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Research Article

Role of Avocado in Agir-Food System and Agro-Processing: Assessments of Food Diversification and Utilization of Avocado Fruits in Ethiopia

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Abstract

The cultivation of fruits and vegetables, including avocados, has increased in recent years in Ethiopia. Among fruits, avocado has known as one of the healthiest fruits, is widely cultivated and available for consumption. The aim of the study was to assess the role and trends of avocado consumption and its role in the country's agri-food systems and agro-processing. Survey conducted in selected avocado-producing districts in Ethiopia, specifically in Sidama, South Ethiopia, Amhara and Oromia Regions. The study employed a mixed research methodology using both qualitative and quantitative approaches. Data were collected through household surveys, interviews and from secondary sources were collected and reviewed. The findings revealed that the average experience in avocado farming among the sampled smallholder farmers was 13.7 years, indicating significant expertise in avocado production and marketing. Regarding avocado consumption and marketing, a high proportion of farmers (87.6%) reported that their main motive for avocado production was for sale showing it is a cash crop. There was also an increase in avocado consumption patterns. Based on the FGD discussions and key informant interviews avocado fruit is processed into variety of recipes such as a sole or mixed juice, parts of salads, sandwiches, paste (served with variety of Ethiopian dishes such as Shiro, Alicha, Key Wot with Injera, *Firfir* with avocado, etc.). The fresh fruits have high agro-processing demands for oil production in Ethiopia for export. In addition, avocado oil is used as cooking oil, and as parts of cosmetics and beauty products. The study revealed that avocado is a nutritious dense food source that can contribute to improved health outcomes of the nation. On the other hand, varieties of recipes containing avocado fruits are being developed and used. Avocado is becoming key parts of food component in the daily consumption among growers. Likewise, the use of avocado in oil production and cosmetics agro-processing industry is increasing. Thus, promoting the consumption of diverse nutritious food avocado as a component would enhance national food and nutrition security and address micronutrient deficiencies. Improving the production and productivity of avocadoes would meet the high fresh consumptions, industry raw materials demand and fresh export foreign earning. Thus, any innovations at all stages (steps) in avocado value chain could help significantly the national avocado agri-food system and agro-processing industry development.

Keywords

Avocado, Food Consumption, Food Security, Nutrition, Recipes

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1. Introduction

Avocado has a large global and domestic market as a fresh fruit, besides its use in the oil, cosmetic, soap, and shampoo industry; as well as processed foods derived from it, such as guacamole, frozen products and avocado paste. Avocado fruits contain high dietary fiber, vitamins (such as vitamin K, vitamin E, and B vitamins), minerals (such as potassium and magnesium), and various phytochemicals, including carotenoids and phenolic compounds (www.hsph.harvard.edu/nutritionsource/avocados). It is also rich source of Omega 3 and Omega 6 fatty acids and proteins [17, 32]. Avocados are unique among fruits due to their relatively high fat content. Avocados are a unique among fruits due to their relatively high fat content [7]. However, the majority of the fat in avocados comes from monounsaturated fatty acids, which have been associated with reducing LDL cholesterol levels and promoting cardiovascular health [7]. It nourishes our bodies and embraces a healthier lifestyle. The wellness life journey starts right on having an avocado fruit on a plate. Food security and nutrition are significant challenges in Ethiopia due to various factors, including limited agricultural productivity, recurrent droughts, poverty, limited access to healthcare and clean water [24].

Agriculture is the backbone of Ethiopia's economy, employing a large portion of the population. However, agricultural productivity is hindered by challenges such as limited access to improved seeds, irrigation systems, and modern farming techniques. These factors contribute to low crop yields and vulnerability to climate change [36]. In addition, Ethiopia is prone to droughts and erratic rainfall patterns, which significantly impact agricultural production and food availability. Droughts can lead to crop failures, livestock losses, and food shortages, particularly in rural areas where communities heavily rely on rain-fed agriculture [18].

Malnutrition, particularly among children, is a pressing issue in Ethiopia. Chronic malnutrition leads to stunting, which affects physical and cognitive development [25]. According to the World Bank, nearly 37% of children under the age of five in Ethiopia are stunted, indicating a long-term impact on human capital and future productivity [34]. Micronutrient deficiencies, including iron, vitamin A, and iodine deficiencies, are prevalent in Ethiopia [21]. These deficiencies can lead to various health problems, including anemia, impaired immune function, and vision impairments [21]. Efforts to address these deficiencies include food fortification programs and promoting diverse nutritive diets such as fruits and vegetables. Diet plays an important role in controlling disease, improving health and maturing a generation [3]. A high intake of fruit and vegetables has been linked to a lower risk of chronic diseases, according to the research reports [17]. There are reports indicating worldwide production of fruit and vegetable crops has grown faster than that of cereal crops, although from a much lower base [4].

Among fruits, avocado fruits are highly nutritious. It is a popular and frequently consumed product in south, south-western Ethiopian households both rural and urban. However, the majority of the fat in avocados comes from monounsaturated fatty acids, which have been associated with reducing LDL cholesterol levels and promoting cardiovascular health [7, 13, 17, 32].

Avocados contain phenolic compounds, such as catechins and flavonoids, which exhibit antioxidant properties [13, 17, 32]. These antioxidants help neutralize free radicals in the body, potentially reducing oxidative stress and inflammation. Several studies have investigated the effects of avocado consumption on blood lipid profiles. Findings suggest that avocado consumption may led to improved lipid profiles, including decreased LDL cholesterol and triglyceride levels, while increasing HDL cholesterol levels [7, 17]. Avocados have a low glycemic index, meaning they have minimal impact on blood glucose levels [13, 17, 32].

Despite their relatively high caloric content, studies have suggested that incorporating avocados into a balanced diet may not lead to weight gain or may even support weight management due to their satiating properties and potential metabolic benefits [7, 17]. Avocados have been found to enhance the absorption of fat-soluble nutrients, such as carotenoids and other phytochemicals, when consumed with other fruits and vegetables [45]. This attribute has led to the concept of "avocado as a nutrient booster" in meal planning. It is a popular and frequently consumed product in south, south-western Ethiopian households both rural and urban. Avocado is also rich sources of minerals including Omega 3 and 6 fatty acids and proteins [13, 32].

In a comprehensive examination of the significant nutrients and distinctions between beef and avocado using data from the (www.soupersage.com/compare-nutrition/avocado-vs-beef), the following key points can be highlighted: Both beef and avocado are notable for their high calorie and potassium content. However, avocado surpasses beef in terms of Vitamin C levels [41].

