Scoping study on fruits and vegetables; results from Ethiopia

An assessment of investment opportunities for the Bill and Melinda Gates Foundation

Huib Hengsdijk, Yared Sertse,Sihin Tesfaye, Eunice Likoko

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Scoping study on fruits and vegetable

Results from Ethiopia

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Wereldwijd lijdt een op de drie mensen aan een of meer vormen van ondervoeding. De teams van de Bill & Melinda Gates Foundation die zich bezighouden met landbouw en voeding, in samenwerking met het Britse Department for International Development (FCDO), willen het potentieel van groente- en fruitketens onderzoeken om het aanbod van voedzame voedingsmiddelen te vergroten en te versterken, en om de lokale marktkansen voor meer inkomsten te vergroten, speciaal voor vrouwen. Dit rapport belicht de conclusies van een onderzoek in Ethiopia en identificeert verschillende oorzaken en mogelijke interventies om de fruit- en groentesectoren te verbeteren en daarmee de consumptie te verhogen.

Currently, one in three of the world's population suffer from one or more forms of malnutrition. The Agricultural Development and Nutrition teams at the Bill & Melinda Gates Foundation, in collaboration with the UK's Department for International Development (FCDO), seek to investigate the potential of vegetable and fruit supply chains to increase the supply of and strengthen demand for nutritious foods, as well as increase local market opportunities for increased income, especially for women. This report highlights the conclusions from a study in Ethiopia, and identifies several root causes, as well as opportunities for interventions to further develop the fruit and vegetable sectors, and with that enhance consumption.

Key words: fruit, vegetables, food system, nutrition, supply chains

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Contents

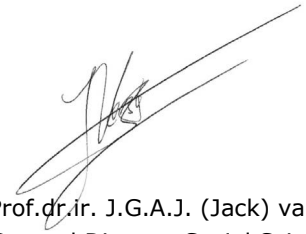
Preface

The world's population is expected to increase by 2 billion persons in the next 30 years, from 7.7 billion currently to 9.7 billion in 2050. In spite of progress made in the past decades, the number of people being undernourished is on the increase again. Globally, 462 million are underweight, while 1.9 billion adults are overweight or obese. This contrast highlights well one of the most prominent global challenges imposed on our food systems, which is: how to make available, accessible and affordable healthy food to all.

To meet the growing demand for food and improved nutrition, food production and its nutritional value need to be enhanced. Compounding this issue is the pressure that existing agricultural systems place on the environment. Although there is scope to bring new land under cultivation, for example in Africa and Latin America, this has the knock-on effect of damaging the climate, biodiversity, natural habitats and more generally the integrity of the Earth's environmental system. The challenge of achieving global food and nutrition security is underscored by Sustainable Development Goal (SDG) 2: "End hunger, achieve food security and improved nutrition, and promote sustainable agriculture."

Fruits and vegetables play a key role in achieving above mentioned goals. This was acknowledged by the Bill and Melinda Gates Foundation (BMGF) and the Foreign, Commonwealth & Development Office (FCDO) which realised that more knowledge on the current state of fruit and vegetable consumption, trade, processing and production worldwide, and notably in low- and middle-income countries, is needed. For that purpose, Wageningen University & Research was contracted to conduct a global scoping study including deep dives into selected countries. After more than a year and a half of research, we are happy to present a number of research outputs that address comprehensively the state of art and main challenges associated with fruits and vegetables. The reports take us through all aspects of food systems in which fruits and vegetables play a role, from consumption to production, but also around the world, from Nigeria to Nepal. The study provides BMGF and FCDO with a clear set of recommendations as to priorities for philanthropical investments that have the goal of enhancing consumption of and economic benefits from fruits and vegetables.

Fruits and vegetables play a key role in meeting current and future food system challenges. With this research we know better where we are and what is needed to address these challenges. I hope our work contributes to setting in motion food system changes urgently needed.



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Summary

Background

The Agricultural Development and Nutrition teams at the Bill and Melinda Gates Foundation (BMGF), in collaboration with the Foreign, Commonwealth & Development Office (FCDO) in the UK, seek to investigate the potential of vegetable and fruit supply chains to increase the supply of and strengthen demand for nutritious foods, as well as market opportunities for increased income, especially for women.

A global scoping study of the horticultural sector in West Africa, East Africa and South Asia was conducted. The Phase I study was based on available literature and secondary data and resulted in the identification of so-called leverage points for interventions in the food system to promote the production, trade and consumption of fruits and vegetables. To test the validity and feasibility of the identified leverage points in specific contexts, seven deep-dive country studies have been performed in seven countries in Bangladesh, Burkina Faso, Ethiopia, India, Nepal, Nigeria and Tanzania.

This country study provides a better understanding of current trends in the horticulture sector of Ethiopia. As a result of this study, BMGF and FCDO intend to identify potential investment options for enhancing the sustainable and inclusive development of the horticulture sector in Ethiopia. The goal of this country study is to understand whether and what kind of investments can be made to accelerate systemic changes in the food system for healthier diets and more economic opportunities for women.

