use and commercialization. The details of how these subsistence productions systems would be shifted from meeting subsistence needs to satisfying the interest of national and global market requirements through avocado industry development and commodity commercialization are reviewed. Through enhancing opportunities and rectifying these challenges of avocado development through institutional frameworks, creating strong avocado industry development policy environment and policy system, it is possible to transform avocado production from subsistence to specialized commodity production in Ethiopia through commitment, good hierarchal governances and leadership up to down to Woreda and avocado cluster associations and member levels. In addition, creating multi-party development actors and forums along the avocado value chain, the desired commodity will get fit into the global markets. Through creating and promoting global competitor private avocado producers and processing companies in Ethiopia, the economic importance of avocado industry in Ethiopia's economy is realized sooner or later.

Keywords

Avocado, Cluster, Competition, Commodity, Smallholder, Market Requirement, Policy Guidelines

1. Introduction

Development of avocado has contributed to income generations, employment and businesses opportunities along the value and supply chains in Ethiopia [2, 12, 34, 35, 37, 42]. Further, avocado cluster development in Ethiopia created many opportunities for youth and women, and for all actors along the value and supply chains including foreign currency

earnings [2, 31]. As a result, avocado production in urban, pre-urban and rural areas of Ethiopia has significantly increased for the last five years, creating highest amount of grafted avocado seedling demand annually. Besides farmers, almost all cities and towns residents are planting avocado trees in their front door and on available spaces as a multi-

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purpose for shades and fruits sources.

As part of Home-Grown-Economic-Reform, the current Government of Ethiopia (GoE) already set 10 in 10-year perspective development plan, in the same plan the GoE has indicated its commitment to promote the production and export of high value fruits and vegetables to maintain the country's trade balance and contribute to the overall economic development and avocado is among the selected crops [31].

Large percentages of fruits are coming from smallholder, from small plot of landholdings an average of <2 ha [32, 34, 35, 41, 42], land is limited and rainy period is very short and irrigation is not much practiced on these small plots of land. Avocado is planted on fraction of this small area of land. Population pressure and increasing population density caused depletion of this small area of land, diminishing this land

holding, soil fertility and water resources have deteriorated the condition of these farming systems, in addition climate change factors making crop productivity unsustainable and low, causing migration of peoples to cities in every regional state. Thus, improving land productivity, fruit crops production and productivity and fruits consumptions in the country such as avocado fruit such as in a cluster way is the key issues in the fruits industry development in the country.

The production of avocado has been on the rise globally for the last decade. According to reports published by FAOSTAT (2020), over the past decade, avocado production has doubled from 4.07 million tons in 2011 to about 8.06 million tons in 2020 (Figure 1). This represents approximately 50.46% increase in avocado production since 2011.

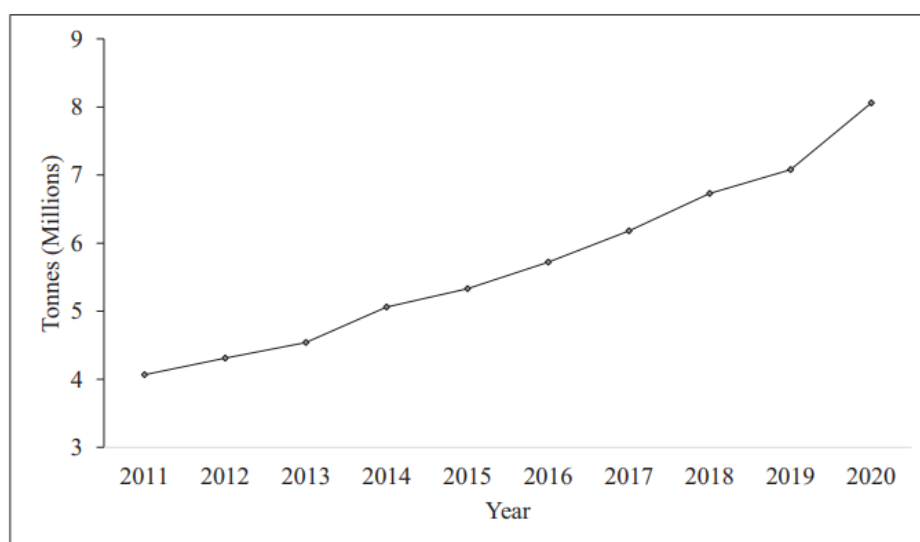


Figure 1. The production of avocado globally between 2011 and 2020 [22].

Mexico harvested about 2.4 million tons of avocados in 2021, making that country the top producer of avocados worldwide with accounting for nearly 30% of global production. The rank of Ethiopia fluctuates yearly, based on the recent FAOSTAT report [21] Ethiopia became the 8th avocado producing country globally by producing 245,336 tones, or 2,453,360.00 quintals according to FAO (FAOSTAT).

Avocado production started in the mid of 19th century in Ethiopia and until 2012 period local unimproved and un-grafted seedling trees were planted throughout the country. Based on the CSA report [3-5, 13, 21, 36] report a total of 30,587.74 ha of land covered with avocado fruits with 2,453,356.28 q production in the smallholder's private peasant holding. Another report indicated that the area coverage by commercial avocado farms is reported to 1,674 ha, with the total annual production of 13,850 tons and productivity of nearly 8.37 t ha⁻¹ [4].