Additionally, avocado proves to be an excellent source of dietary fiber. While beef excels in its niacin and Vitamin B12 content [41], avocado contains higher levels of pantothenic acid and folate. It is worth mentioning that beef is an excellent source of iron, whereas avocado is not particularly rich in this mineral (*Anon*.). However, both beef and avocado are commendable sources of protein. They contribute significantly to meeting the body's protein requirement.

Researchers compared the nutritional contents of eggs and avocados, with each weighing 100g both egg and flesh of avocado [41]; avocado fruit has high content of fat and carbohydrate. Ethiopia's per capita consumption of fresh fruits is one of the lowest in the East Africa region [12]. This is mostly because of low income and weak dietary habits resulting from inadequate awareness on nutritional

benefits. Consumption of edible fruits in Ethiopia is usually in the form of fresh fruits. As such there are no significant major value-added or industrial processed fruits produced and consumed in the country. Consumption of fresh juices as well as processed fruit juice products are imported from the other countries, and are increasing in major cities and other urban areas showing high processed fruits demand [1]. Based on the study report Ethiopia's per capita consumption of fresh fruits is one of the lowest in the East Africa region [12]; this is mostly because of low income and weak dietary habits resulting from inadequate awareness on nutritional benefits. Ethiopia's per capita consumption of fresh fruits is approximately 7 kg per person per year; this is far below the WHO and FAO recommended minimum level of dietary intake (i.e., 146 kg per person per year). Also, Ethiopia's per capita consumption is eight times lower than the average figure for the East Africa region, which stands at 55 kg per person per year (*Anon*). Likewise, Ethiopia's consumption level is well below neighboring countries such as Sudan with 79 kg per person and Kenya with 55 kg per person. However, local consumption is expected to increase as the country's economy continues to grow. In addition, burgeoning population and urbanization trends are expected to drive consumption up. There are also reports that the intake of fruit and vegetables in Ethiopia is very low in Ethiopia as compared with other countries [19].

Some study reported that the prevalence of fruit and/or vegetable consumption in Ethiopia was found to be (1.5%) [more female than male ate fruit and vegetable in Ethiopia [27]. When adjusted for included demographic and residence confounders (age, sex, location, income, education), those in rural area of residence ate ≥5 servings of fruits and vegetable; concluding that fruits and/or vegetables intake in Ethiopia is generally extremely low. Scholars identified the mean Ethiopian family consumption of fruit and vegetable was less than 30% of the WHO's recommendation [15]. Conversely, another researcher stated that the consumption of these crops in Ethiopia is growing about 30-40% per individual in both urban and rural parts between 2011 and 2016 [22]. Now a day's supermarkets retailing fruits and vegetables; the numbers of jam processing companies, availability of fruits in the hotels, supermarkets, restaurants, and vendors are growing. Even though with the current intake rising, Ethiopia's intakes of these crops yet need additional scope to increase.

Many health researchers exhibited that among the children assessed in nine regions, 38.1% couldn't eat any common vegetables (kale, spinach, cabbage, carrot, tomato and pumpkin) weekly [3, 31]. The ratio of index youngsters who couldn't eat any common vegetable was greater in Afar (85.0%), Tigray (77.6%), Amhara (61.8%) and Addis Ababa (59.3%) and moderately small in South Ethiopia (7.0%), Dire Dawa (15.6%) and Oromia with 18.6% [3, 31]. Of all teenagers assessed in nine regions, 36.5% couldn't eat common fruits (mango, papaya, oranges, avocado and banana) during the week. The ratio of teenagers who couldn't eat fruits remained great in Tigray (88.1%) and Afar (83.5%) and small in Harari (23.3%). The proportion of children who did not eat vegetables one time in the week is superior to 75% in Afar and Tigray areas. This is because, in the above-mentioned regions, the availability of these crops in the market is worrisome and need different interventions.

The percentage of teenagers who have taken fruits was significantly greater between the urban dwellers and rural dwellers. In contrast to this, in the eastern part of Ethiopia, the farmer has adequate production of these crops, but they don't consume instead, they focus on taking them to the market for cash. Research scholar found that, the intake of fruits and vegetables in Addis Ababa City rich in vitamin A is a minimum, however, the intake of other types of vegetables is high, and this is due to the daily consumption of onions, tomatoes and garlic [35]. WHO recommends that preschool age children should consume about 75% of vitamin A rich food a minimum of three times a week [34]; otherwise, the society should be considered at risk society. According to this recommendation, many communities in Ethiopia can be categorized 'at risk communities. Similarly, another scholar studied the availability and consumption of fruits and vegetables in nine regions of Ethiopia with special emphasis to vitamin A deficiency [31], they found that 41.5% and 75.5% of households did not produce/ cultivate any of the common vegetables and fruits over the year preceding the survey. The findings indicated that proportion of households who did not produce/cultivate vegetables was high in Addis Ababa (99.7%), Afar (94.9%), Dire Dawa (94.2%) and Tigray (86.4%). The proportion of households who did not produce/cultivate fruits was highest in Addis Ababa (100%), followed in Dire Dawa (95.3%), Afar (92.9%), Tigray (92.2%), Harari (83.3%) and Oromia (81.8%). In the overall, 38.1% and 36.5% of the children studied did not eat vegetable and fruit in the week preceding the survey, respectively; calling for strengthened efforts to promote production and consumption of fruits and vegetables. With this regard, uses of avocado fruits in a variety of ways and recipes are emerged in all production areas.

Avocado is the most available fruits next to banana for consumption in Ethiopia although the availability varies seasonally [11]. Although a significant proportion of Ethiopian does not consume the daily recommended amounts of nutritious-dense foods such as fresh fruits and vegetables in the early days, recently it seems avocado consumption increased much higher through developing variety of local recipes that fit Ethiopian traditional food preparation culture [5].

Currently various use of avocado fruits is emerged as a side dish with many types of foods, as juice either alone or mixed with other fruits juices, components of vegetable salads and other homemade foods products [21]. There is no information documented related to avocado consumption trends and variety of recipes made from avocado as a component of food in

Ethiopia; in addition, agro-processing of avocado is emerging such as edible avocado oil and avocado oil in a cosmetic industry are started since 2020 in Ethiopia and currently the country is exporting avocado oils. Therefore, the aim of this study is to assess the avocado consumption uses and trends in the food baskets of smallholder farmer's food system and review the current role in the agro-processing including cosmetic industry in Ethiopia.

