



Current Status, Potentials and Opportunities of Avocado Production as an Alternative Crop: the Case of Ethiopia: A Review

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ABSTRACT

The current diminishing farmland size and land productivity due to a population pressure, the decline in soil fertility and climate change is as major challenges in crop production making unsustainable necessitating some resilience mechanism. Crop diversification can be a useful strategy. Thus, avocado can be considered as an important alternative crop to the farmers in most areas in Ethiopia as there are high potential and suitability of the agro-ecologies, high domestic and export market potential. Avocado can provide multiple benefits to the farmers especially to improve farmers' income, increase land productivity, sustainability and food security. Furthermore, it has complementary advantages for business and economic activities of growing towns in nearby areas. And avocado is a high yielder, the nutrition value of avocado is recommendable for nutritional deficient people in developing countries including Ethiopia. However, currently, there is a large yield gap of avocado productivity in Ethiopia (about 4.2 t ha⁻¹) as compared to the world (7 t ha⁻¹) of which lack of improved avocado varieties has been a bottleneck. Because of this, recently some improved avocado varieties have been introduced and on distribution to small-scale farmers by the Ethiopian Ministry of Agriculture in collaboration with USAID. And for better achievement, it should be also supported by research to make more sustainable production and productivity. Therefore, a better understanding of avocado is essential. In this review article, world production and local avocado production trend, importance, potentials and opportunities, some constraints and future direction have been discussed.

Key words: Avocado, Land productivity, Nutritional value, Sustainable production.

Avocado (*Persea americana* Mill) is native to the New World, originating in southern Mexico, Central America and the West Indies. Avocado is a dicotyledonous plant from the *Ranales* order and the *Lauraceae* family. It was classified as *Persea gratissima* by Gaertner and *Persea americana* by Miller. *P. Americana* developed subspecies due to geographical isolation that finally originated different botanical types widely known as subspecies or botanical varieties of the *P. Americana*. Also known as ecological races: Mexican, Guatemalan and Antillean (variety Hass) (Dorantes *et al.*, 2004). The avocado was initially introduced to Ethiopia in 1938 by private orchardists to Hirna of Eastern Ethiopia and Wondogenet area in the south and then the production gradually spread to different areas and agro-ecologies in the country where the crop was adapted (Weyessa and Tsegaye, 2011; Zekarias, 2010).

Avocado is a fruit from a tree that has a variable growth and development, reaching a height of 10 to 12 meters in its natural habitat from subtropical-tropical. Avocado is a very productive tree that delivers fruit all year-round. The economic and social importance of avocado resides in the benefit that its cultivation gives to producers, marketers, processors and consumers. The presence of avocado in the world market has been growing steadily in the past two decades (Dorantes *et al.*, 2004).

Besides this, the presence of a large domestic market for horticultural crops including Avocado and the various

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river basins in Ethiopia gives the country a great potential. Despite several constraints such as the social and cultural habits of the population inclined to cereal-based food habit, dietary preferences for meat and other animal products, low consumer awareness, economic reasons of the local consumers and absence of nutrition intervention programs using horticulture, however, recently the demand for horticultural crops especially for export is increasing (Assefa and Tesfay, 2018). Ethiopia has a comparative advantage in many horticultural commodities due to its favorable climate, proximity to European and Middle Eastern markets and cheap labor. However, the production of horticultural crops is much less developed than the production of food grains in the country (EIA, 2012).

Currently, small scale farmers are facing diminishing farm due to population pressure and decline of land

productivity, a decrease in soil fertility and climate change factors making crop productivity unsustainable and low. In this regard, crop diversification is essential and especially avocado can be an important alternative crop which had multiple benefits to the farmer and to the country's development. It has a high potential yield per unit area, more sustainable than field crops in the face of climatic change, increases farmers' income and the nutritional value of avocado improves food security of the people due to its content of several vitamins, mineral elements, phytochemicals and desirable mono-unsaturated fats. However, there is a large yield gap of avocado productivity in Ethiopia is about 4.2 t ha^{-1} (CSA, 2019) as compared to the world average productivity (7 t ha^{-1}) (FAOSTAT, 2019). Therefore, avocado crop improvement requires attention.