As indicated in the FAOSTAT, the avocado production in Ethiopia was drastically declined during the 2021 production

year while production from other avocado countries such as South Africa, Kenya and others are increasing. It is also reported that there is 46.52% increase in avocado area coverage with 134.79% increase in production over the previous year in Ethiopia [3, 4, 32, 48]. These small holder private peasant avocado production use unimproved varieties with traditional farm implements and subsistence farming system as well as limited use of modern farm inputs, that resulted to the sector's poor performance (low productivity of the sector) [3, 4].

Since 2012 attention has been given for commercial avocado development through commodity cluster. Since then, the avocado fruits productions in Ethiopia are showing improvement in terms of extent and use of improved variety, area coverage, modern farm inputs, and modern farming system practices, although not in a combination of scientific ways including nutrition, irrigation and postharvest management. Since registrations of commercial avocado varieties EIAR/ MARC have made remarkable information transfer with the participation of multiple of development actors and

partners in avocado industry development [12, 36, 41, 42].

Many governmental organizations such as MoA, EIAR, ATI, RBoA and almost all NGOs involved and participated in agriculture development and supported avocado fruit seedling multiplications through organizing propagation centers, capacity development and other various ways. Since then, thousands of grafted seedlings of improved avocado variety multiplied and distributed every year, currently area of production is increasing in all regional states of Ethiopia. Currently, cluster avocado productions in Ethiopia reached more than 20,000 ha of land with 85% Hass, 10% Ettinger and nearly 4% is the remaining varieties (Personal communications).

Commodity cluster productions and commercial avocado production started in Ethiopia recently (2015/6), the commercial farms refer to the avocado farms that include private commercial and shareholder farms mainly established for the purpose of profit making by selling agricultural products at local market and export market [3-5, 42].

Currently tens of thousands of ha of land is covered by avocado plantations every year in Amhara, Oromia, Sidama, South Ethiopia, South West Ethiopia, Gambella, Benshangul-Gumuz and Tigray Regional States where Hass and Ettinger varieties are planted under irrigation conditions under avocado commodity cluster and commercial avocado farms. It is from these farms that Ethiopian avocado export was started in 2020 from earlier transplanted commercial varieties.

Avocado fruits are very popular in Ethiopia among both the producers and users. Consumers are consumed in a variety of ways, in urban areas; avocados are consumed as juice, mixed juice, parts of salads, with breads, *Injera*, or in combination with other foods, and fruits and vegetables. It is used as key ingredient of fast foods, mixed with potato and vegetables on the street vendors in the major cities [8]. It is very common to see peoples are enjoying their dinner in the early evening along the roads and streets and many women are busy in preparing these fast foods. However, it was reported that the annual per capita fresh fruit consumption in Ethiopia is very low nearly 7 kg, with 8 times lower than the average consumption for the East Africa countries with 55 kg, and 21 times below WHO and FAO recommended minimum intake levels [24]. This might be due to low production, productivity and postharvest loss of fruits including avocado, poor planning of fruits development, lack of functional institutions and policy environment in strengthening the fruits sector in Ethiopia. There are very weak supporting functions on avocado fruits development such as input suppliers, extension services - development agents, credit/ financial service providers, harvesting, storage and post harvesting handling services, transportation services, absence of skills and training service providers, low research involvement, etc. [24].

Based on the survey conducted in Lemo Woreda, Hadiya Zone, Southern Ethiopia [30] found that, avocado growers replied that children who eat avocados have supple skin, good growth, strong physical development and improved cognition

[24, 30]. The communities have perceived various health benefits of avocado such as avocado fruit is next to milk and it gives good health benefit such as it replaces egg, milk and meat; avocado is good for children's health and skin; it gives good growth and strength for children; it boosts memory of children; avocado is consumed without any risk to diabetics and people with high blood pressure.

The yellow-fleshed fruit with a distinctive nutty flavor, Hass fruit, is catching on in the European market. This is why Ethiopia is developing from traditional exports such as coffee and cut flowers to include avocados.

Ethiopia started export of avocados in August 2020 (www.ethioembassy.org.uk/ethiopia-exports-first-avocados-by-train). Since then, Ethiopia is exporting some amounts of avocado annually. International exporters are also exporting Ethiopian-grown avocados. The UK, Europe and the Middle East are among the destinations of the Ethiopia's avocado. According to figures from UN Comtrade, Ethiopia earned just above 1 million US Dollars (about 52 million Ethiopian birr) from avocado exports in 2021. This is the highest recorded value in the country's history. It is an increase of 11% from the previous year [45].

Based on recent reports, Ethiopian is exporting fresh avocado fruits into the Gulf Countries such as Bahrain, Djibouti, Saudi Arabia, Somalia and UAE, and some European countries such as Belgium, France, Netherlands, Spain, Sweden and United Kingdom countries since the last five years [34].

The objectives of this paper are 1) to explore opportunities of avocado fruits production in the smallholder's economy 2) to reveal current challenges in the smallholder avocado development are facing 3) to suggest technical and institutional solution and policy frame works required along the avocado value and supply chains.

2. Avocado Development Opportunities

The pace of the global avocado production is remarkably high compared to other tropical fruits. Such increase in production is driven by high consumer demand and requires expansion of the industry and many researchers reported that Ethiopian avocado sector has a bright prospect [13, 30]. The ready market for avocados in Ethiopia is not only expanding at a fast rate internationally but also locally. The fact that the fruit can be used in various ways has made it very popular among the larger population in Ethiopia [45].