2. Materials and Methods

Major avocado-producing and marketing districts were selected as the research study area because of being the first district among six (Dale from Sidama region, Boloso Sore from South Ethiopia, Kersa and Ada'a districts from Oromia Region, and Semen Mecha and Jabina Tena from Amhara Region which have the potential for avocado production. Although avocados do well in different areas, the southwestern part of Ethiopia, the Sidama, South Ethiopia, Southern West Ethiopia, Central Ethiopia Regional States are the key production belt. The other major avocado-producing regions are Oromia and Amhara. The following map shows the four Regions of Ethiopia where the six major selected avocado-growing districts are located (Figure 1).

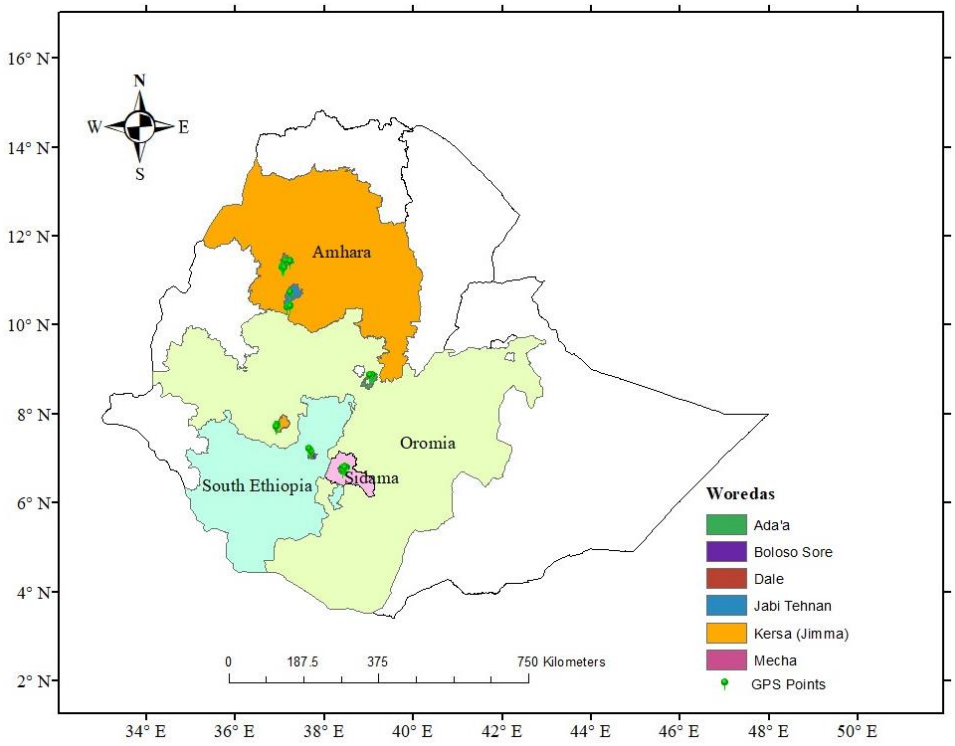

Figure 1. *Map of the study areas in Sidama, South Ethiopia, Oromia and Amhara Regional States (Tamirat et al., 2024).*

2.1. Data Collection Methods

This study used a mixed research approach in which both qualitative and quantitative data collection and analysis methods were employed. Primary data were collected from Avocado producers, heads of households, heads of villagers and communities, local buyers, wholesalers, and retailers using a questionnaire. A household survey was conducted with randomly selected target households (HHs) in the six target Woredas and 12 Kebeles based on a Sample Size proportion to Population (SSP) principle. Qualitative data were collected using different data collection methods, including key informant interviews, focus group discussions, and document reviews. KII with the government sector office, research organizations, cooperatives, unions, and private ventures participated in the qualitative study.

2.2. Sampling and Sample Size Determination

Sample selection was done using multi-stage sampling processes. In the first stage, six districts were selected from the Sidama, South Ethiopia, Oromia and Amhara Regions purposively due to avocado production and marketing potential. In the second stage, from each District, 12 avocado-producing Kebeles were identified. In the third stage, with a required degree of precision about 268 samples of household heads were chosen from each Kebeles. The samples were then distributed to the appropriate Kebeles using a population proportional to the sample size. Accordingly, 268 HHs par-

ticipated in the household survey from Sidama Region, Dale district (105 samples), South Ethiopia, Boloso Sore district (43 samples), Oromia Region, Kersa and Ada'a Districts (61 samples), and Amhara region, North Mecha and Jabina Tena districts (59 samples).

2.3. Methods of Data Analysis

Both qualitative and quantitative data analysis methods were used to analyze information obtained from HH surveys, FGDs, KII observations, and secondary sources. The data collected from the sample avocado producers and traders were analyzed using descriptive statistics, which included mean, standard deviation, frequency, and percentiles. Then, Value chain mapping was used to present and summarize the outcome from grounded theory. The study used value chain analysis, which is particularly effective at tracking product flows, illustrating the actual processes of value-adding, identifying key actors, and their relationships with other actors in the chain, and measuring the distribution of their benefits. The content analysis was performed by transcribing all responses and field notes from field observation, which helped to identify key patterns, trends and themes, and value chain issues in the data.

In addition, information on avocado based food products lists were collected from snacks and restaurants in Sodo and surrounding towns. Observations were made through restaurants and groceries and juice houses including street vender to find out avocado based foods stuffs.

3. Results and Discussions

3.1. Proportion of Avocado Consumption and Marketing in the Study Areas

The survey found that the main objective of avocado production by the majority of smallholder farmers (87.6%) reported that their motive of avocado production is for sale. Marketing evolves when there is a surplus production. Therefore, one of the study's main emphases was on understanding the varieties of foods produced from avocado fruits. The information from the household survey showed that use of avocado for HH consumption accounts only 12.4% of the total production the results indicate a substantial proportion of avocados are being sold rather than consumed.

3.1.1. Amounts of Avocado Harvested

The study showed that sample avocado farmer in study areas harvested an estimated various amounts of avocado fruits, such as in Sidama, they harvested 36350.1 kg; in Wolaita they harvested on the average 34022.7 kg; in Amhara regional state, harvested 47881.5 kg and in Oromia they harvested 44009.3 kg avocado yield (Figure 1).

3.1.2. Amounts of Avocado Sold

Farmers sell some number of avocado fruits from the harvested yield. During the study period farmers sold 33431.8 kg of avocado in Sidama, whereas avocado growers sold 32730 kg in Wolaita; and avocado growers sold 45660.2 kg in Amhara; and finally sample avocado growers in Oromia sold 41487 kg during the study period (Figure 2).

