



Incorporating Avocado production in agri-food systems: benefits, opportunities, and challenges: Lemo Woreda's experience in Hadiya Zone, Southern Ethiopia

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November 2022

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Acknowledgements

The authors would like to acknowledge the contributions of Africa RISING site coordinators for their unreserved support, who provided useful information and played a prominent role in linking the research team with the respondents.

Appreciation is also extended to key informant study participants from SNNP regions' Lemo woredas. Finally, we thank Africa RISING beneficiary households for their willingness to provide us the information, for their time and valuable contributions at large. This study was supported financially by the Africa RISING program of the International Livestock Research Institute (ILRI).

The authors also acknowledge the editorial input of Vincent Johnson of the Science Writing Service for the Bioversity-CIAT Alliance

Disclaimer

The report was made possible through the generous financial support of the Africa RISING program of the International Livestock Research Institute (ILRI). The views expressed herein are those of the authors and do not necessarily reflect the opinions or policies of the International Livestock Research Institute (ILRI) and the Alliance of Bioversity-CIAT as well as any of the organizations involved in the study.

Acronyms

AR	Africa Rising -Africa Research in Sustainable Intensification for the Next Generation
CSA	Central Statistics Agency
DA	development agent
FAO	Food and Agriculture Organization (of the United Nations)
FGD	focus group discussion
HEW	health extension worker
HH	household
ILRI	International Livestock Research Institute
KII	key informant interview
SI	sustainable intensification
SNNPR	Southern Nations, Nationalities, and Peoples' Region of Ethiopia
ToT	training of trainers
USAID	United States Agency for International Development
WHO	World Health Organization

Summary

Avocado (*Persea americana*) is a tropical and subtropical fruit that consists of water, lipids, carbohydrates, proteins, and a diverse range of organic acids, fiber, vitamins, and minerals which help boost health. It has become one of the most accepted and distributed fruits worldwide due to its smooth and creamy texture, nutritional composition, and benefits for human health. Ethiopia is among the top 10 avocado-growing countries in Africa. Several studies have highlighted Ethiopia's great potential for avocado cultivation. Many avocado growers are small-scale farmers, including producers in the current study area, where it has become a greater source of income for local business owners, significantly increasing production coverage.

The current study was conducted in Lemo woreda, which is one of the avocado-producing areas in the Hadiya zone. It is one of the areas where the International Livestock Research Institute's (ILRI) Africa Rising (AR) project has managed to increase the number of avocado-producing smallholder farmers. The AR project has assisted rural communities in the area by offering high-yielding avocado varieties. The objective of the study was to explore the potential benefits of incorporating avocado into the agri-food system, considering the value chain among smallholder farming communities.

The team conducted 10 focus group discussions (FGDs) with purposefully selected project beneficiaries, and 7 key informant interviews (KIIs) with AR site coordinators, health extension workers (HEWs), and development agents (DAs). The findings were organized into three themes: 1) Avocado production opportunities and challenges, which include environmental, individual, and institutional factors that threaten avocado production, as well as existing opportunities for production sustainability. 2) Avocado production benefits and consumption challenges; the economic benefit, household (HH) consumption, perceived health benefit, and avocado consumption challenges. 3) Market opportunities and challenges identified by study participants in the market.

Water shortages were reported as the main limiting factor for successful production by all the participants. The majority use donkey carts to transport water from local rivers to support production. Additionally, frost was mentioned as a key challenge affecting avocado trees, causing the flowers to fall off and the leaves to dry. Another factor was interference by wild and domestic animals and pests. Unless fenced well, seedlings can be grazed by cows, deer, or other herbivores. Hedgehogs also feed on the bark of mature trees, which limits and dries the growth. Moreover, the main individual limitations mentioned include gaps in grafting knowledge and seedling skills, and poor plant husbandry.

The participants also listed different benefits, which are categorized into economic, household consumption, and health benefits. Most of the time, women are the ones who sell avocados at the market and then buy both food and non-food household items. In addition, nowadays, according to the farmers, avocado is becoming one of the foods eaten with bread/Enset, especially during the dry season since cabbage or kale are less available. They said that children who eat avocados have supple skin, good growth, strong physical development, and improved cognition. However, the participants also mentioned the challenges that restrict them from consuming avocado regularly. This includes inadequate household and village-level production that was also confirmed by the project site coordinator and high fruit prices, especially during the dry season, which restrict purchase and consumption particularly for non-AR beneficiaries.

In addition, farmers reported that the woreda community is now aware of avocado's benefits and wanting to expand avocado production in their farms. Those smallholders yet to start production showed interest in obtaining seedlings from AR to plant in their backyards. Both the woreda agriculture expert and the AR officer also affirmed that the local agro-ecology is suitable for avocado production. Furthermore, the huge market opportunity at Hossana town, and the availability of universities, road access, and government commitment and support all offer opportunities to sustain local avocado production. Nevertheless, weak market linkage was mentioned as a main limiting factor for the avocado market. Especially during high production times, the market might not be economically viable.

In general, considering the objective of the assessment, it can be concluded that AR support helped the Lemo woreda to introduce avocado production as a key local agricultural product and changed household consumption habits. However, the market system establishment for avocado sales was not successful. The next step should include looking for ways to create a market system that includes not only avocados but also to other agricultural products.

Introduction

Avocado (*Persea americana*) is a tropical and subtropical fruit that originates from South America. According to some archaeological studies, it was found in Mexico in 8000 B.C and in Peru between 3000 and 4000 B.C (1). It is a seasonal evergreen tree that can be propagated by seedlings or grafting (2). The trees prefer warm sub-tropical weather and retain their leaves if the temperature is mild, well-watered, and protected from cold (3). It has become one of the most accepted and distributed fruits worldwide due to its smooth and creamy texture, nutritional composition, and benefits for human health (4–6).

In 2001, global avocado production was 2.8 million tons, grew to 6 million tons in 2017, and is currently estimated to be more than 7 million tons (7). Mexico, the United States, Colombia, Indonesia, Chile, and the Dominican Republic, are the top producing countries (8). Avocados are also produced throughout Africa, particularly in South Africa, Kenya, and Ethiopia, for both domestic consumption and commercial markets (7). Avocado production and trade is being promoted in developing countries, playing a vital role in economic growth and poverty reduction (9).

Avocado's nutritional composition consists of water, lipids, carbohydrates (sucrose, glucose, and fructose), and proteins. The categories of lipids identified are neutral lipids, glycolipids, phospholipids, and free fatty acids. It also contains a range of organic acids (malic acid, citric acid, and oxalic acid) (10). In addition, it is a good source of fiber, vitamins B, vitamins K1 and E, magnesium, potassium, and phytochemicals such as carotenoids, phenolics, and phytosterols, which help confer better health (5). According to studies, eating more avocados lowers cholesterol levels and helps prevent chronic diseases like breast cancer, diabetes, hypertension, and cardiovascular disease (5,11,12). Additionally, a US study revealed that individuals who consumed more avocado had significantly lower body weight, body mass index (BMI), and waist circumference than non-consumers (12,13).