2.1. Ethiopia Has Favorable Climatic Conditions for Avocado Growing

Ethiopia has suitable large mid altitude areas, ample water resources, optimum temperatures, fertile soils, availability of commercial varieties with many nurseries. It was suggested that 6 million of ha of land is highly suitable, whereas more than 15 million ha of land is moderately suitable for avocado production in the country [11, 29] (Unpublished). With some modi-

fications the moderately suitable areas could be suitable for avocado production. With well-organized institutional structures and policy environment, Ethiopia can produce and export huge quantity of fresh avocado to the global market with regular fresh fruits supply. Like key producing countries such as Mexico, Peru, Guatemala, and other countries if well planned production. With potential of producing in the whole humid and vast altitudinal ranges (1000 masl- 2300 masl) in all regional states of Ethiopia particularly in areas with irrigation water resources available are ideal for avocado productions.

2.2. Multiple Uses of Avocado Trees and Fruits in the Smallholder Household

Avocado tree was primarily planted as a vital part of coffee and enset shade in agroforestry systems [2]. From these trees avocado fruits were harvested and used by the farmers and the extra fruits were taken to the local markets. It is reported by many nutritionists that that avocado is high dense fruits full of proteins, vitamins, minerals and oils [8]. It then becomes one of the food ingredients recipes in many Ethiopian urban and rural households, including far distances where avocado is not cultivated. The household farmers consume some amounts of avocado fruits yield and sell some remaining amounts.

The study indicated that recently nearly 17.42% of fruits yields are consumed by the household whereas before ten years whereas 11.86% of fresh avocado were consumed; there is a clear indication of increased trends in fresh avocado consumptions. Thus, planting avocado fruits would really ensure food and nutrition security of the growers during at least the harvesting periods.

Again, avocado trees are used as shade trees for some spices and coffees, if planted in the home garden of farmers, front door area of urban, pre-urban and city areas, it gives shade for the family during the hot days besides fruit supplying to the family. The flower of avocado is used by bees during pollination.

2.2.1. Household Food Security and Nutrition Aspects of Avocado Growers

The study showed that many household avocado growers face some food and nutrition shortages; the household members of avocado growers are not able to eat kinds of foods they preferred [8]. Here planting avocado fruits would really ensure nutrition and security of the family during the harvesting periods. There are farmers who store matured avocado fruits on selected trees in the home-garden as the fruits can stay on the tree for three months and harvest at the latter seasons when the need arises for family consumption until the start of avocado seasons.

(i). Avocado Consumption Trends

Awareness of the people on the health benefit of avocado fruit stimulated new local consumers every time and currently

new avocado food recipes are coming [8]. Non-avocado consumers are becoming avocado consumers in new areas. In addition, according to the farmers, avocado is becoming one of the foods eaten with bread/ Enset, during the dry season since cabbage or kale are less available Lemo Woreda's experience in Hadiya Zone, Southern Ethiopia [30]. There are local reports indicating avocado consumption as primary food alone, or avocado could complement staple food consumption (Enset) and avocado replaces vegetables such as cabbage and Kale as side meal [29, 49].

(ii). Avocado Demand Trends

In parallel with consumption trends, various uses of avocado fruits have stimulated and created high fresh fruits demands throughout the year [25]. This high demand again created every urban and pre-urban household are looking and asking for improved avocado seedling, youths are organized in avocado seedling productions and many new clusters developing in the non -traditional areas in many regional states of Ethiopia [29, 31] and there is high stimulation along each value chain steps.

2.2.2. Year-Round Fresh Fruits Availability from Local Types

Fresh avocado fruits are available year-round from local types and one can get fresh fruits in Ethiopian cities and towns all the time. There is no distinct period when local fresh avocado fruits are not available in the market in Ethiopia. All markets in Ethiopia are full of local avocado fruits throughout the year. Whereas the maturity and harvesting season of commercial avocado varieties are concentrated from July and extends to October/ December in different regional states of Ethiopia. There is small harvest in February from these commercial farms in some parts of the country [29, 41, 49].

2.3. Availability of Grafted Seedling of Commercial Varieties

Currently there are more than 4000 avocado nurseries are active in Ethiopia supplying grafted commercial varieties, indicating high promise of increase in production areas annually throughout the nation (Personal communications). If these nurseries are subjected to seedling quality control and growers get guarantee [7], the number of areas coming to under avocado production annually in Ethiopia is so large that, with proper postharvest quality management, Ethiopian can earn higher foreign currency beside quite large domestic supply for consumption and for oil productions.

2.4. Increasing Global Consumption

Avocado consumption is rising worldwide as a result of the fruits' favorable effects on digestion, vision, and heart health. Production has increased as a result of rising demand on a

global scale. According to FAOSTAT report, production of 8.05 million metric tons of avocados, up nearly 1 million tons made, the global avocado market size was valued at USD 14.85 billion in 2022 and is expected to grow at a compound annual growth rate (CAGR) of 7.3% from 2023 to 2030 [14-20, 38,46]. First, the growing demand for avocados worldwide has increased production and international trade. Consumers increasingly recognize avocados' health benefits and nutritional value, driving a rise in global consumption. Another critical factor is increased production in different regions of the world.

2.5. Favorable Social and Economic Conditions for Avocado Production

The survey study showed that during the last two years, 88% percent of avocado growers increased their avocado areas, whereas before ten years it was 46.86% of the growers tends to increase their avocado areas [35].

2.5.1. Employment Creation and Participation of Youth and Women in Avocado Business

The introduction and dissemination of avocado seedlings has contributed to income generations from fruits, employment and businesses along the value chain actors as a result, avocado production has significantly increased [30].