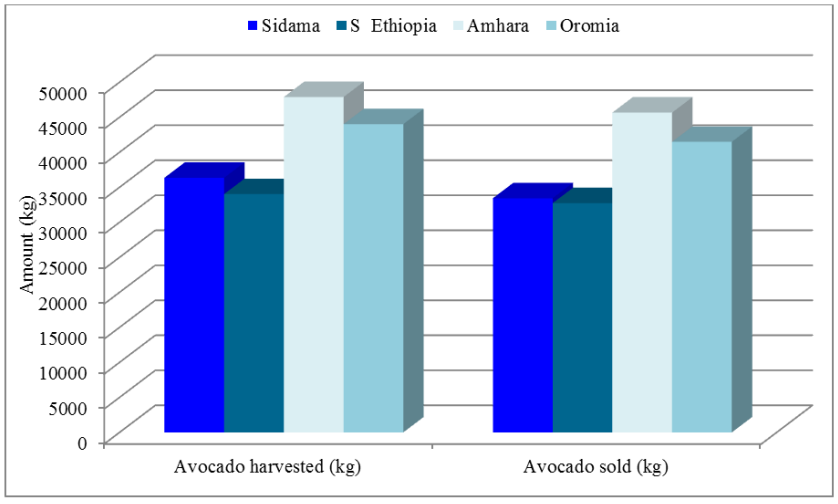

Figure 2. *Comparison of average amounts of avocado harvested and sold by the sample HH.*

3.1.3. Avocado Consumption

The survey found that there is a variation among regions in avocado consumptions. The result showed that sample avocado grower in Sidama region used 2391.3 kg/ year of avocado for avocado consumption; whereas in sample

grower in Wolaita sample avocado grower used 5094.7 kg/year of avocado for home consumption; whereas in Amhara used 1698.8 kg/year for home consumption and finally sample avocado grower household in Oromia used 3040.8 kg/year for home consumption (Figure 3). Avocado consumption represents 12.4% of the total avocado production; and this finding suggests that a relatively smaller proportion of avocados are consumed locally as compared to the amount sold, showing avocado is becoming a cash crop in the major production areas of Ethiopia. Based on the results of the study, avocado fruits contribute highly to the food and nutritional security and as a cash crop in the sample production areas as it is consumed in a variety of ways. The study showed that maximum and highest quantity of avocado fruit is used in in South Ethiopia (Wolaita) in a variety of food recipes and side dressing recipes followed by Oromia as indicated in Figures 7-12 in this paper.

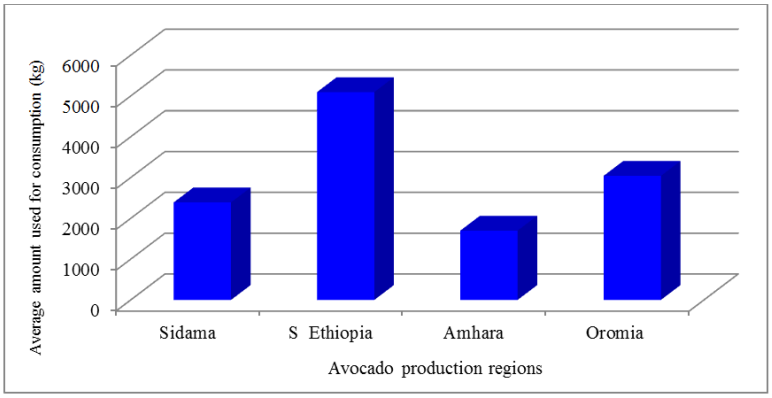

Figure 3. *Average amounts of avocado fruits used for consumption in different production regions during the study period.*

Many scholars reported that avocado is important at the household level (HH) consumption in Lemo Woreda, Hadiya Zone, Southern Ethiopia [10, 20]. They reported that the avocado grower HH consume avocado a) as primary food alone, b) as staple food consumption (with Enset), c) avocado replaces cabbage as side meal and d) avocado replaces kale as side meal.

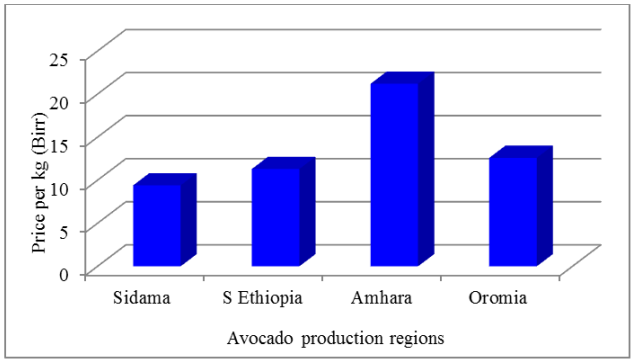

Figure 4. *Average price of avocado fruits per (kg) in different regions during the study period.*

Average price of avocado Sample avocado growers sell some number of avocado fruits with various prices depending on the variety, seasons and the production areas. The study showed that sample avocado grower in Sidama region sold avocado fruits at 9.4 Birr per kilo; whereas in Wolaita sold at 11.3 Birr per kilo in Amhara sold at 21.2 Birr per kilo and finally sample avocado growers sold avocado fruits in Oromia at 12.6 Birr per kg (Figure 4). The reason for the highest price of avocado in Amhara region is most of the varieties are Hass and Ettinger whereas in Wolaita, Sidama and in Oromia are those local seedling types with inferior quality.

3.1.4. Income from Avocado Sale

It is known that sample avocado grower gets some income annually from selling some number of avocado fruits. The study found that avocado growers in Sidama got gross income of total of 341690.9 Birr; whereas sample avocado grower in Wolaita got a total of 384456.5 Birr; avocado farmer in Amhara region got 1015087.8 Birr and finally avocado grower in Oromia region got a total of 554517.18 Birr per year (Figure 5). The reasons for the lowest income from avocado fruits both Sidama and Wolaita areas are most avocado trees are local types with more diverse utilization of avocado fruits in the regions. In addition, large amounts of avocado fruits are consumed in Sidama, South Ethiopia (Wolaita) as compared to Amhara Region.

Some scholars found that avocado has significant source of HH income in Lemo Woreda, Hadiya Zone, central Ethiopia [20], it is source of income, specifically for women; by selling of avocadoes women buy food and non-food item needed for the household, use income from avocado instead of selling livestock during the food shortage period, buy oil, coffee, salt, exercise books for children, fertilizer etc., with avocado revenues, thus avocado fill livelihood gaps with cash income

from avocado sales.