Method

We investigated key questions on fruits and vegetables, that were identified during Phase I. To add scope and focus to the study we selected 3 fruit (avocado, mango, orange) and 3 vegetable crops (cabbage, tomato, carrot). The crop selection is justified based on opportunities for 1) an uptake of consumption among poor and middle-class urban and rural consumers, 2) economic importance and income generation for farmers, 3) importance for nutrition, and 4) empowerment opportunities for women. We used a mix of 10 focus group discussions (FGD), 30 key informant interviews (KII) and a consumer survey to provide an answer to the key questions identified, allowing for in-depth information gathering as well as cross referencing and triangulation.

Key findings

Consumption of fruits and vegetables is very low in Ethiopia, resulting in insufficient levels of micronutrients in local diets. Currently, fruit and vegetable supply cannot satisfy the market demand during a large part of the year associated with the seasonality of rainfed production. Consequently, consumer prices of fruits and vegetables are high during this time of the year, limiting the accessibility of fruits and vegetables for the majority of the population with low incomes.

A first step to lower consumer prices is to reduce the cost price of production of fruits and vegetables. Recent production growth in fruits and vegetables in Ethiopia is based on area expansion. Current productivity of fruits and vegetables is low, and yield gaps are very large. Using better quality inputs and optimizing input use to increase productivity is the low hanging fruit to close this yield gap. Realizing such productivity increases will require knowledge and skill building at individual farmer and group levels because fruit and vegetable production exposes farmers to a range of challenges from controlling new pests and diseases, joint irrigation scheme management, proper harvesting techniques and handling, to engaging in new marketing channels. Better knowledge and skills of farmers could

also contribute to lower losses at farm level. Effects of poor product quality at farm level trickle down further in the supply chain to cause additional losses. Reducing such losses will not only depend on technical know-how but also on the introduction of new technologies, such as new crop varieties, collection, storage and transport of the harvested produce.

There are little meaningful interactions and relationships between smallholders and consumers, limiting market-oriented production. The void is filled by non-value adding actors that set low farm gate prices to boost own profit margins. Due to a lack of trust among actors in the supply chain, in combination with informal price agreements, the market is burdened with price disputes, which are not conducive for the joint development of innovative food products and a more market-oriented production. More formal smallholder-market linkages, such as through contract farming and direct sales to retail, are still very limited. With the increasing rise of supermarket retail, direct sales and contract farming will likely increase and could contribute to more secure incomes for farmers, but not necessarily higher incomes.

Increasing the production of fruits and vegetables alone will not be sufficient to increase the consumption. Consumer awareness about the health benefits of fruits and vegetables is growing but still low. Food safety is becoming more important for urban consumers, but clear and enforceable food standards are lacking in Ethiopia. Consumer voices are little heard in the value chain by the absence of organized consumer groups.

Investments in fruit and vegetable supply chains in Ethiopia have the potential to positively contribute to several food system outcomes, especially related to food and nutrition security. As barriers to promote the production, trade and consumption of fruits and vegetable are interlinked, a mix of interventions at different stages of food system need to be developed to overcome these barriers, and to realize the desired food system outcomes. Due attention should be given to possible trade-offs but also potential synergies of interventions.

1 Introduction

1.1 Background

The Agricultural Development and Nutrition teams at the Bill and Melinda Gates Foundation (BMGF), in collaboration with the Foreign, Commonwealth & Development Office in the UK, seek to investigate the potential of vegetable and fruit value chains to increase supply of and strengthen demand for nutritious foods, as well as increase local and export market opportunities for increased income, especially for women. Wageningen University and Research was assigned to conduct this study.

First, a global scoping study of the horticultural sector in West Africa, East Africa and South Asia was conducted. This phase I study was based on available literature and secondary data and resulted in the identification of so-called leverage points for interventions in the food system to promote the production, trade and consumption of fruits and vegetables.) These potential leverage points and related research questions were formulated in general terms only. To test the validity and feasibility of the identified leverage points in specific contexts, deep-dive country studies have been carried out in seven countries in Bangladesh, Burkina Faso, Ethiopia, India, Nepal, Nigeria and Tanzania. This report describes the findings of the Ethiopia country study.

1.2 Objective

The objective of the study is to identify opportunities for action and investment in the fruit and vegetable sector of Ethiopia to guide future engagement by the BMGF.

1.3 Research questions

The potential leverage points and associated research questions that were identified in the global phase I scoping study serve as an entry point to contribute to this objective (Table 1.1).