Avocado industry can create both on-farm and off-farm employment opportunities for all farmers, particularly for youth and women. In addition, the industry further create business opportunities such as nurseries operation, scion sources and rootstock supplies, seedling transporters, pack house operations, sorting and grading activities are usually by youth and women. Most fresh avocado fruits retailers along the road side are by women, fast foods from avocado recipes are prepared in the street vendors. Study reports found that women are the ones who sell avocados at the market places and road sides and also buy both food and non-food household items in Lemo Woreda's in Hadiya Zone, Southern Ethiopia [29, 30, 49].

2.5.2. High Fresh Avocado Fruits Demands for Oil Pressing Industries

There is high demand for fresh avocado fruits throughout the year for oil pressing industries in Ethiopia proved that avocado oil processing in Ethiopia has high both market and economic feasibility of the business idea, since, the net present value is positive which mean acceptable and viable for implementation. Fresh avocado fruits are required for avocado oil extraction throughout the year. It was reported that Yirgalem Integrated Agro-Industrial Park (IAIP) located in Sidama Regional State has earned more than \$4.4 million from avocado oil export during 2022 fiscal year [47]. Sunvado Avocado Oil Factory supplied 120 tons of avocado oil to foreign markets in the 2022 fiscal year [48]. Similarly other

avocado oil factories in Ethiopia are currently supply their crude and refined avocado oil to European markets [8].

2.6. Reliable Cold Logistics Link Form Addis Ababa to Djibouti Railway Line Connection

There is now a reliable logistics link in the form of the fully operational Addis Ababa-Djibouti railway line and the sea freight connection to markets in Europe and the Middle East. This makes their prices competitive. Low production costs make Ethiopian avocados cheaper compared to avocados from its competitors in Peru and Chile.

2.7. Filling the Seasonal Gap in European Markets

Avocado price in Ethiopia is profitable when avocado exporters in Ethiopia take advantage of the seasonal gap in European markets. In September when Peruvian supply runs out, Ethiopia still has avocados will be available [45]. In addition to normal supply season of avocado fruits from August to October, currently, Hass and Ettinger varieties are supplying small fruit yield in many cluster areas. Further there are continuous avocado fruits harvesting from local types throughout the year in the high rainfall areas of Ethiopia such as Kaffa and other places.

2.8. Increasing Beekeeping and Improving the Habitat of Pollinators

Avocado industry, as production is highly dependent on pollinating activity such as bees [21], planting avocado would enhance pollinator's sustainability and prevent from environmental degradation such as runoff through increasing ground recharge, keep loss of biodiversity and minimize excessive use of agrochemicals. Pollinators could be protected using a holistic approach by implementing beehives in avocado plantations; protecting or restoring natural habitats surrounding orchards that support native pollinator communities (e.g. honey wasp, honeybees); growing other flora that is attractive to pollinators and reducing the use of synthetic pesticides.

2.9. CO₂ Sequestrations of Avocado Plant

Avocado orchards have a significant capacity to remove CO₂ from the atmosphere and sequester (store) in trunk and in the soil [44]. Researchers reviewed potential role of fruit trees in the carbon sequestration, because due to their structural differences from annual crops [39], fruit trees are told to absorb considerable quantities of atmospheric carbon [33]. Trees and grasslands sink atmospheric carbon; whereas agricultural practices (ploughing, cultivation, etc.) generate greenhouse gases [40]. All plants can do this, but trees are the most likely to sequester large amounts of CO₂. Avocado trees sequester carbon when they convert carbon

dioxide into wood and roots, and as they grow, they produce liquid carbohydrates which flow through their roots and create stable forms of carbon.

Researchers, from Mexico [28] analyzed the energy balances and greenhouse gas emissions from export-oriented avocado orchards in Mexico; they compared 12 avocado orchards under organic and conventional management during two production cycles (2010 and 2011) in a representative region of Central Mexico. They found that there were no significant differences in energy consumption and GHG emissions between organic and conventional systems with 55 and 56 GJ ha⁻¹, and 3.30 t CO₂ equiv. ha⁻¹ and 3.57 t CO₂ equiv. ha⁻¹, respectively. The soils on which most of avocados are grown on are very sandy and in their original state contain less than 1% organic matter. Soils are the largest terrestrial sink for carbon on the planet.

Avocado farming techniques allow carbon sequestered in two ways. Firstly, trees do what all trees do naturally. Living roots release sugars and other exudates to encourage their microbial environment, including supporting mycorrhiza (Carbon Sequestration – Avowest Avocados). In a healthy Californian soil an estimated 20,000 km of hyphae, or fungal filaments, were found beneath every square meter of soil. Also, as tree roots die the carbon that is within them is more likely to stay in the soil than to be released back into the air, when the trees, the carbon dioxide that was absorbed by the trees and pruned off can now add to the organic matter content of the soil. Thus, development of avocado crop in Ethiopia would contribute to the sequestrations of large quantity of CO₂ per ha per year in the future [31].

2.10. Conservation Agriculture (CA)

Planting avocado tree fits conservation agriculture ecological approach to regenerative sustainable agriculture and ecosystem management [22] based on the practical application of context-specific and locally adapted with 1) minimum mechanical soil disturbance (no-till seeding/planting and weeding, and minimum soil disturbance with all other farm operations including harvesting); 2) permanent maintenance of soil mulch cover (crop biomass and cover crops); and 3) diversification of intercropping of some vegetable, root and tuber and spices crops cropping system (economically, environmentally and socially adapted associations involving annuals and/or perennials, These essential practices are combined and enhanced with other complementary practices of integrated crop, soil, nutrient, water, pest, labor, energy and land management practices to generate and sustain optimum performance of productivity and ecosystem societal services [21-22]. Enhancing avocado production would contribute to conservation agriculture at large [21].