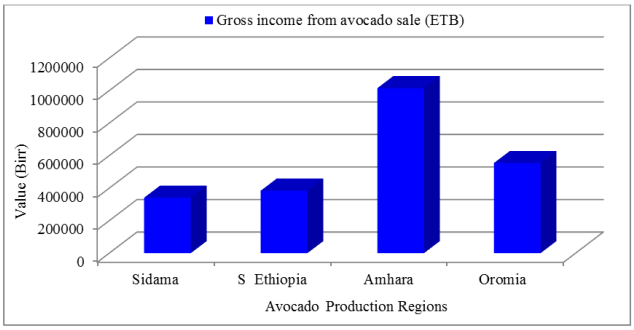

Figure 5. *Avocado grower's average gross income from sale of avocado during the study period.*

3.2. Production and Consumption Status of Avocado in Last Two Years and Ten Years

The current study showed that the production of avocado increased nearly two-fold as compared to the last ten years. The selling of avocado fruits also increased with an increased in production. It is observed that the high proportion of avocado fruit produced by the farmers is mostly targeted for home consumption in the earlier days and currently avocado fruits are becoming multi-purposes commodity and farmers sell large percentage of avocado fruits (Figure 6).

3.2.1. Percentage of Avocado Production Growers Sold During the Last Two Years

The percentage of avocado production sold by a sample grower was estimated (average last 2 years). The results indicated that avocado grower in Sidama sold nearly 87.5%; in Wolaita sold 85.8%; in Amhara sold 78.2%; and finally in Oromia sold a total 82.6% fresh avocado fruit (Figure 6). In all study areas the percentages of avocado fruits sold currently by far greater than the last ten years. This indicates that avocado is a cash crop and its demand is increasing than ever.

3.2.2. Percentage of Avocado Production Growers Sold During the Last Ten Years

The percentage of avocado production sold ten years ago is much lower in quantity, for example avocado grower in Sidama sold an estimated amount of 58.2% of fruits produced, whereas sample grower in Wolaita sold an estimated amount of 63.2%) of fresh fruit produced; sample farmer in Amhara indicated that they sold nearly 34.7% of total avocado they produced and finally sample avocado grower in Oromia sold 51.3% of the total production (Figure 6). This study showed that the popularity of avocado fruit is increasing, showing high market demand and home consumption for avocado growers. Thus, this is parts of the drivers for avocado production expansions in all regions including Tigray, Gambella, Benshangul-Gumuz, South West Ethiopia and all cities and towns in Ethiopia.

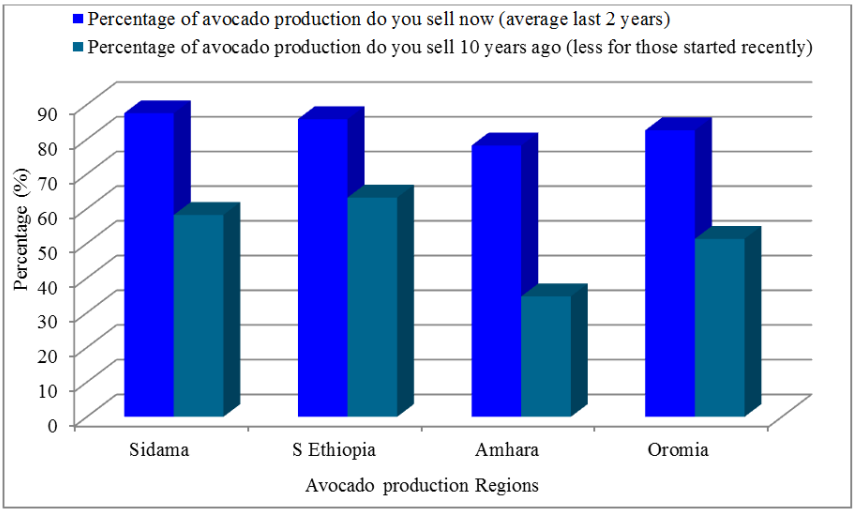

Figure 6. *Comparison of percentages of avocado fruits sold.*

3.2.3. Percentage of Avocado Production Growers Consumed During the Last Two Years

The survey assessment has gone into the depth of the percentage of amount and proportions of avocado production that currently the growers consume (average last 2 years). The result showed that in Sidama avocado growers currently consume a total of 12.5% fruits produced; whereas in Wolaita growers consume 14.2% of the total fruits produced and in Amhara avocado growers currently consume 21.8% of avocado fruits they produced; and finally avocado grower in Oromia currently consume 17.4% of fruits they produced (Figure 7). Similarly, the percentage of avocado production consumed ten years ago were assed from sample growers; the

results found that avocado grower in Sidama consumed an estimated 41.8% of fruits they produced; whereas avocado grower in Wolaita consumed an estimated 36.8% of fruits they produced; and farmers in Amhara consumed nearly 65.3% of avocado fruits they produced and finally avocado growers in Oromia used to consume an estimated 48.7% percent of fruits they produced (Figure 7).

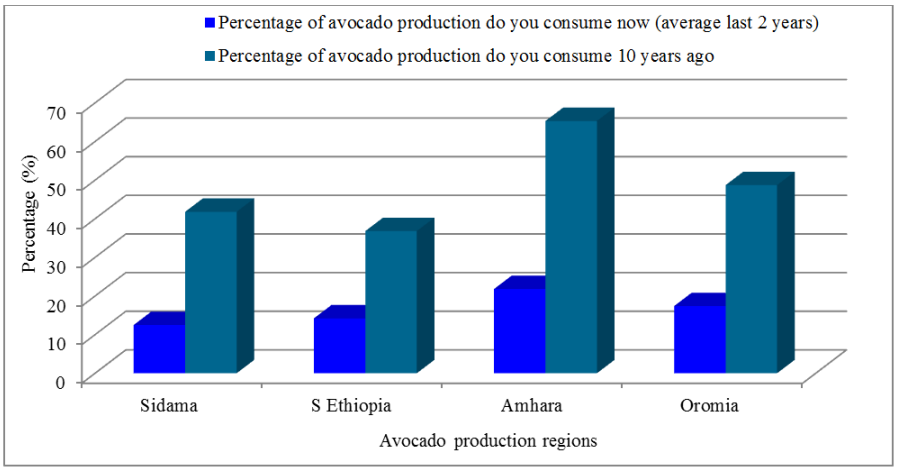

Figure 7. *Comparison of avocado fruits consumed over years in different regions of Ethiopia.*

3.2.4. Percentage of Avocado Production Growers Consumed During the Last Ten Years

The result of the study revealed that the portion of avocado consumed from the total production tends to increase with time. The average avocado fruits consumed increased from 11.70% (last ten years) to 17.43% (last two years). This shows that the farmer's and family's awareness on nutritional and health benefits of avocado consumption are created. The improvement observed in terms of avocado fruit consumption could be due the attention given to the area by government through active participation of ministry of agriculture and research centers and Medias. The previous study stated that avocado is available, accessible and affordable almost all over in Ethiopia throughout the year except some regional variations. However, the consumption habits of the society were not good and in some areas the society has limited awareness on the avocado's health benefits [14]. However, the current study showed that the consumption of avocado fruits is increased as compared to the last ten years.