The best and easiest way to consume avocado is to eat it by itself in addition to any meal (12). It is also consumed as avocado toast, avocado salad, ice cream, and in a country like Ethiopia, it is also consumed as a puree or juice. Apart from the fruit itself, avocado is made into various products. The main industrialized products are oil and guacamole (10). Avocado peel and seed extracts are also rich in antioxidants and anti-inflammatory agents, which can be used for food and pharmaceutical purposes (14). Furthermore, research has proved the benefits of using avocado as a key ingredient in cosmetic (skin care) products (15).

The consumption of avocados internationally continues to grow every year. Following growing demand both in local and international markets, farmers across the world are adopting profitable avocado farming. However, growing avocado as a single crop has its own disadvantages by draining the soil and taking away most of its mineral properties (16). Avocado production consumes huge amounts of water, which has its own impact on the water supplies of the production area (17). On the other hand, the qualities of the avocado could be affected when they are exposed to biotic and abiotic stresses. Salinity, irradiance, water stress, and temperature are examples of abiotic stresses, while insect pests (avocado looper, coconut bug, red mites, and fruit fly) cause biotic stresses (18).

Because of their high perishability, avocados require ongoing cold chains and must be handled in a timely and coordinated manner both during and after harvest (15). Avocado supply-chain delays are particularly problematic because of the possibility of product shrinking during shipping, which not only compromises product quality but also decreases market value, reducing farmer

revenue (15). Therefore, it is crucial to understand the aspects that contribute to avocado efficient production and marketing.

Avocado production benefits and challenges in Ethiopia

Ethiopia has a conducive landscape and climate conditions for the production of tropical, subtropical, and temperate fruits and vegetables (19). Ethiopia is among the top 20 avocado-growing countries, and was first introduced to Ethiopia around 1938 by independent fruit producers in Hirna and Wondo-genet (20,21). It has gradually been distributed to different parts of the country where conditions are favorable for production.

Avocados are currently quite popular in Ethiopia among both the producers and consumers. Their introduction and dissemination has contributed to income generation, employment and businesses. As a result, avocado production has significantly increased(21). In urban areas, avocados are consumed as juice, in salads, or in combination with other vegetables. In some parts of the country, including Addis Ababa, it is used as a key ingredient in cosmetics, especially for facial skin care. However, Ethiopian annual per capita fresh fruit consumption (7kg), including avocado is 8 times lower than the average consumption for the east Africa region (55kg), and 21 times below WHO and FAO recommended minimum intake levels (22). This could be due to low income, below-capacity production and weak dietary habits resulting from inadequate nutritional awareness.

Several studies have shown Ethiopia's potential for avocado cultivation (23). Including the current study area, most avocado growers are small-scale farmers with different methods of production. Previously, avocado trees were planted primarily as a vital part of coffee and enset agroforestry systems (19,21). As coffee requires shade trees, smallholder producers consider avocado as one of the important shade trees while also benefiting from the sale of the avocado fruits (21,24). Additionally, avocados are cultivated as individual trees in court yards, where they provide shade for people and animals (19). The main growing season is from May to October. Major avocado varieties grown include: Hass, Pinkerton, Fuerte, Bacon, Ettinger, and Nabal, and it is available seasonally in the local market (22).

Avocado production is constrained by several factors including, farmer-, institutional-, natural- and infrastructure-related issues. According to Ethiopian studies , farmer-related constraints include inadequate farmer skills, and scant knowledge of production (25), product management, seed selection, fertilization, irrigation, and harvesting (26). Farmers are unaware that seedling quality, varietal choice, and appropriate farming techniques all affect productivity (21). This means production benefits are limited. To produce quality fruits that meet requirements, farmers need appropriate training and have access to quality seeds that are resistant to diseases.

During the past few years, avocado farming has gained support from the government and several organizations, and as a result, it is now a substantial source of household (HH) income and national hard currency. However, the industry is mostly restricted to the domestic market, and Ethiopia's manufacturing system is built on tradition rather than being sufficiently supported by scientific guidelines.

An avocado marketing system in Ethiopia

Selling fresh and processed fruit products provides low-income farm households with revenue that can act as a safety net (27). Yet the Ethiopian agricultural marketing system is constrained by several factors such as lack of market information systems, poor transportation, high handling costs, and restricted access to credit (20). Avocado is transported from producers to local collectors via middlemen before arriving at the local market. They pay farmers less for their

avocados and charge more for them in the market (21,27). Storage facilities are scarce all along the chain, and the absence of collective bargaining power has forced individual farmers to accept unfavorable deals (27). Without having convenient marketing conditions, potential increases in output, rural incomes and foreign exchange are yet to be realized.

Moreover, research in the Gomma woreda found that the harvesting method, involving children mostly climbing and shaking trees, and striking fruits with wooden sticks, has an impact on the market and degrades produce quality (28). A research review (29) also indicated that due to managerial, technical, storage, and other issues, Ethiopian post-harvest losses are high, emphasizing the need for education and training on post-harvest loss reduction at different levels of the post-harvest chain. Therefore, investigating the efficiency of the marketing system through studies and analyzing factors that determine the market chain is crucial to increasing farmer benefits.

Overview of the Africa RISING Program

The Africa Research in Sustainable Intensification for the Next Generation (Africa RISING (AR)) is one of the International Livestock Research Institute's (ILRI) programs initiated in 2012 as the collective name for three linked sustainable intensification (SI) projects funded by the United States Agency for International Development (USAID). The purpose of AR program was to create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security (30).

The first four-year phase of the AR project (2012–2016) identified and validated solutions to problems experienced by smallholder crop-livestock farmers in Ethiopian highlands. During this phase, AR implemented various action-based on-farm research activities aligned with the Ethiopian government effort (30,31). In phase II (2016–2021), the project has been working with small farm households, focusing on sustainable intensification of mixed farming systems to contribute to greater food security, more balanced gender equity, improved nutrition, diversified income, and enhanced human and institutional capacities (31).

In addition, the AR program designed and implemented nutrition education interventions to address the knowledge gaps of experts and farmers in project implementation districts. These interventions include the development of a nutrition training manual in local languages, training of trainers (ToT), and cooking demonstrations for experts. The national nutrition team provided practical training using the manual for the woreda-level nutrition team, for the development agents (DAs), health extension workers (HEWs), and for model farmers in the districts. Thereafter, HEWs and DAs have provided follow-up and counseling for care-givers at the community level in the program intervention areas (30).