3. Challenges of Avocado Development in Ethiopia

Currently, Ethiopia becomes one of major avocado pro-

ducers but it is very conventional in terms of planting materials and supply of quality fresh fruits to the international market beyond domestic consumption due to various challenges in the avocado development sector. The key challenges are:

3.1. Smallholder Production and Rapid Expansion of Local Avocado Types

Nearly more than 90% of avocado trees in all regions except Amhara Region is planted from seeds, seedling materials with extremely non-uniform in tree and fruits characteristics and fruits quality. The survey conducted across many regional states of Ethiopia showed that more than 60% of avocado tree population is planted from seeds [9]. Most surveys are being conducted along the road side where farmers have access to inputs and other agricultural technologies, thus if tree inventory is conducted through into rural avocado farming furthest distance from the road, different data would have been obtained. Thus, more avocado development strategies have to be designed that makes most rural farmers accessible to improved inputs.

Because of climate and land suitability of larger parts of the country for avocado production, the production by itself surged without much research and development investment input. Once tested every farmer collected seeds and planted in his/ her home-garden [49]. The farmer to farmer seed dissemination was the key factor that currently many farmers have many trees as high as 400 trees grown from seeds (Personnel communication). These trees grown from seeds seem relatively tolerant to stress as compared to commercial varieties (Personnel communication).

3.2. Low Smallholder Farmer Interest and Perception Towards Avocado Cluster Development

Despite receiving training and improved avocado seedling, farmers participating in avocado cluster awareness-creation programs are still not fully aware of the precise precautions required during pit preparation, transplanting and post transplanting management practices including hoeing, irrigation after the rain stops, and protection from animals [23]. This is why many thousands of transplanted avocado seedlings are died every year. Some researcher found that the main limitations of avocado productions along the value and supply chains are poor land preparation, transplanting techniques, poor irrigation water management during the dry season, poor drainage water management during the rainy season, poor post transplanting field management practices, poor nutrient management, poor farm protections from domestic and wild animal damages [6, 27, 30] This imply that awareness and management required during and post transplanting management practices should be given for the growers and training should be continued regularly with field monitoring and

improvement, In order to minimize large scale seedling establishment failures, it requires intensive long term demonstration and learning plots before large scale expansion [23].

3.3. Shortages of Irrigation Water and Poor Irrigation and Drainage Water Management

Avocado seedlings are transplanted in all areas at the beginning of the rainy season without irrigation water sources and without follow up furrow line preparation if irrigation water sources are available. Poor drainage water management is also very common in new and old avocado plantations throughout the whole rainy season that stagnant water are observed under each seedling and trees after the rainfall. After the rain stops each seedling and tree plantations does not get irrigation water requirement of the seedling and the plantations at the right amount and right time [26]. This shortage of irrigation water would make low survival rate and low establishment seedling and the plantations during the coming dry season and consecutive years.

3.4. Absence of Phyto-Sanitary Certifications of the Planting Materials and Documentation on the Nursery Operations

There is shortage of seedlings of commercial variety; if available there are no phyto-sanitary certifications and no guarantee of the planting materials. In additions, there are introductions of avocado planting materials and scions from abroad with the absence of optimum, reliable, sensitive exchange of plant materials procedures for detection virus and viroid.

Currently more than 400 avocado nurseries are operating in the country, however none of or very few of them have documentations, and almost all nurseries in the country has no documentation of nursery operations. In principle every nursery operator should have documentation data so that it is easy to trace all information of the seedling materials. In addition global avocado fruit marketing requires both nursery and field management documentation.

3.5. Absence of Standard Production and Value Chain Guideline Fitting to the Global Market

There is no standard avocado production and value chain guideline prepared for production fitting to the global market [7, 8, 23, 34, 35, 41]. Thus, special training and related support is needed to provide to Ethiopian farmers to utilize their potential, to improve their production knowledge and skills.

3.6. Major Avocado Production Constraints

The avocado subsector promises high potential in Ethiopia, but it is characterized by low yields and low income for producers. Studies conducted showed that even though avocados can contribute to their livelihoods they are confronted by a number of constraints [34, 35, 43] including, lack of irrigation facilities, low productivity, poor post-harvest, lack of high skill extension services, and limited knowledge, pest and diseases, lack of true type seedlings /poor seedlings quality and high price (Table 1). Avocado farmers in Ethiopia have low access to improved grafted varieties due to high costs and limited experienced nursery operators. Limited post-harvest technology, lack of processing plant, limited private investment in the avocado value chain, lack of avocado producer platform.

Table 1. Major avocado production constraints in the sample areas in Oromia, Amhara Sidama and Wolaita production areas.

Major constraints for avocado production	Frequency	Percent	Rank
Land shortage	160	59.7	6
Lack of irrigation facilities	218	81.3	1
Low productivity	215	80.2	2
Lack of true type seedlings /poor seedlings quality and high price	179	66.8	5
Lack of scion sources	146	54.5	7
Lack of extension services and limited knowledge on avocado management	207	77.2	3
Disease and insect pest	192	71.6	4
Fruits aborting	146	54.5	7
Poor postharvest management	207	77.2	3

Source: Tamirat *et al.*, (2024b)

3.7. Major Avocado Marketing Constraints

Similar studies have been conducted to identify key avocado marketing constraints [34, 35]. The study identified most important value chain constraints, which affected the marketing of avocado and its actors along the chain, were; the low market price of avocado, lack of links between producers and consumers, perishability nature of the product, weak information flow, quality problems, poor infrastructure, and transportation systems and packaging problems were critical (Table 2).