3.3. The Food Security Status of the Stallholder Avocado Growers

The food security status of the sample avocado growers in study area are presented in Table 1; the results of the study revealed some of the household members of avocado grower would not have enough food as replied by the interviewees. An estimated 43.8% of avocado growers in Sidama would not have enough food for a year whereas in Wolaita area sample avocado growers with nearly 53.4% have no enough food; similarly avocado growers in Amhara region nearly 28.8% have no enough food and finally in Oromia region an estimated 29.5% of avocado growers have no enough food (Table 1). The study found that quite large number of interviewees stated that household members are not able to eat foods of with their preference and get a limited variety of foods during the study period.

Table 1. *Food security aspects of sample avocado growers in the study area during the study period.*

Categories	Regional State								Average percent (%)
	Sidama		South Ethiopia		Amhara		Oromia		
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	
HH members would not have enough food	46	43.8	23	53.4	17	28.8	18	29.5	38.9

Categories	Regional State								Average percent (%)
	Sidama		South Ethiopia		Amhara		Oromia		
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	
HH members not able to eat the kind of foods you preferred	80	76	34	79	33	56	41	67.2	69.6
HH members have to eat limited variety of food	71	67.6	28	65.2	22	37.3	30	49.2	54.8
HH members eat food that did not want to eat	39	37.2	18	41.8	19	32.2	16	26.2	34.4
HH members eat a small meal than you felt you need because there was not enough food	47	44.7	22	51.2	15	25.4	17	27.7	37.3

Source: Household Survey Data, (2023)

3.4. Food Preference (HH Members Not Able to Eat the Kind of Foods They Preferred)

The study further identified that the HH family members do not able to eat the kind of food stuffs they preferred, as in Sidama where 76% of avocado growers do not able to eat the kind of food stuffs they preferred; whereas in Wolaita an estimated 79% of avocado grower HH do not able to eat the kind of food stuffs they preferred. Similarly, an estimated 56% of avocado grower in Amhara region do not able to eat the kind of food stuffs and finally an estimated of 67.2% of stallholder avocado growers in Oromia do not able to eat the kind of food stuffs (Table 1).

The survey assessments found that quite large of HH members have limited variety of foods as in Sidama where 67.6% of HH avocado growers have limited variety of foods; whereas in Wolaita nearly 67.2% of avocado grower HH have limited variety of foods; and in Amhara region an estimated 37.3% of avocado grower HH have limited variety of foods and finally 49.2% avocado grower HH in Oromia have limited variety of foods (Table 1).

All the details of HH members that eat food that did not want to eat as in Sidama, (37.2%); Wolaita, (41.8%); Amhara, (32.2%); Oromia with 26.2%) (Table 6). Similarly, the HH members eat a small meal than they feel/ need to eat because of no enough food as in Sidama, (47.7%); Wolaita, (51.2%); Amhara, (25.4%) and finally in Oromia with 27.7% of HH members that eat food that did not want to eat (Table 1).

The study results indicated that people eat a low amount of food and rely on very few varieties of food because of food scarcity. Availability, accessibility, and utilization are among the pillars of the national food security agenda. On the other hand a research scholar found that small holder avocado producers in Sidama region participating in market channels have higher food security than those farmers who are not involved high-value avocado market channels [28, 30]. Thus, they concluded that encouraging more households to participate in the high-value avocado market channels would raise the overall food security of the farmers.

Food availability is determined by the level of food production and stock levels. The current study showed that there is a food insecurity indicator in the most study areas. Eating behavior, culture, socio-economic status, and education levels are also other factors affecting the nutritional security of society [2, 14, 16, 21]. The nutritional benefits of avocados are not much well understood by most of the communities, promotion and awareness creation should be done to create more production and utilization.

3.5. Utilization Diversity of Avocado Fruits in the Study Area

Avocado has very high nutrient dense fruit [7], available throughout the year in Sidama, Wolaita, and many other growing areas of Ethiopia; with this nutrient content, every farmer in these areas grows local avocado trees in their homestead with coffee, Enset, and other perennial and annual crops; with very simple managements practices, farmers harvest large quantity of avocado fruits every year from local avocado types. From these fruits yield, smallholder farmer and urban inhabitants such as Boditii, Sodo of Wolaita Zone and other avocado production areas developed diverse utilization, varieties of food recipes from avocado fruits. These include avocado juices, avocado paste and other side dressing avocado recipes; in addition, there are currently four avocado oil processing industries in Ethiopia.

3.5.1. Avocado Juices

Avocado is a versatile fruit that has been produced for its

flavor, nutritional worth, socio-economic and multipurpose benefits in Ethiopia. It is no longer considered as an exotic fruit has become a part of the everyday diet due to the growing demand for natural products. It has already a large market and is sold as a fresh fruit for side dressing, sole and mixed juices (Figure 8). Additionally, avocado fruit is the main part in the breakfast, meal and snacks (Figure 9).

Figure 8. *Variety of avocado juice (sole or mixed with other fruits).*

Figure 9. *Avocado breakfast, meal and snacks.*

3.5.2. Side Dressing

avocado is used as parts of salad and side dressing with preparation takes less than 2 minutes; ready avocadoes fruits alone or with addition of some spices can be part of any salad in every day family dish (Figure 10). Avocado is one the highest-fat plant foods, making it a popular inclusion in vegetarian diets; the slightly earthy but neutral flavor of avocados works well in sauces, salad dressings and sandwiches [37].

Figure 10. *Meshed ripened avocado fruit ready for side dressing.*

Ripened avocado pulp is meshed with addition of some spices and served with *Injera* and bread in most households, Restaurants and Hotels in Sodo and other Southern Ethiopian towns as shown in Figure 11.