Significance of the study

To fulfill the demands of the growing population, agricultural crop diversification is necessary to promote food security, nutrition, and income (32). Together with its partner organizations, the government of Ethiopia implements projects in different parts of the country to enhance avocado production and marketing. Accordingly, the Africa RISING program has managed to increase the number of participating smallholder farmers who are growing avocado by offering high-yielding varieties in the Lemo woreda of the Hadiya zone, south-western Ethiopia which is located within the key avocado production belt (22). The overall dietary diversity in the *woreda* is limited among rural households where they mostly consume enset with overcooked vegetables (30). To combat this the program also provided a nutrition education and cooking demonstration to health extension workers and its beneficiaries.

According to the data obtained from the woreda, in the past few years, the quantity of avocado produced has increased significantly. The report for the Hadiya zone also showed that various development and research actors, like the AR contributed to production increases. Within the next few years, the Woreda expects productivity to be doubled, which would lead to surplus production (34). Therefore, documenting the progress of the farmers regarding the economic and nutritional benefits of avocado production and consumption could promote sustainability, and the experience could also be shared with other sites.

Objectives

Overall Objective

To explore the potential livelihood benefits of incorporating avocado into local agri-food systems considering the whole value chain among smallholder communities in Lemo woreda, Hadiya zone, Southern Nations, Nationalities, and Peoples' Region (SNNPR) of Ethiopia.

Specific objectives

- To explore avocado's current contribution to the agriculture, food, and market systems of smallholder communities.
- To explore opportunities for including avocado in the agri-food and market systems of smallholder communities.
- To explore the existing barriers and potential bottlenecks that impede including avocado in the agri-food and market systems of smallholder communities.

Methods

Study population and area

A qualitative study was conducted in Lemo woreda in October 2022. This included Focus Group Discussions (FGDs) with farmers producing avocado and key informant interviews (KIIs) with AR site coordinators, health extension workers (HEWs), and development agents (DAs). All avocado-producing AR beneficiaries were involved in the FGDs.

Lemo woreda is located in the SNNPR. It's one of 11 woreda in Hadiya Zone surrounding Hossana town. It is bordered by the Kembata Tembaro Zone to the south; Duna and Soro to the southwest; Gomibora to the west; Misha to the northwest; Ana Lemo to the northeast, and to the southeast by Shashogo (35). According to 2022 Ethiopian CSA population projection (36), the population of Lemo woreda is 157,107 (77,662 men and 79,445 women); with an area of 354.37 square kilometers, and has a population density of 443.3 per square kilometer.

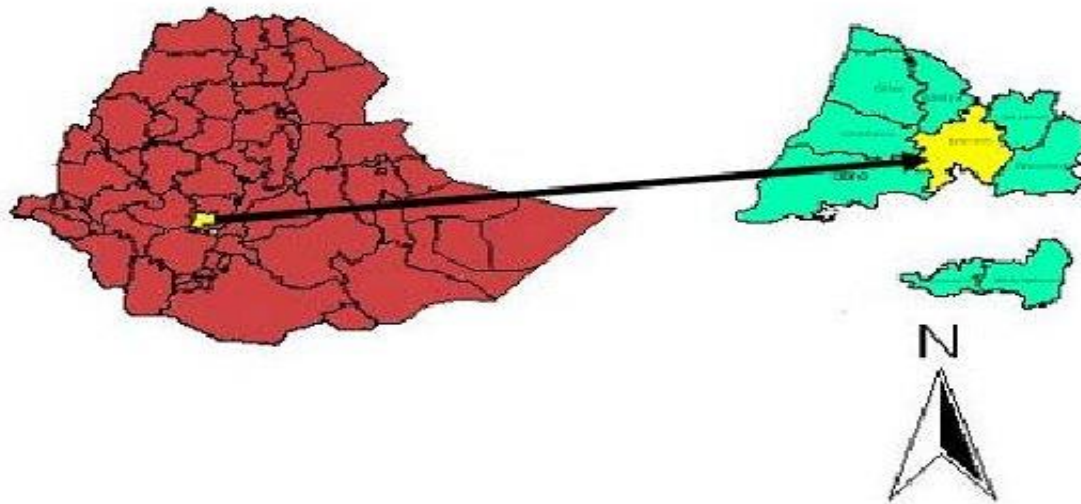


Figure 1: Location of Lemo Woreda in Hadiya zone, Ethiopia.

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Study setting and procedure

FGDs and KIIs were carried out following the guide attached under the “appendix”. Data collection was led by an expert with experience in conducting nutritional and agricultural studies. In addition, the data collector received thorough training on study objectives and data collection tools. The discussion was conducted in Amharic along with local language translations.

During the various sessions, probing open questions such as 'What?' 'Why?' and 'How?' were mostly used. The sessions were conducted at the participants' convenience of time and place. The process continued until a saturation level was achieved (no new information presented).

Data analysis

All the discussions were recorded using a tape recorder after obtaining permission from the participants. The data collector conducted the transcription and shared it with the study team. The study team read the transcription and listened to the recorded discussion several times. Then the analysis was conducted thematically. Transcripts were reviewed to develop codes related to research-question topics. Then, on the basis of conceptual similarity, codes were divided into categories and subcategories.

Results and Discussion

The team conducted 10 FGDs with 7–8 participants per FGD, and 7 KIIs each with 2 DAs, 3 AR site officers, and 2 HEWs in the woreda. The KII results were discussed together with the FGD themes as a subordinate.

In general, three themes emerged during the FGD analysis (Table 1): 1) avocado production opportunities and challenges; 2) avocado production benefits and consumption challenges; and 3) market opportunities and challenges. The first theme was supported by three categories: a) environmental factors, b) individual factors, and c) institutional factors. The second theme was supported by four categories: a) economic benefit; b) household level consumption; and c)

perceived health benefit; and D) avocado consumption challenges. The third theme was supported by two categories: a) market-related opportunities, and b) market-related challenges (Table 1).

Table 1: Overview of the themes, categories and sub-categories concerning avocado production challenges and opportunities, benefits, and marketing.