Table 2. Major avocado marketing constraints in Oromia, Amhara Sidama and Wolaita production areas.

Major constraints for avocado marketing	Frequency	Percent	Rank
Low market price of avocado	246	91.8	1
Distant to avocado markets	188	70.1	5
lack of access to market information	156	58.2	7
Quality problem	194	72.4	4
Lack of packing and transportation facilities	181	67.5	6
Poor market linkage	239	89.2	2
Traditional weight measures	110	41.0	9
Perishability and seasonal maturity of avocado	181	87.5	3
Poor infrastructure	151	57.0	8

Source: Tamirat *et al.*, (2024b)

3.8. Harvesting and Postharvest Related Problems

Avocado growers have no national guideline that keeps harvesting and postharvest handling at high quality produce [27]. Although EHPEA developed different manuals related to pre-harvest and post-harvest chains [14-20], no one uses these manuals and stallholders use conventional practices at all the supply chain stages.

3.9. Institutional Challenges in Avocado Development

There are key institutional challenges that avocado development in Ethiopia are facing. There should be strong national supporting functions of avocado development in Ethiopia, these includes input suppliers, extension services - development agents, credit/ financial service providers, storage and handling services, transportation services, skills and training service providers universities, research and ATVETs and NGOs [22]. These challenges lead to weak competitiveness of Ethiopian avocado industry. There is weak institutional framework in all regional states that with poorly planning, campaign planting, poorly implementing, monitoring. These challenges resulted in the current smallholder avocado development in the country has low yields quality, low and productivity. The details of few key institutional challenges are summarized below:

3.9.1. Weak Development Planning with Absence of Follow up Monitoring

Every region has been planting Hass and Ettinger avocado varieties in clusters form every year, however all lack of proper development planning with clear follow up and

monitoring modality in all regional states. No region has annual survival percentages of avocado seedlings planted every year. Currently there is no Hass tree inventory data on number of trees coming to production. Except MoA, and regional BoA, other equally important sector development offices are not participating in the avocado development. MoTRI, MoH, Cooperative Agency, Finances.

3.9.2. Absence of Nursery, Scion, Rootstock Sources and Nursery Seedling Certifications

Seedling quality problems are among the input problem in avocado industry development. These arose from absence of certified scion sources, root stock seeds sources and absence of certified seedling sources. There are nearly more than 4000 avocado nurseries, but no single avocado nursery has been accredited and no single avocado seedling certified in any year in the country, with no seedling certification updated. Many avocado growers in all regions are planting unknown quality seedlings every year with very low survival percentages [49], lead to low establishment of the plantations, poor follow up and finally results with significant economic losses [6-10].

3.9.3. Absence of High-Quality Inputs and Poor Documentations

All avocado growers have poor access to high quality inputs along all the value chain and supply chain stages [23, 29]. These start from low seedling quality inputs, and all other agricultural inputs [9]. Global competition requires documentations of all inputs and varieties used. These documentations include all management inputs, which id audited during GlobalGAP certification. Thus, avocado producers are not aware of there is no public organizations that prepare avocado cluster farms for certification. There also poor supply chain inputs start from harvesting until the fresh avocado reaches

consumers. Smallholder avocado growers used sack for packaging and transporters bulk un-graded avocado fruits on ISUZU without any temperatures and humidity control [49]. There are no infrastructures developed for avocado grower smallholders along the value chain and supply chain [29, 49].

3.9.4. Inadequate Access to Services

Since there is stringent global avocado market competition including Ethiopia, avocado production and products requires a continuous services from the government and from marketing sectors. All smallholder and cluster avocado growers have inadequate access to services required for the high quality fresh produce (particularly, farm auditing as per the GlobalGAP, financial services, scientific pest, irrigation water and nutrient management services, proper harvesting and postharvest management practices, MRL (maximum residue level) testing, GAP Certificate, etc...). Thus unless organizations providing these services well organized and provide efficient services for avocado growers, there is a high probability that Ethiopian avocado produce do not compete with avocado produced in other countries.

3.9.5. Inadequate Technology Generation, Research and Information Transfer

Production and postharvest problems of avocado fruits rolls for years [29, 49]. Currently there is a poor technology generation, transfer, with very low research input in national fruits development. Quite large number of smallholders continued production of avocado with conventional methods such as planting from seeds, no irrigation water application, no fertilizer application, with very primitive harvesting a, poor transportation and postharvest management. These methods of avocado production even cluster farming, the fruits is likely fit the global market requirements of avocado.

3.9.6. Absence of Integration of Development Actors

There are many development partners involved in the avocado industry development, but there is no development partners that recognize and acknowledge the contributions of others and complement each other. There should be avocado development forum where development partners work together and share roles and responsibilities.

3.9.7. Absence of Domestic and Export Standard Guidelines and Implementing Institutions

Export avocado requires variety of guidelines, among the guideline's documentations of the variety, nursery labels, and nursery and field inputs used, etc. Absence of these guidelines and implementation institution along the avocado value chain in Ethiopia will make the country very low competitor in the global market. There are very fragmented nursery and field management practices without implementing and controlling institutions. Although EHPEA developed guidelines related to postharvest practices, no is pushing the smallholder growers

to follow the guidelines [14-20].