One of the basic constraints in avocado production and productivity in Ethiopia is lack of improved varieties and the local variety is low yielding potential with low quality which doesn't fulfill the current international and/or domestic market demand in amount and quality. The attempts made so far to improve avocado production in Ethiopia is not adequate. Thus, this review article tries to improve understanding on current status of avocado production in Ethiopia as compared to the global trend and make future recommendation. In this review, an overview on botanical description of avocado, the current status of world and Ethiopian avocado production trend, nutritional value of avocado, potentials and opportunities, constraints, recent efforts made in avocado production have been discussed and future recommendations are made.

An overview on botany of avocado cultivars

Persea is the genus, *americana* is the species relating the avocado to its origin in the New World. The avocado species have generally been classified into three common races: Mexican, Guatemalan and West Indian (Dorantes *et al.*, 2004). Reports indicate that the biochemical data along with morphological, geographical and physiological data concluded that the three races were more related than different. Due to this, these races should be better called "varieties" rather than separated into species. As a result, researchers suggested that the proper separation should be for Mexican *Persea americana* var. *drymifolia*, for Guatemalan *P. americana* var. *guatemalensis* and for West Indian *P. americana* var. *americana*. (Bergh and Ellstrand, 1986).

Most researchers still use the term "races" to separate the three types. And it should be understood that the term "variety" is correct botanically when referring to "sub-species". However, "variety" is commonly used to refer to "cultivars", such as 'Hass' or 'Fuerte' (Bender, 2001). Varieties within each race largely conform to specific common traits within the grouping, but hybridisation readily occurs between the races that are also "horticulturally" graft compatible (Whiley, 2013).

Basic floral structure of avocado

Avocado flower behavior is noteworthy which is quite different from any other plant. Nature has provided for avocado cross-

pollination by creating two kinds of botanical varieties. The A type flower is functionally female in the morning of the first day and functionally male in the afternoon of the second day, if the weather is warm. The B type flower is functionally female in the afternoon of the first day and functionally male in the morning of the second day. Both are functionally female on their first day and functionally male on their second day, but they differ in the time of day that they are male and female. A variety of one type provides pollen (functionally male) when a variety of the other type is receptive (functionally female). On trees of an A-type cultivar, flowers open for the first time in early or midmorning, remain open and pistillate until about noon, then close and remain closed until about noon of the second day, when they reopen and begin shedding pollen with the pistil no longer receptive. Finally, they close permanently that night. Flowers on trees of a B-type cultivar function analogously but with transposed timing. The opening cycle on a B-type tree spans about 24 hours. The difference in cycle time reflects the relative length of the closed period between openings. Cross pollination occurs when pollen is transferred from male flowers of a type A cultivar to female flowers of a type B cultivar and vice versa. The yield increasing effect is best when A and B trees are one or two rows away from each other (Bender, 2001).

Status of worldwide avocado production

The recent FAOSTAT data of 2018 revealed that avocado is produced globally on 918, 531 ha and production of more than 6.4 million tons showing about the productivity of 7 tons per ha. Besides this, the last two decades data shows avocado production and area coverage worldwide is increasing linearly (Fig 1). About 70% of production comes from Latin American countries followed by Africa (14%), Asia (12%), Europe (2%) and Oceania (1.6%) (Fig 2) (FAOSTAT, 2019). This indicates globally the production of avocado is increasing.

Moreover, the FAOSTAT data of 2019 indicated that the world 10 top largest producers of avocado include Mexico followed by Dominican Republic, Peru, Colombia, Indonesia, Kenya, Brazil, Haiti, Chile and Israel (Table 1). The area coverage and production in Mexico is significantly higher than the other producing countries. On the other hand, the productivity of avocado in some of these countries like Dominican Republic is specifically the highest (46.6 tons/ha) followed by Brazil (15.9 tons/ha), Kenya (15.7 tons/ha), Israel (13.2 tons/ha), Indonesia (13.1 tons/ha), Peru (12.5 tons/ha), Mexico (10.7 tons/ha) which are even exceeding the world average productivity (Table 1).

Status of avocado crop area, production and productivity in Ethiopia

In Ethiopia, currently, 84,793.7 tons of avocado was produced on an estimated area of 19,758.75 ha of land with a productivity of 4.2 tons/ha. Horticultural fruits generally have about a 2% proportion of the total crops. And Oromia region shares 34% area coverage and production contributing 34.6% in Ethiopia (CSA, 2019). And, in Ethiopia,

there is high investment potential in horticulture with an estimated irrigable potential area of more than 767,300 hectares with several incentives (MOAR, 2009). Therefore, the current avocado area coverage, production and productivity status is very small in relation to the existing production potential of the country. The data shows generally the existence of a large yield gap as compared to the world average requiring improvement in all dimensions. The existing local varieties under production in Ethiopia are low yielding potential and poor quality that can't fit the consumers' demand for local and world market. This requires

replacing the local with varieties of improved high yielding potential and quality.