Theme	Category	Sub-category	Codes	
Avocado production related opportunity and challenge	Environmental factors	Water shortage	<ul style="list-style-type: none"> - No nearby water accesses - The district office does not allow using mains water for avocado - Try unsuccessfully to source underground - Remote water source (Travel an hour by foot/cart) 	
		Climate change factors	<ul style="list-style-type: none"> - Long dry season reduces water content - Frost attack causes flower fall 	
		Animal/insect/pest meddling	<ul style="list-style-type: none"> - Hedgehog & deer eat avocado tree bark - Mites damage roots - Cows, sheep, and other herbivores feed at seedling phase - Monkeys eat fruits 	
		Suitable environmental and climatic condition	<ul style="list-style-type: none"> - Suitable environment - Good climatic condition - Suitable soil type 	
	Individual factors	Farm management skills	<ul style="list-style-type: none"> - Have no proper grafting knowledge - Have no proper seedling knowledge - lack of grafting materials and equipment - Poor plant management - No idea how to manage flowers falls 	
		Motivated Farmers	<ul style="list-style-type: none"> - Interested individuals to expand avocado farm - Good HH-level consumption - Strong market demand 	
	Institution related factors	Poor access to quality avocado variety & seedling	<ul style="list-style-type: none"> - Inadequate quality seedling distribution - Limited HHs receive quality grafted seedlings - Inadequate production at community level 	
		Lack of avocado seedling and training center	<ul style="list-style-type: none"> - Lack of continued technical support by AR and DAs/experts - Lack of training facilities - Lack of grafting center 	
	Avocado production	Economic Benefit	Significant source of HH income	<ul style="list-style-type: none"> - Becomes income source, specifically for women

Theme	Category	Sub-category	Codes	
benefits and consumption challenges			<ul style="list-style-type: none"> - Buy food and non-food item needed for the household - Use income from avocado instead of selling livestock - Buy oil, coffee, salt, exercise books for children, fertilizer etc., with avocado revenues - Fill livelihood gaps with cash income from avocado sales 	
	Household level (HH) consumption	Recognized as HH meal	<ul style="list-style-type: none"> - Consumed as primary food alone - Avocado complements staple food consumption (Enset) - Replaces cabbage as side meal - Replaces kale as side meal 	
	Perceived health benefit	Avocado health benefits	<ul style="list-style-type: none"> - Next to milk, it gives good health benefit - Replaces egg, milk, meat - Good for children's health and skin - Give good growth and strength for children - Healthier and stronger children - Boosts memory - Consumed without any risk to diabetics & people with high blood pressure 	
	Avocado consumption Challenges		Small production	<ul style="list-style-type: none"> - Due to small production, most consumed in HH
			Lack of adequate money	<ul style="list-style-type: none"> - Available but expensive - High price during dry season
			Poor storage in the house	<ul style="list-style-type: none"> - After ripening difficult to store - Manage the fruits while on the tree - Harvest consumable amounts at family level - No way to improve the shelf life of already ripe fruit - Use ventilation and fruits spacing to extend the shelf life of already ripen fruits
	Market opportunity and challenges	Market related opportunity	Encouraging market demand	<ul style="list-style-type: none"> - Proximity and road access to market - No significant problem to sell the fruit with partial negotiation - Sell to Juice Houses in the nearby town
Market related challenges		High transportation cost	<ul style="list-style-type: none"> - High transport cost to town 	
		Poor market network	<ul style="list-style-type: none"> - Avocado price during production season is not attractive 	

Theme	Category	Sub-category	Codes
			-Prefer to consume it in HH when price is low -The cost fluctuates seasonally -Feed to livestock when excess produced -Inadequate ripening technique

Avocado production overview in Lemo woreda



Hass



Ettinger



Nabal



Fuerte



Reed

Figure 2: avocado varieties mentioned by farmers

According to the Africa RISING Regional Coordinator, 80 farmers from Jewe and Upper Gena Kebele’s of Lemo woreda received awareness-raising and hands-on training on avocado production. Farmers were invited to Butajira Nursery Center for exposure trips, where they observed the process of producing avocados firsthand. In addition to professional assistance on how to manage the trees and harvest the fruit, all had received 6 grafted avocado seedlings from the program. The farmers also confirmed that they had received 6 grafted avocado seedlings from AR and planted these in their backyards. Some of the farmers also bought additional seedlings from private vendors through the Woreda agricultural facility, although they were not as fruitful as the seedlings from AR. Farmers who took part in the assessment mentioned five to six types of avocado varieties including Ettinger, Fuerte, Hass, Nabal and Reed, as depicted in Fig 2.

Some mentioned that Hass has two varieties, which makes the variety number to six. However, the AR coordinator pointed out that just five different avocado varieties were provided by the program, and the majority of HHs cultivate more than three. The most widely produced varieties are Nabal and Hass. The farmers mentioned that Hass and Ettinger are tastier and more favored for household consumption, while Nabal is preferred for its higher yield and marketability.

Juice houses tend to prefer Nabal due to its high flesh and water content. The AR coordinator also confirmed that Nabal was distributed dominantly, and the farmer’s preference is both on yield and fruit taste; Nabal is more preferred for its yield; and Hass and Ettinger are preferred for their taste. Seasonal availability (yield) is mainly determined by the variety type and tree management (watering and compost application). Household with diversified avocado varieties have a higher chance to get a steady fruit supply throughout the year.

Furthermore, the study participants were able to classify the different varieties using: -

- (1) Leaf size, color, surface roughness, and shape,
- (2) Fruit shape, size, and taste
- (3) Tree Height
- (4) Fruit color after cutting or removing from tree.

In general, farmers have good awareness on different type of avocado tree and varieties

Theme 1: Avocado production-related opportunities and challenges

Study participants reported the opportunities and various challenges to sustainably increase avocado production. Opportunities to sustain production were separately categorized for the sake of discussion.

Opportunities to sustain production - According to the farmers, the woreda soil type and climate conditions are highly suitable for avocado production. They even mention that it is better than Butajira (the area where they visited and received training before beginning cultivation). In addition, the farmers reported that the community in the woreda is now aware of the benefits of avocado and wanted to expand in their farm. Those who had not started avocado production expressed their interest in obtaining seedlings to plant in their backyards. Both the woreda agriculture expert and the AR officer also mentioned that the ecology of the area is suitable for avocado. Besides, the huge market opportunity (Hossana town), the availability of universities, road access, and government commitment and support are the opportunities in the area to sustain the avocado production. In general, the woreda and AR project offices have suitable environments and motivated farmers to expand and sustain avocado production in the area.

“The benefits could be sustained; the avocado trees have still not reached their maximum maturity stage so that more fruit could be obtained in the future. Moreover, being convinced by the current benefits, the farmers have started expanding the plantation.” (AR site coordinator)

Challenges to sustain production - The challenges were classified into different factors, including environmental factors, individual factors, and institutional factors.

The environmental factors reported which challenge avocado production include water shortage, climate-change issues, and wild/domestic animal and pest meddling.