Figure 11. *Variety of meals (A and B) – food recipes with avocado (Firfir with avocado, fried eggs with avocado, Keyi Wot at Wolaita Sodo).*

3.5.3. Avocado Paste

Avocado spread is a whole food plant-based recipe, rich in heart-healthy fats and an incredible source of nutrients. Avocado pulp could be processed into foods as paste; this paste recipe is simple to make and uses fresh at home in a few minutes. It is made of avocados, onion, tomatoes, pepper, lime juice, garlic and salt depending on the availability of the ingredients almost in all production and at far consumption areas (Figure 12).

Figure 12. *Avocado paste (made at home).*

Avocado is used with tomato sauces and onion on cooked or meshed potato, such as *Panchera* (walking road side, evening fast food) (Figure 13).

Figure 13. *Panchera (Street vender evening fast food) and avocado salads.*

There are few agro-processing Food Complex Plants in Ethiopia such as *Kaliti food complex* that fortify its endeavor of blending avocado to produce *macaroni* and *pasta* [29].

3.5.4. Avocado Cooking Oil

Avocado cooking oil is another product becoming popular these days in the globe and in Ethiopia because of its high nutrition content. There are many avocado oil factories in Ethiopia. The oil is produced by pressing the pulp of the avocado fruit. Some retailers in Ethiopia sell a 750 ml bottle of avocado oil at 550 Ethiopian Birr while a 350 ml bottle is 315 Ethiopian birr. This value addition oil processing in Ethiopia

made high fresh avocado fruits demands throughout the year from all types of avocado varieties and local types making all value chain actors business interest.

3.5.5. Avocado Oil Cosmetics and Beauty Products in Ethiopia

Avocado oil is good for skin and hair; avocado oil has a moisturizing and calming effect on the skin and protects it against UV radiation from the sun (Figure 14). There are local cosmetics and beauty products processing plants in Ethiopia like Cosmetic Industry *'Zenit Gebse Eshet`* has instigated processing of hair pomade by means of avocado as raw material [29]. There are many other types of cosmetics and beauty products one can find locally in the retailer shops.

Figure 14. *Avocado cosmetics available in various shops (organic hair and skin care) in the local markets.*

Body lotion and lipstick with avocado oil, organic extra virgin and blended (butter, lemon or garlic) with avocado oil. It also has an important share in the cosmetics and beauty products like soaps face creams and shampoos [39]. The oleic acid in cosmetics made from avocado moisturizes the skin, reduces signs of aging, and cures dandruff, acne, and psoriasis [38]; vitamin E contained in the oil can reduces damage from UV rays. Its carotenoids help relieve pain and inflammation, improve eye health, and prevent cancer.

3.5.6. Avocado Seeds and Rejected Fruits as Animal Feeds

The nutritional and phytochemical composition of avocado seeds has been well studied and discussed [6]. Avocado seeds are rich in polysaccharides, proteins, lipids, vitamins, minerals, and other bioactive substances [6]. Same authors reported that avocado-seed extracts also have many health-related bioactive properties, such as anti-hyperglycaemic, anticancer, anti-hypercholesterolemia, antioxidant, anti-inflammatory and anti-neurogenerative effects are clearly demonstrated how these properties can be used to formulate or fortify food [6].

Currently avocado seeds, mechanical damaged fruits, overripe fruits, fresh by products are locally used for animal feeds in all cities and towns in Ethiopia. Dairy and animal fattening business peoples are daily collecting (purchasing) rejected and unmarketable fruits due to bruise, remaining overripe fresh avocado fruits along the supply chains from aggregator centers, fruits stores and retailer shops where overripe fruits are not sold. However, studies on avocado seeds suggest they may reduce the risk of heart disease and fight off bacteria and fungi; nevertheless, further research in humans is required before any conclusions can be made [42].

3.6. Global Avocado Oil Market

Avocado oil and butter are produced from the avocado fruit, avocado fruit; the largest producing countries include Mexico, Dominican Republic, Peru, Colombia, Indonesia, Kenya and Brazil [43]. Variety of avocado oils such as Extra Virgin Oil, Virgin Oil, Pure Oil and Blends Oils are produced [43]. It is estimated that less than 10% of the global avocado production is processed with the lion's share of avocado fruit is consumed as fresh.

The top ten exporting countries of avocado oil with a summary of price and 1- and 3-year export market growth are shown in Table 2; the share of export in 2022, 1-year growth in export value 2021-2022, and 3-year growth in export value 2019-2022 is led by China followed by the Netherlands and Germany.

Table 2. *Top ten exporting countries of avocado oil with a summary of price and 1- and 3-year export market growth.*

Rank	Country	Share in Export Value 2022	Export Value 2022, USD	1-Year Growth in Export Value 2021-2022	3-Year Growth in Export Value 2019-2022
1	China	20.51%	$474.95M	+34.10%	+8925.68%
2	Netherlands	15.99%	$370.15M	+7.58%	+56.08%
3	Germany	14.37%	$332.72M	+17.25%	+65.99%

Rank	Country	Share in Export Value 2022	Export Value 2022, USD	1-Year Growth in Export Value 2021-2022	3-Year Growth in Export Value 2019-2022
4	Sweden	6.05%	$139.96M	+1.20%	+21.65%
5	United States	5.53%	$128.09M	+33.63%	+58.42%
6	Spain	5.36%	$124.08M	+37.27%	+75.63%
7	India	4.51%	$104.48M	+3.23%	+17.85%
8	Singapore	2.74%	$63.49M	+10.14%	+58.33%
9	Belgium	2.72%	$63.06M	+4.23%	+32.88%
10	France	2.44%	$56.57M	+13.00%	+11.15%

Note-This top ten avocado oil exporting country list is based on HS code 151620 which is the representative HS code for Avocado Oil [40].

There is a growing demand for natural ingredients in European cosmetics sector, creating opportunities for exporters of avocado oil from developing countries [43]. Avocado oil has a number of functional and active properties giving it applications in a wide range of formulations [43]. Avocado is a popular fruit with European consumers, encouraging personal care formulators to start using avocado oil in their formulations. It is expected that the demand for avocado oil will continue to rise in the coming years in Europe [43].

3.7. Role of Avocado Fruit in the Oil Production in Ethiopia (Agro-Processing)

Avocado oil is becoming popular these days because of its high nutrition content with high demand in Europe, the Middle East and the U.S [39]. It is not only good in the kitchen but also for skin and hair [39]. Avocado oil has a moisturizing and calming effect on the skin and protects it against UV radiation from the sun; the global avocado oil market size is expanding at a high rate. The market stood at US533.53 million dollars in 2020 and jumped to US553.27 million dollars in 2021.