Nutritional value of avocado

Avocado has nutritional, industrial and health benefits. It is considered as one of the main tropical fruits containing fat-soluble vitamins which are less common in other fruits, besides high levels of protein, potassium and unsaturated fatty acids. Avocado fruit has been recognized for its health benefits, especially due to the compounds present in the lipidic fraction, such as omega fatty acids, phytosterols,

Table 1: The area, production and productivity of the top 10 world avocado producing countries.

Country	Production area (ha)	Production (tons)	Productivity (tons/ha)	Rank
Mexico	215942	2300889	10.7	1
Dominican Republic	14190	661626	46.6	2
Peru	42788	535911	12.5	3
Colombia	63534	535021	8.4	4
Indonesia	35136	461613	13.1	5
Kenya	23298	364935	15.7	6
Brazil	15315	242932	15.9	7
Haiti	39916	231719	5.8	8
Chile	29224	162988	5.6	9
Israel	10520	138766	13.2	10

Source: FAOSTAT (2019).

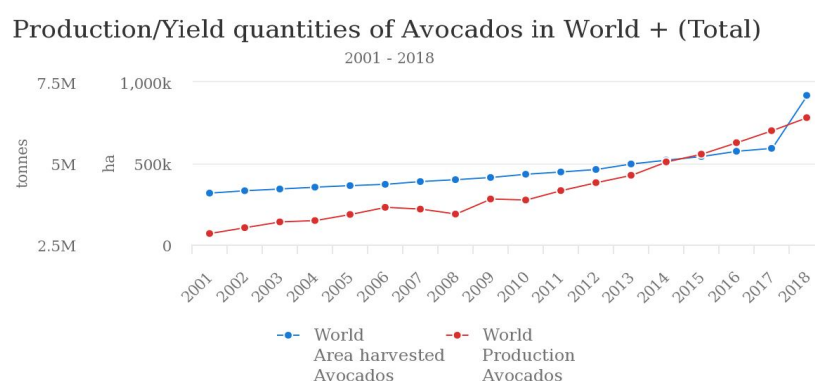


Fig 1: The trend of world avocado production (Millions of tons) since the 2001-2018 year.

Production share of Avocados by region

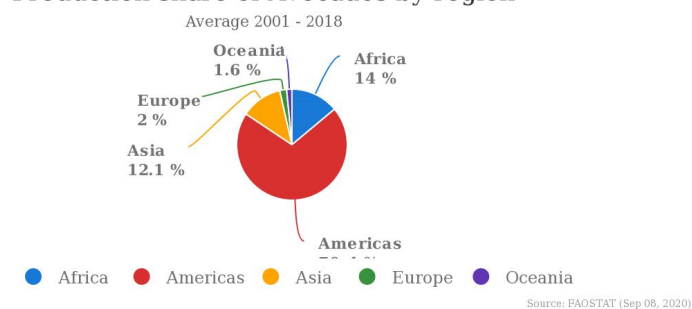


Fig 2: Production share of avocado by region
(<http://www.fao.org/faostat/en/#data/QC/visualize>).

tocopherols and squalene. Studies have shown the benefits of avocado associated to a balanced diet, especially in reducing cholesterol and preventing cardiovascular diseases. The pulp contains variable oil content and is widely used in the pharmaceutical and cosmetics industries, pulp processing and in the production of commercial oils similar to olive oil (Duarte *et al.*, 2016). Moreover, according to NHANES data, the average avocado consumption is one-half fruit, which provides for a nutrient and phytochemical dense food consisting of significant levels of the following: dietary fiber, potassium, magnesium, vitamin A, vitamin C, vitamin E, vitamin K1, folate, vitamin B-6, niacin, pantothenic acid, riboflavin, choline, lutein/zeaxanthin, phytosterols and MUFA rich oil at 1.7 kcal/g. This caloric density is medium-low because avocado is about 80% by weight is water (72%) and dietary fiber (6.8%). Avocados also have a diverse range of other nutrients and phytochemicals that may have beyond cholesterol vascular health benefits. The avocado oil consists of 71% monounsaturated fatty acids (MUFA), 13% polyunsaturated fatty acids (PUFA) and 16% saturated fatty acids (SFA), which helps to promote healthy blood lipid profiles and enhance the bioavailability of fat-soluble vitamins and phytochemicals from the avocado or other fruits and vegetables, naturally low in fat, which is consumed with avocados (Mark and Adrienne, 2013).