Water shortages were reported as the main limiting factor for successful production by all the participants, although some of the farmers have underground water access. Farmers in Upper Genna Kebele mentioned that there is a pipeline controlled by the woreda office, but they are not allowed to access water for avocado production due to the water shortage. It is only for household (HH) consumption. Thus, they dug for underground water in their compound, but it was not successful. They use donkey carts to transport water from local rivers so that production may continue. The participants recommended different solutions to resolve the water shortage problem, including provision of water conserving materials by AR, digging underground water, negotiating with the woreda to increase the water amount of the pipe, and allowing farmers to use the mains water for avocado production. A woman in Upper Gana Kebele explained her water shortage problem as written below: -

“There are villages with water shortages. For instance, my house is next to a road, and during the dry season, the flowers and small avocado fruits drop off owing to traffic dust and a lack of water. There is a water pipeline in the village, but it is only for household consumption due to the small amount of water content. I was advised to dig underground water, so I tried in two places, but it was not successful due to stone blockage. During the training at the university, we were told to organize in a group and pay to bring underground digging and pumping machines, yet it has not been successful, and we are still waiting.” (Upper Gana Kebele_ FGD1 participant)

As the study participant noted, successful avocado production requires an adequate water supply. On the other hand, studies have revealed that rising avocado demand and production are already causing water stress in some countries (37). Therefore, stakeholders should work together to address the water shortage as well as come up with suggestions on water management, considering the risks other countries experience because of their large avocado production.

Climate change-related issues is another group of environmental challenges raised. The farmers mentioned that over the past two years the dry season was longer, which prolonged the water shortage issue. Besides that, the frost was mentioned as one of the main challenges which affected avocado trees, causing flowers to fall off and the leaves to dry out.

Avocado trees are quite sensitive to soil water availability and mild moisture stress (frost), which can lead to fruit shed or leaf drop (38). This can lead to a significant reduction in yield and negatively impact productivity. Frost is the formation of ice crystals on plants, which can lead to the freezing of internal sap (39). The level of frost damage to avocado trees depends on the variety. Nabal and Hass are among the most sensitive varieties which are widely produced in Lemo woreda. A study also revealed a strong relationship between excessive frost damage and avocado trees with inadequate nitrogen fertilization (40). Farmers around the world employ different techniques to reduce frost damage, including orchard site selection and design, under-tree irrigation, frost covers (e.g. horticultural fleeces) for young trees, etc. (39). Therefore, the experts in Lemo woreda should try to identify the factors behind high frost damage in the area and come up with recommendations accordingly.

In addition, the farmers emphasized flower fall due to frost and other unknown factors. However, the avocado tree is renowned for producing very light fruits despite having a lot of flowers, due to poor pollination (41). Avocado trees are less attractive to bees and other pollinators (insects and birds), so the avocado tree grows more flowers to attract the pollinators, but only some succeed. Researchers advise a bee farm near the orchard to boost pollination and the yield. Additionally, farmers employ their own strategies to draw pollinators. Ensuring pollination compatibility and flowering synchrony should also be considered. Therefore, assessing the local environment and disseminating fundamental information and strategies could assist farmers in acting more effectively.

The other environmental factor mentioned by the farmer was the **interference of wild/domestic animals and pests**. During the seedling phase, unless fenced well, saplings can be grazed by herbivores such as cows or deer. Hedgehogs also feed on mature tree bark, which limits and dries the growth. Additionally, mites feed on the roots and sometimes on the bark, which eventually dries the tree. The farmers try to mitigate these problems by fencing the backyard and the seedlings, and some of them dig a ditch around the tree to restrain the hedgehog. For mite protection, farmers recommend continuous, and simple digging around the seedling. Nevertheless, for better protection, they call for AR and other stakeholders to provide wire fencing combined with thorn hedging, which can effectively protect seedlings, especially from hedgehogs and deer.

The damage caused by insect pests could be a primary factor in future production reductions unless the experts working in the area act now. The South African Subtropical Growers' Association reported that 13% of avocado fruit losses in 2019 were attributable to insect infestations (42). Although pest issues have not been strongly highlighted in the present assessment, local experts should start taking preventative action now. Various methods can be considered, including cultural, mechanical, chemical, biological, and sanitary, considering the effect of intervention methods on both pests and the habitat. In the case of Lemo woreda, the main enemies mentioned are animals, and as the farmers mentioned, creating the affordable market for better fencing material (wire with thorns) is the responsibility of the woreda. The AR projects could also provide support in facilitating the process.

Individual factors mentioned are mainly associated with **farm management skills**. Despite receiving training during seedling distribution, farmers participating in awareness-creation programs are still not fully aware of the precise precautions required when problems arise. The

main limitations mentioned include grafting knowledge gaps, seedling skill gap, poor plant management, etc.

Although the farmers received awareness-creation training, the farmers reported limitations on their basic avocado production skills. A previous study conducted in Lemo woreda which assessed the challenges to avocado marketing reported that age and education level negatively affected the avocado market, which could be associated with production skills and training acceptance level (26). In addition, a study in Kenya also reported that increasing human capital and farmer education contribute to farmer's ability to adopt new technologies for increased avocado production (16). Thus, any farmer training should consider individual factors (age, educational status, etc.) that could affect their training acceptance.

Institution-related factors include the challenges and limitations of stakeholders supporting avocado production. The farmers reported that it would have been very productive if they could have received additional seedlings from AR, but these were difficult to access. Some of the farmers tried to buy from the private vendors as a solution, but this was not successful due to the poor quality of the seedlings. The seedling purchased from a private vendor either does not grow at all or does not develop enough to bear fruit. In addition, the farmers wanted to have a local grafting and seedling center where they could access quality seedlings and training, but this was not yet available. The other issue mentioned was getting continued training and follow-up on the production process, but they could not get that sufficiently from either the woreda or the AR experts. The AR coordinator also mentioned that the avocado production is not adequate in Jewe and Upper Gena kebeles. But there is adequate production at the AR-benefit household level only. A participant from upper Gena explained the challenges as below: -

"I have good water access and I am interested in expanding the farm, but I couldn't get any grafting and seedling training. I bought seedlings from the market, but it was not as successful as I had hoped. In addition, I tried to do the grafting by myself, but it failed." (Upper Gena Kebele_ FGD3 participant)

Another participant said, *"There are professionals trained for avocado grafting who know how to do grafting, how to take care of the plant, and how to develop the skills. Thus, we want to get the training again from these AR and/or Woreda experts. They are not doing the follow-up continuously. The need for avocado is rising, so we need the training to do the seedlings ourselves." (Upper Gena Kebele_ FGD3 participant)*

Strong institutional support is necessary for the production and supply of high-quality goods, yet the majority of smallholder farmers lack this support. This assistance consists of technical guidance and agricultural inputs (43). Lack of these facilities limits smallholder farmers' productivity for HH consumption and profitable markets. To make these facilities more available for smallholders, the government offices, AR, and other stakeholders should expand seedling centers and increase regional training programs for avocado cultivation.