3.9.8. Absence of Packers and Pack Houses

The operations of packers, packaging and pack houses operations in avocado development are the key stages linking avocado producers with consumers [29, 49]. Currently, there are no packers and pack house established for avocado commodity in Ethiopia as a result harvesting and post harvesting of avocado fruits are very poor with more than 40% total loss [49]. Thus, creation of private and public packers and pack house is the key development stage in avocado fruits industry both for domestic and for export chain.

3.9.9. Absence of Transporters with Refrigerated Facilities

Currently avocado fruits are bulked and transported to Addis Ababa central market with poor transportation leading to large quantity losses. Fresh avocados are bulked on the ISUZU/ FSR with nearly 6000 kg of avocados per ISUZU [49]. Transportation of avocado requires refrigerated and other facilities that consumers get good quality of avocado fruits.

3.10. Avocado Industry Development Policy Environment and Policy System Challenges

Although there are rules and guidelines required for avocado fruits development, under MoA, EAA, BoA, Farmer Cooperatives/ Unions, Ministry of Trade, Ethiopian food standards, food laws and regulations, currently no any laws, regulations and guidelines are exercised in the avocado industry development.

The policy environment includes all aspects surrounding policy-making; this would include the broader socio-economic aspects of avocado development in organizational strategy-making. There are four environments that influence how policy is made: the structural environment, the social environment, the economic environment and the political environment [50].

3.10.1. Improve Market Information and Marketing System

Agricultural marketing is a process which starts with a decision to produce a saleable farm commodity, involves all the aspects of market structure or system, both financial and institutional, based on technical and economic considerations, and includes pre- and post-harvest operations, assembling, grading and storage. It covers the services involved in moving an agricultural product from the farm to the consumer. These services involve the planning, organizing, directing and handling of agricultural produce in such a way as to satisfy farmers, intermediaries and consumers. Although agricultural marketing of cereal grains and coffee is highly advanced in Ethiopia, fruits

and vegetable marketing such as avocado is at an infant stage. Perishability and bulkiness add-up complications on the marketing of avocado fruits and absences of services providers such as packers and transporters made avocado growers are usually at risk that farmers cannot negotiate prices of fruits at all. Development of practical avocado marketing strategies would benefit producers increase farm income, growth of agro-based industry, employment creation and better living standards [29].

3.10.2. Enhancing of Monitoring and Follow up of What Is Planned and Planted

Much emphases were given to annual avocado planting in Ethiopia, whereas there is no or very low level of monitoring of avocado farms planted through clusters [9, 10, 23, 29]. Millions of grafted avocado seedlings are planted every year, but yields proportional to area planted is not coming to both domestic and intentional markets [9, 49]. Thus, strong monitoring and follow up of annual avocado planting is required.

3.10.3. Enhancing the Capacity of the Smallholder Cluster Through Training

The avocado fruits value chain sector is primarily consisting of small farms, business scales, which have no economic and political influential capacities to upgrade avocado production for satisfying both domestic and global market so that Ethiopian produces is competent with other key producers and exporters [45-49].

3.10.4. Improve Infrastructures and Maintenance

More irrigation facilities are required for avocado production with regular maintenance. There are limited irrigation schemes prepared for avocado production in Ethiopia, however the regular scheme maintenance will not start immediately and would take some time after the rainfall ends. This would cause that avocado tree flowers and set fruits while there is no irrigation water supply leading to excesses flower and fruits fall [1].

3.10.5. Ensuring Formulation of Linkages Among the Value and Supply Chain Actors

Currently, there are no linkages among avocado value chain and supply chain actors in the country such as nursery operators- inspectors – farmer producers – packhouse operator – transporters- exporters – linkages in the avocado industry development. There should be common forum that would enhance toward the competitiveness of Ethiopian avocado industry. Where there is/ are strong linkages among the avocado development actors and partners, it is easy to trace any problem from the sources and take immediate actions so that Ethiopian avocado becomes competitive in the global markets.

3.10.6. Ensuring Farm Recording and Documentation System in Each Producer Cooperatives

Strong development planning goes with strong implementation of the development on the ground. The paper work will be changed in to practice in such a way that monitoring, accreditation of avocado nurseries, certification of avocado seedling record of number and status of nurseries in each region. Identification and authorization of mother tree scion sources areas and rootstock sources in each region is a key starting point. The nursery record should be in place on each nursery as per the guideline. All practices of nursery operations should be should be recorded including with annual seedling certifications. Similarly, seedling disseminations should be recorded by each nursery operators. In a similar way farmers also should have record where a given cluster would have one documentation center that for GlobalGAP and farm auditing.

Each avocado producing region would have data and documentation center on number and annual capacity of nurseries in the region, number of areas planted each year (ha), number of survived trees, expected total yield and estimated export percentages.

3.10.7. Ensuring the Implementation of GAPs and Other Standards

Good agricultural practices (GAPs) has evolved in recent years in the context of a rapidly changing and globalizing food economy and as a result of multiple concerns about food production and security, food safety and quality, and the environmental and social sustainability of agriculture. In order to export avocado and be competitive in the global market, avocado industry development must have initiative offices or branches that implement the required GAP practices and producers in avocado production. Currently no organizations that attends and prepare avocado cooperatives and growers for the GAP, and other standards for avocado such as the United Nations Economic Commission for Europe (UNECE) and the Codex Alimentarius Commission draw up quality standards for fresh fruits and vegetables, and both the Organization for Economic Co-operation and Development (OECD) and UNECE interpret standards [4, 5, 22]. Quality standards must reflect current production and trade practices to be helpful to traders. A standard should be applicable in all regions where it is used; otherwise, it will become a technical barrier to trade (*Ibid.*). There are series of stringent requirements related to food safety standards (ISO 9001 certificate) and fresh fruits and vegetable such as HACCP, and traceability are required when exporting to highly demanding EU markets. Thus, there should awareness creations on the benefit of GAPs for avocado growers, implementations of GAP, and improvements over years.