Furthermore, research reports showed that an estimated over five million people are suffering from a lack of vitamins and essential minerals in Ethiopia which is about 60 to 80% of health problems in Ethiopia are due to communicable diseases and nutritional problems (Habtamu and Adugnaw, 2016). Therefore, avocado is a suitable remedy to improve the food security of the people.

Potentials, opportunities and constraints in Ethiopia

Ethiopia has a comparative advantage in many horticultural commodities due to its favorable climate, proximity to European and Middle Eastern markets and cheap labor. However, the production of horticultural crops is much less developed than the production of food grains in the country. Moreover, reports show that about 2.4 million tons of vegetables and fruits are produced by public and private commercial farms which are estimated to be less than 2 percent of the total crop production. Avocado is among fruit crops of significant importance and with a potential for domestic consumption, export markets and industrial processing (EIA, 2012).

Besides this, the presence of a large domestic market for horticultural crops and the numerous river basins in Ethiopia makes the great potential for irrigation. Despite several constraints such as the social and cultural habits of the population inclined to cereal-based food habit, dietary preferences for meat and other animal products, low consumer awareness, economic reasons of the local consumers and absence of nutrition intervention programs using horticulture, however, recently the demand for

horticultural crops especially for export is increasing (Assefa and Tesfay, 2018). Another important aspect of avocado is it can suitably produce in sole crop or intercropping system. For instance, in Jimma area of western Ethiopia, avocado is produced by small-scale farmers in sole crops or intercropped with coffee or other fruits. And the average amount of fruit-bearing in an individual farmer is about 8 plants with an average harvest of 198 kg per tree (Zekarias, 2010). However, the local variety is low yielder with the poor quality produced in different parts of the country especially in the south and southwestern Ethiopian region, it is commonly intercropped with coffee and other horticultural crops including spices in a home garden. Therefore, the lack of improved avocado varieties has been a major constraint in avocado production.

Current efforts of improving avocado production in Ethiopia

To improve the avocado production and productivity in Ethiopia, recently it is recognized by the government and private investors as an important potential crop with multidimensional benefits. Because of this, some small projects are underway such as the "Smallholder Horticulture Project (SHP)" which has been implemented by the joint program by the Ethiopian government in collaboration with USAID Ethiopia and MASHAV of Israel to develop a competitive and sustainable fruit development sector focusing on establishing a base for the avocado export market from Ethiopia. Thus, the project can promote Ethiopian avocado in the international market for the last three consecutive years and this avocado is becoming competent in European and Asian markets. Therefore, the demand for improved avocado seedling is now increasing in the country and there is big interest from the government and the private sectors (local and international) to plant / invest and produce avocado for the export market (<https://ehpea.org/avocado-the-new-trend-of-ethiopian-horticulture-business/>). Furthermore, the same project has recently introduced Hass avocado variety from Israel and distributed to more than 2000 farmers. And in the last four years (2016-2019), the program has exported Hass from Ethiopia and found the results encouraging and worth expanding (<https://www.devdiscourse.com/article/business/506372-avocado-soon-to-be-marked-as-ethiopias-major-export-report>). Thus, the recent introduction of some improved avocado varieties for dissemination to the farmers was an important step in avocado production. However, for sustainable production and productivity, the current efforts should be supported by research as it requires appropriate recommendations of all technological packages in the area. Besides this, the effect of climate change also influences several biotic and abiotic factors that would directly or indirectly affect the productivity of the crop.

From several internationally known commercially available avocado varieties, the few recently introduced avocado varieties to Ethiopia (Oromia region) include Hass,

Nabal, Ettinger, Fuerte and Pinkerton. These varieties are being used as a scion while the local variety is used as rootstock (personal communication).

Distinctive characteristics of the varieties introduced

Hass

Persea americana x 'Hass'. It was developed from Guatemalan avocado. The Hass avocado is the most commercial variety grown in the world. It is characterized by its pebbly green skin that ripens to black. The fruits are easy to peel and are high in oil content with an excellent nutty rich flavor. Hass has the longest fruiting season of any avocado. This is an A-Type avocado and will produce on its own. A B-Type avocado may be planted adjacent to it in order to produce a more consistent crop (Bender, 2001). www.louiesnursery.com/plants/avocado-trees/nabal-avocado).