Theme 2: Avocado production benefits and challenges for consumption

The second theme explores the benefits the farmers obtain from avocado production. They listed different benefits, which are categorized into economic, household consumption, and health benefits.

Economic benefits: According to the farmers, avocado is becoming a **significant source of additional HH income**, particularly for women. Most of the time, women are the ones who sell the avocados at the market. With the cash income from the avocado fruits, they then buy both food and non-food goods for the house. They purchase different consumables and items, including oil, coffee, sugar, salt, children's exercise books, fertilizer, and household materials.

Previously, when they needed money, they used to sell livestock, but since avocado production, they have been able to fill gaps by using avocado money.

Household level consumption: The other benefit reported was HH-level avocado consumption. In the area the available staple food is enset with kale or cabbages. Nowadays, according to the farmers, avocado is becoming one of the foods eaten with bread/enset especially during the dry season since cabbage/kale is not available. When the cabbage season comes back, they return to it not because it is preferred but because it is cheaper than avocado. They said that avocado is expensive otherwise they would have use both, since avocado improves dietary diversity and appetite. The AR coordinator also mentioned that at AR beneficiary HH-level avacado production is in excess and is consumed alone with little or no processing. In general, the farmers indicated that the improved fruit yield from grafted seedlings, the better production skills acquired, and the technical help from AR contributed to the improvement of consumption status. A woman in Jewe Kebele explained the advantage of eating avocado as follows: -

"Avocado is a nutritious food and has vitamins too. We learn about the advantages after we start to use it. It is useful for both children and adults. Especially for children, it is good, and for a child who does not start eating hard foods, avocado is preferable due to its smooth texture. It also helps to eat other foods rather than eating one kind of food. It has everything in it, including vitamins and proteins. It is equivalent to eating meat and eggs. In general, it is one of the best foods which can be labeled as number one". (Jewe Kebele, FGD 4)

On the other hand, the participants also mentioned challenges that limit them from consistently consuming avocado. The first is small HH- and village-level production, especially during the dry season. Thus, only children and sometimes the elderly eat avocado, particularly for none-AR participants or farmers not growing grafted seedlings. Second, fruit price increases during the dry season, which holds them back from buying and using it for household consumption. Lack of proper storage facilities also limits HH-level consumption. After the fruit is collected from the tree, it should be quickly consumed or transported to the market before it decays. They tried to spread the fruits apart on cooler ground, but this was not effective.

"We manage it while the fruit is on the tree; we harvest only the household consumable size; once it ripens, it is difficult to extend for an extra day or two, even though airing and ventilating the room is done to extend it for a day or two." (Jewe Kebele, FGD 1)

During exposure visits, the AR personnel and agriculture professionals created awareness about nutrition. The respondents valued the benefits of avocado intake and food variety are well known. The HEW interviewed also reported that dietary diversification using avocado in the woreda is showing progress, particularly in AR supported HHs. The change could be related to the production level in the respondents' HHs, which improves their feeding habits.

Perceived health benefit: The third benefit category reported by the study participants was the perceived health benefit from avocado consumption. The farmers mentioned that eating avocados has health advantages equal to (some say 'next to') consuming milk, meat, and/or eggs. Many of the health benefits were seen in children. They said that children who eat avocados have oily skin, good growth, strong physical appearance, and improved cognition. In addition, because eating avocados improves health, kids are no longer visiting clinics. Additionally, they claimed that those with diabetes and high blood pressure can easily ingest it and that it protects against a variety of diseases.

Theme 3: Market related opportunities and challenges

The third theme that emerged from the discussion with the assessment participants was the **challenges and opportunities associated with avocado marketing**. Regarding the **market opportunity**, the participants said that being close to the larger market—Hossana town—provides an excellent opportunity for them to sell their goods. The town's avocado demand is high, and the distance to transport their products is not prohibitively long. Additionally, they do not use a middleman when selling their goods to customers (juice houses), thus they may estimate prices while taking their manufacturing costs into account. Nevertheless, mostly they sell the product at the estimated price from the buyer, and they said it is not always such a good price, especially during the rainy season, due to greater production.

The second category is the challenges related to the **market network**. **Market** linkage was mentioned as the main limitation of the avocado market. The participants mentioned the "Khat"¹ market as an example to explain the chain. They said "Khat" buyers go to every place where the Khat grows and buy them, but for the avocado they must take them to the town themselves, which gives them an additional cost. Especially during high production periods, the market might not be attractive. Thus, some say they feed it to livestock in the house to get the indirect benefit of the milk or meat. They hope the market will have its own chain in the future. The Woreda agri-officer (DA) further stated that the price is determined by the juice houses since the farmers lack negotiation skills on their own because they lack a market network. The other challenge faced by the farmers is the **rise in transportation costs** to the city to sell their products. Sometimes they walk or ride a cart for 1-2 hours to sell the product in Hossana town.

Marketing of agricultural products consists of exchange functions, physical functions, and facilitating functions (44). Transportation, product transformation, and storage are physical functions, while financing, risk bearing, and marketing information are facilitating functions (27). When the avocado marketing chain of Lemo woreda is weighed against the abovementioned criteria, one can conclude the marketing system is poor. Only individual farmers struggle from production to marketing. Currently, the country has started exporting avocados to the European and other markets, which opens the opportunity for farmers to produce quality products and join the export business. By attempting to access the export market, the door to the entire market system could be opened. The woreda agri-office and other stakeholders are expected to invest a lot of effort to create the market chain with the farmers' interests in mind, at least from the yard to the adjacent market. In addition, learning from experience of neighboring countries like Kenya could help. In Kenya business-oriented individual farmers and groups carrying out fruit farming come together and formulate an organization which facilitates marketing (45). According to the report now they are benefiting from the production more than before. Such kind of experiences could be adopted after contextualization.

¹ Khat or qat plant native to eastern and southern Africa *Catha edulis*, sold for its stimulant properties: <https://en.wikipedia.org/wiki/Khat>

Conclusion and recommendations

The community in Lemo woreda has started considering avocado as a key agricultural product for household consumption and economic benefit. AR-supported HHs have especially benefited from avocado production via increased consumption and economic gain from sales. In addition, increased smallholder awareness levels about the benefits of avocado production offers an opportunity to expand and sustain avocado production in the area. However, the benefit is primarily restricted to HHs who obtain seedlings from AR, demonstrating the necessity of local nursery facilities and seedling education. The farmers tried in vain to access seedlings from other sources, which calls for AR intervention to expand production to other HHs to make avocado available for consumption as a staple food.

Avocado production in Lemo woreda is challenged by various factors which limit its productivity and the benefits gained from fruit sales revenues. The challenges included environmental issues, individual limitations, and institutional factors. The shortage of water, animal/pest damage, and factors related to farmers' awareness and knowledge are among other challenges. Furthermore, the lack of quality seedlings and local distribution centers was mentioned as a bottleneck to expanding avocado production in every HH in Lemo woreda.