3.10.8. Employing Fresh Fruits Trade and Marketing Standards Benchmark

Trade standards provide a product description for commercial agreements between seller and buyer. Different prices can be set when they contain quality classes. Today the United Nations Economic Commission for Europe (UNECE) and the Codex Alimentarius Commission draw up quality standards for fresh fruits and vegetables, and both the Organization for Economic Co-operation and Development (OECD) and UNECE interpret standards (*Ibid.*).

By providing commonly agreed product descriptions, standards clarify the buyers' requirements for producers, sorters, and packers. This reduces misunderstandings and returns. Quality standards can increase waste by limiting the lowest acceptable quality if there is a demand for products of a quality/grade below the standards' lowest permissible limit and if it is compulsory to apply the standards. But if standards correctly reflect market requirements, they will not increase waste since buyers would have the same requirements even if standards did not exist. To some extent, the influence between standard-setting and market requirements is reciprocal. The detail of UNECE Minimum Quality Specifications, International Standards for Fruit and Vegetables (OECD), Fair-trade, BRC Global Standards are available from various sources.

3.10.9. Enforcing Implementation of Ethiopian Food Safety and Sanitary Guidelines

Each packinghouse should be constructed in a way that risk of contamination of fruit is minimized and operate under the standard guideline. The following considerations (from the Food Safety Enhancement Program of the MoH Food Inspection) should be taken into consideration:

Product control, the food safety and quality management system: This aspect is based on the ISO 9001 certificate. There are checks concerning product specifications, supplier inspections, traceability and other requirement.

Food safety plan – HACCP: To secure the BRC certificate, an HACCP plan must be in place, the Hazard Analysis and Critical Control Points plan.

There are theoretically many ISO Ethiopian standards applied on fresh fruits and vegetables required for GlobalGAP such as ES ISO 9001: 2015 – QMS; ES ISO 22000: 2018-FSMS; ES ISO 26000, a standard for social responsibility; ES ISO 14001 for Environmental management. Currently many growers supposed to export avocados are not aware of these entire requirements. All avocado production and handling should be practiced under the existing standards, including inclusion new additional requirements as the requirements are becoming more stringent than existing.

3.10.10. Employing the Compulsory Ethiopian Food Safety Standards

Food quality and safety standards are critical for developed and developing economies, where consumer safety is among

the primary issues in food supply chain management. After the rapid development of many economies, quality standards have focused on consumers' demand for safe food and beverage. Therefore, food quality and safety protection emerged with the objectives of safeguarding consumers from economic and health risks and ensuring the functioning of food markets in an orderly manner by prohibiting the production and sale of unsafe food products and fraudulent acts committed on foods. Ensuring the food quality and safety of domestically produced, exported, and imported food and products constitute one of Ethiopia's food quality and safety protection areas. This is with an assumption that maintaining the quality of these foods is essential to protect public health, satisfy consumers' expectations, enhance foreign earnings, and keep the confidence of food trading partners. Hence, governments ensure the quality and safety of domestically produced, imported, and exported food and food products. Everyone involved in the food quality assurance system, from the farmer to the consumer, is expected to share in ensuring good quality and safe food supply to domestic consumers and foreign markets. According to the law, farmers and processing companies are responsible for food safety assurance. In addition, they need to prove that they have applied diligence and traceability practices.

4. Summary and Conclusions

In order to find solutions for improving smallholders' livelihoods and generating incomes from avocado fruits, all aspects of agriculture should be addressed, including soil quality and irrigation systems, better crops and plant materials, agro-techniques, agricultural extension, post-harvesting and marketing. Adding horticultural crops, both fruits and vegetables, to the smallholders' production basket can greatly improve their economic situation and avoid the risks involved in monoculture farming.

In order to exploit all opportunities of avocado sector, every challenges exist in the sector shall be rectified. These start with strong avocado development planning; designing various policy formulations and ways as how to facilitate the transformation of the existing avocado production in Ethiopia. These further require urgent integrations, participations and partnerships among all stakeholders along the avocado value chain in Ethiopia.

Abbreviations

ATI	Agricultural Transformation Institute
ATVETs	Agricultural Technical Vocational Education and Training
BoA	Bureau of Agriculture
CODEX	Codex Alimentarius Commission
CSA	Central Statistics Agency (Services)
DA	Development Agent
EAA	Ethiopian Agriculture Authority

EHPEA	Ethiopian Horticulture Producers and Exporters
EIAR	Ethiopian Institute of Agriculture Research
ESA	Ethiopian Standards Agency
GAPs	Good Agricultural Practices
GoE	Government of Ethiopia
HACCP	Hazard Analysis and Critical Control Points
ISO	International Organization for Standardization
MARC	Melkassa Agriculture Research Center
MoA	Ministry of Agriculture
MoH	Ministry of Health
RBoA	Regional Bureau of Agriculture
NGOs	Non-Government Organizations
WHO	World Health organization
IAIP	Integrated Agro-Industrial Park
MoTRI	Ministry of Trade and Regional Integration
MoH	Ministry of Health
PH	Post-harvest
OECD	Organization for Economic Co-operation and Development
UNECE	United Nations Economic Commission for Europe

Conflicts of Interest

The authors declare no conflicts of interest.

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