According to the Ethiopian Food, Beverage and Pharmaceutical Industry Development Institute (EFBPIDI), Ethiopia earned about US1.7 million dollars from the export of unprocessed avocado oil in 2020 (*Anon*). As per Volza's Ethiopia Export data (updated 1 January 2024), avocado oil export shipments from Ethiopia stood at 185, exported by currently 13 active Ethiopia exporters to 94 buyers [44]. Ethiopia exports most of its avocado oil to Netherlands, Sudan and Italy [44]. It is exported in the form of Crude Avocado oil, and avocado hair oil. The growing awareness of the health benefits of avocado oil is expected to boost the market growth in the coming years. Currently, there are more than four types of avocado oil producing companies in Ethiopia.

3.8. Avocado Fruits Demands of Agro-Processing in Ethiopia

The increasing number of avocado oil processing facilities in Ethiopia gives smallholder farmers a chance to tap into the lucrative market abroad. Growers can discuss with the nearby oil producing companies and supply high quality avocado fruits throughout the year so that high oil production will be obtained annually in Ethiopia that earns high foreign currency to the country.

YBM Avocado Oil has a processing capacity of five tons per hour, and if all factories similar production capacity, an estimation of 20 tons (200 q) fresh fruits are required per hour for all factories [39]. Although all companies are trying to organize smallholder avocado growers into a cooperative farm and support avocado producer cooperative farms in various ways, strong producers- processors dialogue platforms, producers-exporters platform, etc. should be created for the sustainable improvement of the production, productivity and quality of produce. Finally avocado industry led strong avocado research-development technical team should be created that guide avocado national development.

It is clear that smallholder avocado farmers who have been growing for the domestic market have a great opportunity for supplying their fresh high quality avocado fruits for domestic consumption and for processing industry throughout the year as per the maturity and minimum quality standard set by the industry; whereas smallholders growing commercial avocado varieties have more opportunities for supplying high quality avocado fruits produced as set by the GlobalGAP for export market. In this case Federal Cooperative Commission and Regional Cooperative Agency with other relevant institutions should work in organizing avocado input suppliers, producers, post-harvest handling, packhouse operators, traders, transporters, exporters, and other actors so that the support of avocado grower cooperatives, traders, exporters enhanced and fruits quality and production sustained.

Finally digitalizing avocado orchards, plantations, clusters details, number of trees, types of varieties, age of the trees, name of farmers, area covered, name of Kebeles, Woreda, Zone, and Region are important and essential for planning various inputs along the avocado value and supply chains. Digitizing also helps to predict (forecasting) annual avocado

fruits yield for the national avocado industry development. Thus it is essential to create agri-digital platforms at each value and supply chain stages of avocado development so that avocado industry development gets achieved.

4. Conclusion and Recommendations

Avocado is a nutritious and complete food, utilized in a diversity of ways and with great potential in almost all regions of Ethiopia in particular Sidama, South Ethiopia, Amhara, Oromia, Central Ethiopia, Tigray, parts of Gambella and Benshangule-Gumuz Regional States. Study has been conducted with the objective of assessment of role of avocado in agri-food system and agro-processing, consumption trends, uses in the sample four Regional States of Ethiopia. Both qualitative and quantitative data were collected and analyzed.

The study found that the highest numbers of household members are not able to eat foods of their preference and get a limited variety of foods indicating that people eat a low amount of food and rely on very few varieties of food because of food scarcity. Similarly, the study revealed that nearly 48% of the interviewees responded do not have access to enough food to satisfy their nutritional requirements. In addition, the result of the study revealed that the portion of avocado consumed from the total production tends to increase with time; the average avocado fruit consumed increased from 11.70% (last ten years) to 17.43% (last two years). This shows that the farmer's, cities and town inhabitant's awareness on nutritional and health benefits of avocado consumption is widely improved and demand is created. It is observed that the high proportion of avocado fruit produced by the farmers is mostly targeted for commercial purpose a decade ago. The current study showed that the production of avocado increased nearly two-fold as compared to the last ten years. It was found that smallholder farmer and urban inhabitants developed diverse utilization, varieties of food recipes from avocado fruits; these include avocado juices, avocado paste and other side dressing; in addition, there are currently four avocado oil processing industries in Ethiopia.

The study revealed that varieties of uses are of avocado fruits have emerged that contribute to food and nutrition security of the smallholder farmer. The study found that avocado fruits are prominent place ranging from fresh fruits to salad side dressing in the family household food baskets among growers, urban inhabitants in the sample areas such as Wolaita, Sidama. The study showed that use of avocado fruits in a variety of ways can surely contribute to contribute to the nutrition security of the country. Promoting nutrition education and raising awareness about the importance of consuming a diverse diet, including variety of food component containing avocado fruits is crucial. Information campaigns should emphasize the nutritional benefits of avocados fruits, targeting both rural and urban populations. Efforts should be made to encourage value additions of avocado fruit. However, the share of avocado fruit in the family food budgets and contribution to daily and seasonal calorie requirement, and overall contribution to the family nutrition requirements requires further scientific study. However, there is a serious competition among various uses of avocado fruit commodity such as fresh use, export market, edible oils production factories and cosmetic industries besides high post-harvest loss occur annually in Ethiopia. Thus in order to meet the annual demand (required quantities), various strong industry-growers-exports platforms are required that facilitate supply of high quality and quantity of avocado production both from commercial varieties and from local land races that can increase the household family nutrition and their annual income from avocado production. Innovations at any stage (step) in the avocado value and supply chains could help significantly the national agri-food system and agro-processing through increased production, productivity and income generations for all actors along the value chain and supply chain actors. Likewise avocado fruit is becoming one of the important daily dietary components in the major growing areas of Ethiopia with various recipes contributing to nutrition security and healthy diets of the smallholder. With the awareness created on avocado nutrition, urban agriculture and home garden farming practices, and rising of prices of meat, would enhance more consumptive uses of avocado fruits in both rural and urban areas are expected. Further studies are required on the nutritional contribution of avocado fruits in a family daily diet and optimizing and standardizing avocado-based food recipes in Ethiopia.

Abbreviations

CSA	Central Statistical Authority
EIAR	Ethiopian Institute of Agriculture Research
FGD	Focus Group Discussion
GAIN	Global Agriculture Information Network
GlobalGAP	Good Agricultural Practices
HH	Household
Kebeles	Small unit of Administration
KII	Key Informant Interview

Conflicts of Interest

The authors declare no conflicts of interest.

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