The project team recommends the following to address these challenges:

1. Stakeholders should work together to better manage **water shortages** and negotiate for stronger woreda support. They should consider the risks and management strategies (such as irrigation concessions) other countries experience.
2. The experts in Lemo woreda should help implement learning on how farmers around the world employ different techniques to reduce **frost damage**, including orchard site selection and design, under-tree irrigation and frost cover (e.g., horticultural fleeces) for young trees.
3. Introducing orchard beehives could boost **pollination** and corresponding productivity. Woreda assessments of local environments and disseminating fundamental information could assist farmers to employ their own strategies to attract pollinators. Ensuring pollination compatibility and flowering synchrony should also be considered, through training and supplying the correct combinations of varieties.
4. **Herbivore grazing** can be prevented by adequate plot fencing and /or digging ditches. For **mite** protection, farmers recommend continuous simple digging around the seedling.
5. Although **other pest issues** have not been highlighted in this assessment, local experts should start taking preventative cultural, mechanical, chemical, biological, and sanitary actions, according to specific pest control advice.
6. To address other individual issues, most particularly **lack of good management** skills, the woreda should promote farmer trainings that consider individual factors such as age and educational status
7. Government officers, AR, and other stakeholders should expand **seedling centers** and increase regional **training** programs for avocado cultivation.

The absence of an organized market supply route in the region was also explored in the study. Most farmers sell their produce to nearby consumers and local collectors in the nearby town. As a result, farmers do not profit fairly from their produce. As a result, it is essential to establish a market network and an organization (in which the farmers are members) that works to the advantage of smallholder farmers.

Regarding market-related opportunities and challenges the authors recommend:

1. Growers need to become better at **negotiating**.
2. Developing a **specific avocado supply/value chain** including for exports. Learning from experience of neighboring countries like Kenya could help.

In general, considering the objective of the assessment, it can be concluded that AR support has greatly helped the Lemo woreda to introduce avocado production as one of the agricultural products in the area and changed HH-level consumption habits. However, market opportunities should be created to reap the full range and extent of benefits.

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Appendix

Focus group discussion guide

Introduction and consent request

Note to the Facilitator:

Introduce yourself, explain who you work with, why you are here, and introduce anyone on the team who is with you observing, taking notes, taking photographs, or helping in anyway.

Introduction: Hello, my name is _____. I am working with the Alliance of Bioversity International and CIAT to help evaluate and document lessons learned from the Africa RISING (AR) program. The project aimed to promote agricultural technologies in Tigray, Amhara, Oromia and SNNP regions. The aim of this research is to capture the potential livelihood benefit of incorporating avocado into the agri-food systems considering the whole value chain.

This discussion should not take more than one hour. There is NO right or wrong answer. Your ideas and answers to our questions are very important to us. You are free to answer or not to one or more of the questions we are going to ask. You should feel very free to express whatever you are thinking. We will not share your name, and your responses will be anonymous.

At the start of the scheduled discussion repeat the introduction and then ask: Do we have your permission to continue? Do we have your permission to take photographs? Do we have your permission to record the session? (Please note if the group gives permission for taking photographs, note anyone who does not give permission and do not photograph them.)

Note to Note-Taker: Try to capture the major ideas. Always note the specific question that the facilitator and participants are referring to. If the facilitator asks a question that is not on the guide, note the question as it is asked and try to capture the answers. If you need more space, use the extra paper, and note the name of the discussion and the corresponding number of the question. Ensure the session is recorded

I have explained to the participant the survey purpose and procedures and we have discussed the rights of the participants. I have answered questions to the best of my ability that the participant had.

Signature of interviewer _____ Date ___/___/___

I have understood the survey purpose and procedures and we have discussed my rights as a participant. My questions have been answered to my full satisfaction and I agree to take part in this interview.

Signature of participant _____ Date ___/___/___

Date _____

Name of interviewer(s): _____

Interviewee details

Name _____

Focus group discussion with Africa RISING beneficiaries

The questions are organized in to four sections (production related, Market availability, accessibility, Consumption related, and perceived benefits)

1. Production related issues

1.1. Barriers to production

- 1.1.1. Do you have avocado fruit tree in your yard?
- 1.1.2. For how long have you been using this avocado tree?
- 1.1.3. Do you think there is adequate production of the fruit in your area?
- 1.1.4. Have you ever encountered any challenges in production of avocado fruit? (e.g., water access)
- 1.1.5. How big is this problem?
- 1.1.6. How do you see the mitigation for this problem?
- 1.1.7. What must be considered when farmers think of avocado fruit production?

1.2. Enablers to production

- 1.2.1. What is the enabling environment to produce the fruit in your areas?
- 1.2.2. What kind of opportunities are there in your area that encourage avocado production?

1.3. Varieties available

- 1.3.1. How many varieties of avocado are available in your area? Do you have all the varieties in your farm?
- 1.3.2. How detail do you know about the varieties in general?
- 1.3.3. How do you identify the varieties?
- 1.3.4. Which one is the most common variety? And why?
- 1.3.5. Do you have preference of certain varieties over others? And why?

1.4. Seedling

- 1.4.1. Where did you get the seedling?

2. Market availability, accessibility

2.1. Enablers to market availability

- 2.1.1. What are the different types of markets you can access?
- 2.1.2. Are you able to get avocado fruit from these markets?
- 2.1.3. How far are these markets from your home?

2.2. Barriers to market availability

- 2.2.1. Have you ever encountered any challenge in access to the market to purchase avocado fruit?

2.3. Loss of avocado

- 2.3.1. How do they see the shelf life of the fruit?
- 2.3.2. What mechanism do you have in place to minimize the loss of the fruit?

2.4. Any processing to market avocado

- 2.4.1. Do you have any processing idea to maximize the use, (e.g., solar drying, or any other alternative – what is their impression about it?)

2.5. Price and affordability

- 2.5.1. How affordable is the fruit by the community?
- 2.5.2. Does the price fluctuate?
- 2.5.3. What do you do with the fruit in case of destructive demand?

2.6. Target customers

- 2.6.1. Do you have a target customer who buy your products regularly?

3. Consumption

- 3.1. How do you rate the consumption of avocado (high, medium, low, non) ?
- 3.2. Enablers to avocado consumption
 - 3.2.1. What are the enabling factors that encourage the consumption of the fruit?
- 3.3. Barriers to avocado consumption (e.g. price, taboo, etc)
 - 3.3.1. Have you ever encountered any challenges/ barriers that hinder from consuming avocado fruit?