Fuerte

Persea Americana x *Fuerte* hybrid. The Fuerte avocado is the second largest commercial variety behind Hass. It is B-Type blossom type which most growers' plant adjacent to the Hass for a more consistent production cycle. This avocado tends to produce heavily in alternate years (Bender, 2001) ([://www.louiesnursery.com/plants/avocado-trees/nabal-avocado](http://www.louiesnursery.com/plants/avocado-trees/nabal-avocado)).

Pinkerton

Persea Americana x 'Pinkerton'. The Pinkerton avocado is a highly recommended avocado due to their consistent production, flavor and manageable tree size. This variety is a heavy producer of green pebbly-skinned flesh fruit. The small seeded fruits have an exceptional flavor with high oil content and are relatively easy to peel. Flower Type is Type-A [https \(://www.louiesnursery.com/plants/avocado-trees/nabal-avocado\)](http://www.louiesnursery.com/plants/avocado-trees/nabal-avocado).

Ettinger

Persea americana x 'Ettinger'. It is tall and early maturing variety. Ettinger avocado originated in Israel and was introduced into the U.S. in 1954. Excellent quality bright green fruits have light yellow flesh that surround a large seed. The tree is vigorous and very prolific. Fruits ripen slightly before and with Fuerte. Flower Type is Type-B [https \(://www.louiesnursery.com/plants/avocado-trees/nabal-avocado\)](http://www.louiesnursery.com/plants/avocado-trees/nabal-avocado).

Nabal

Persea americana x 'Nabal' hybrid. The Nabal avocado is a round shaped avocado of Guatemalan origin. It produces large round fruits of exceptional quality. The flesh is creamy and greenish-yellow in color. Flower Type is Type-B ([https \(://www.louiesnursery.com/plants/avocado-trees/nabal-avocado\)](http://www.louiesnursery.com/plants/avocado-trees/nabal-avocado)).

The rootstock and scion

The vegetatively propagated rootstocks are used successfully

in many woody, perennial fruit crops including avocado to overcome certain problems related to productivity, soil factors, disease, growth habit, fruit quality, etc. The most common criteria when dealing with the selection of new fruiting scions (cultivars) the requirements for superior new rootstocks can be defined clearly as tolerance to *Phytophthora* root rot and potential to produce high yields (Köhne, 2005). Common seedling avocado rootstocks in California have traditionally been selected from the Mexican or Guatemalan races of *Persea Americana* (Bender *et al.*, 2001). Productivity of fruit tree crops is known to be intrinsically dependent on the choice of rootstock, whether it be either their ability to resist diseases or to impart higher production to the scion through the enhancement of physiological processes. There was no single rootstock that had superiority across all production regions. However, the highest yielding rootstocks overwhelmingly came from the Guatemalan and West Indian horticultural races And, hybrids with Mexican and Guatemalan race genes were in the second most successful group. Furthermore, the influence of rootstock on fruit quality did vary considerably according to growing location and year of assessment, a number of trends could be identified (Whiley, 2013). Therefore, selection of appropriate rootstocks-scion combination is crucial.

CONCLUSION AND FUTURE RECOMMENDATIONS

Avocado is a multipurpose fruit plant for small-scale farmers especially to increase farmers' income, land productivity, sustainability and food security. Furthermore, it has potential complementing benefits to small business and economic activities of growing towns in the nearby areas. However, there is a large yield gap of avocado productivity in Ethiopia (about 4.2 t ha⁻¹) as compared to the world average (7 t ha⁻¹) and other countries which requires huge improvement. In this regard, the recent efforts made by the Ministry of Agriculture in collaboration with USAID and MASHAV of Israel to introduce new improves avocado varieties and distribute to the farmers is an excellent initiative to solve some of the problems. For better achievement in promotion and sustainable improvement of production and productivity of avocado, consideration of the following points would be important.

- i) Creating awareness among farmers about the importance of avocado as a source of nutrient and income, it's the cultivation and sustainable production and nutritional food security.
- ii) Establishment of more nurseries and strengthening collaboration work with other organizations for easy and quick multiplication and dissemination of the improved avocado seedlings
- iii) Strengthening research and collaborative work on avocado is essential to introduce avocado germplasm and subsequent development of technological packages as the current and future performance of avocado is influenced by biotic and abiotic factors so that maintaining its sustainability is important.

- iv) The domestic and export demand for avocado is high. Thus, it is a suitable investment area for private or government organizations which needs encouragement
- v) Establishment of market channel and the required facilities shortly is essential.

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