If yes, please specify

- 3.3.2. Any sorts of challenges/bottlenecks that hinder from using the fruit at household level, (e.g., easily spoiled, darkening of the flesh part, market access, price taboo)

4. Perceived benefits of avocado

4.1. Nutritional benefits: for whom?

- 4.1.1. How do you value the importance of avocado?
- 4.1.2. What are the benefits?
- 4.1.3. What can increase this benefit?
- 4.1.4. Who is the most benefited by the fruit?
- 4.1.5. To what extent did this fruit improve your HH's dietary status?
- 4.1.6. Have you seen any changes in the diets of your under five child?

If yes, what was the change? Was it positive or negative?
What explains the change?

- 4.1.7. Can any of this change be related to the consumption of the fruit? Is the change "little", "somehow/ moderately", or "highly" related to AR?
- 4.1.8. Have you seen any changes in the health of your under five child?
If yes, what was the change? Was it positive or negative?
What explains the change?
- 4.1.9. Can any of this change be related to the consumption of the fruit?
Is the change "little", "somehow/ moderately", or "highly" related to AR?
- 4.1.10. Do you still think you consume the fruit at household level in case of destructive demand?

4.2. Economic benefits: income source

- 4.2.1. How do you value the economic importance of avocado?
- 4.2.2. What are the economic benefits?
- 4.2.3. What can increase this benefit?
- 4.2.4. What is your interest as you see the benefit as a cash or nutrition?
- 4.2.5. How do you spend the money from selling avocado? Is it for buying food/non-food item?

Key Informant interview guide

Introduction and consent request

Introduction: Hello, my name is _____. I am working with **Alliance of Bioversity-CIAT** to help evaluate and document lessons learned from the Africa RISING (AR) project. The project aimed to promote agricultural technologies in Tigray, Amhara, Oromia and SNNP regions. The aim of this research is to capture the potential livelihood benefit of incorporating avocado into the agri-food systems considering the whole value chain.

Your participation in this study is completely voluntary. This means that you do not have to participate in this study unless you want to. You can even withdraw at any point, participating or not participating in the survey will not affect your relationship with AR now nor in the future. Please note that the Interviews will be recorded, but your name, and your responses will not be shared other than the research team.

Would you be willing to participate in the study? (If yes, proceed; if no thank them for their time and end the call).

I have explained to the participant the survey purpose and procedures and we have discussed the rights of the participants. I have answered questions to the best of my ability that the participant had.

Signature of interviewer _____ Date ___/___/___

I have understood the survey purpose and procedures and we have discussed the rights of me as a participant. My questions have been answered to my full satisfaction.

Signature of participant _____ Date ___/___/___

Section 1: Key Informant Interview with AR Field Staffs

Date _____

Name of interviewer(s): _____

Interviewee details

Name _____

Organization _____

Position _____

Contact _____

1. For how long have you been working on Avocado fruit production with Africa RISING program?

2. Could you mention what sort of support Africa RISING has been providing to its beneficiaries to promote avocado fruit production? _____
3. Do you think there is adequate production of the fruit in your area? _____
4. What enabling environment are there to produce the fruit in the areas? _____
5. How many varieties of avocado are available in the area? Do the beneficiaries have all the varieties in their farm? _____
6. Which one is the most common and preferred variety? And why? _____
7. Where did the beneficiaries get the seedling? _____
8. What are the benefits of the fruit? _____
9. Have the benefits been sustainable? (still ongoing now – expectations for the future?)

10. Did any major changes in their livelihood came because of this support? If so, what?

11. Have this intervention been effective? In what way?

12. Have you heard any challenges in production of avocado fruit from the beneficiaries? (e.g., water access) _____
13. How big is this problem? How do you see the mitigation for this problem? _____
14. What must be considered when farmers think of avocado fruit production? _____
15. What are the different types of markets in the area? _____
16. How far are these markets from the community? _____
17. Can avocado fruit be available from these markets? _____
18. Are there any challenge encountered by the farmers in accessing the market to purchase avocado fruit? _____
19. Are there any avocado processing mechanisms in place to maximize the use, (e.g., solar drying, or any other alternative – what is their impression about it?) _____

20. How affordable is the fruit by the community? _____
21. Does the price fluctuate? _____
22. How do you rate the consumption of avocado (high, medium, low, non)? _____
23. For what purpose do the beneficiaries use the fruit mostly? (Consumption or sell) _____
24. What are the enabling factors that encourage the beneficiaries to consume the fruit? _____
25. Are there any challenge/ barrier that hinder the beneficiaries from consuming avocado fruit? _____
- If yes, please specify
Any sorts of challenges/bottlenecks that hinder from using the fruit at household level, (e.g., easily spoiled, darkening of the flesh part, market access, price taboo) _____

Section 2: Key Informant Interview with HEWs

Date _____

Name of interviewer(s): _____

Interviewee details

Name _____

Organization _____

Position _____

Contact _____

- 1) Do you think there is adequate production of the fruit in the area? _____
- 2) What enabling environment are there to produce the fruit in the areas? _____
- 3) How do you see the availability of avocado fruit in the market? _____
- 4) Have you provided any training to the beneficiaries to promote avocado consumption? If yes, what kind? _____
- 5) How affordable is the fruit by the community? _____
- 6) How do you rate the consumption of avocado (high, medium, low, non) by the community? _____
- 7) Have you seen any changes in the diets of the beneficiaries? _____
- 8) For what purpose do the beneficiaries use the fruit mostly? (Consumption or sell)? _____
- 9) Are there any enabling factor that encourage the beneficiaries to consume the fruit? _____
- 10) Are there any challenge/ barrier that hinder the beneficiaries from consuming avocado fruit? _____

If yes, please specify

Any sorts of challenges/bottlenecks that hinder from using the fruit at household level, (e.g., easily spoiled, darkening of the flesh part, market access, price taboo) _____

10. What do you think the community would do in case of destructive demand? _____

Section 3: Key Informant Interview with DAs

Date _____

Name of interviewer(s): _____

Interviewee details

Name _____

Organization _____

Position _____

Contact _____

1. Do you think there is adequate production of avocado fruit in the area? _____

2. What enabling environment are there to produce the fruit in the areas? _____

3. How do you see the availability of avocado fruit in the market? _____

4. Have you provided any support to the farmers to promote avocado production? If yes, what kind? _____

5. How affordable is the fruit by the community? _____

6. For what purpose do the beneficiaries use the fruit mostly? (Consumption or sell)? _____

7. Are there any challenge/ barrier that hinder the beneficiaries from producing avocado fruit? _____

If yes, please specify

Any sorts of challenges/bottlenecks that hinder from using the fruit at household level, (e.g., easily spoiled, darkening of the flesh part, market access, price taboo) _____

What do you think the community would do in case of destructive demand? _____