Table 1.1 *The potential leverage points and associated research questions addressed in this report*

Leverage point	Research questions
1. Increase in production leads to lower fruit and vegetable consumer prices	How does seasonal variation in weather influence fruit and vegetable production, yields and market prices (disaggregated by fruit and vegetable category)? What are the main causes and volumes of production losses, and where do they occur? What are the main barriers for farmers to increase the production of fruits and vegetables? What keeps farmers from intensification? Do female producers face greater barriers than male producers, and are there examples that have lowered these barriers? Are quality inputs and services accessible and is the enabling environment supportive to intensification? Does the intensification of fruit and vegetable production offer additional opportunities for women? Does it overburden women? How do women balance working on fruit and vegetable production with household tasks? Are the latter 're-negotiated' or mitigated by other strategies?
2. Reduction in cost price will make production of fruits and vegetables more profitable to smallholders	How much are the production costs and can we compare them across the seven countries? What happens to the farm gate price when costs are reduced? What happens to the income of farmers when farm gate prices are lower?

Leverage point	Research questions
3. More efficient value chains can lead to lower fruit and vegetable consumer prices	Does value chain efficiency result in lower farm gate prices and/or consumer prices? Data on prices: farmgate and consumer prices. What are the risks, costs and types of coordination for the key fruit and vegetable categories? How can more efficiency be achieved and are there examples of such enhanced efficiencies?
4. More secure fruit and vegetable markets increase value chain efficiency, farmer income and reduce wastage	Are there examples that more secure markets (formal markets) are beneficial to smallholder farmers? How should farmers benefit from such arrangements?
5. Intermediary actors communicate consumer needs to producers and (jointly) develop innovative food products	How do traders and processors (male and female) connect to consumers? Are they organized to support each other? Do they impose standards on producers? What examples are there of women succeeding? Are these exceptions or at scale in the different levels of the food value chain? Are there examples of traders and processors (male and female) who are capable of responding to consumer needs by developing innovative food products? What are the conducive conditions for information sharing and what is the role of trust?
6. More and higher diversity in fruit and vegetable crops produced and traded leads to more and more diverse fruits and vegetables in the food environment	Has the introduction of new fruit and vegetable varieties contributed to more fruits and vegetables being consumed? What are the trends in fruit and vegetable consumption in the seven countries, are these dependent on season, geographical location (production/non-production areas), and can these trends be disaggregated by different types of fruits and vegetables?
7. Prices of fruits and vegetables are always higher compared to other food categories	Why are consumer prices of fruits and vegetables higher compared to other domestically produced food crops? Are there differences between categories of fruits and vegetables and what explains these differences?
8. Women's participation in fruit and vegetable production and value chain operations leads to higher income and empowerment of women	Are there examples of the successful integration of women in profitable production and value chain operations? What explains these successes and is there evidence of them being scaled up? What business models work best for women's inclusion and leadership?
9. Higher income by women leads to higher consumption of fruits and vegetables	If fruits and vegetables become more commercial (or scaled up) will the income be controlled by women?
10. Public enforcement of standards will enhance food safety for consumers of fruits and vegetables	What relevant standards (public/private) are in place? How are these standards enforced? Do consumers trust these standards? How are they perceived and acknowledged by other stakeholders in the food system?
11. Nudging and public extension will improve consumer awareness of the health benefits of fruits and vegetables and consumption preferences	Are there specific policies and strategies formulated and implemented for improving diet quality among different consumer categories and do they include strategies on fruit and vegetable consumption? Is there evidence of their impact? How have policies enabled women to address systemic constraints that they face, and to successfully access sufficient nutrition? An inventory of innovative policy and strategy examples implemented — who is implementing them? Are consumers' motives taken into account?
12. Increased food safety, consumer awareness and responses to consumer preferences lead to higher acceptability of fruits and vegetables	What are consumer motives and barriers to (not) consume (specific) fruits and vegetables, such as indigenous vegetables, for different household members?
13. Improved availability, affordability and acceptability leads to an intake of fruits and vegetables in amounts that meet the recommendations	If everything is as planned (available, affordable, acceptable) will consumers increase fruit and vegetable intake in their diet, according to the recommendations?

1.4 Approach

The results presented in this report are based on:

1. An extensive review of production statistics, secondary data, reports and articles published on fruits and vegetables in Ethiopia during the last decade;
2. A large number of focus group discussions and interviews with key informants in the fruit and vegetable sector in Ethiopia, which were carried out in the period March-April 2021; and
3. A non-representative and limited survey of fruit and vegetable consumers, which was carried out in March-April 2021.

The literature review was conducted using Google search and a snowball technique to identify reports and articles published in the last 10 years related to fruit and vegetable production, markets and consumption, in the context of Ethiopia. Approximately 200 reports and articles have been identified, reviewed and, if relevant in the context of the study, their findings summarized in this report.

Although the potential leverage points were central in the focus group discussions and interviews with key informants, to narrow down the discussions, three vegetables and three fruits were selected, i.e. cabbage, tomato, carrot, avocado, mango, and orange. These crops were selected based on production, socio-economic, consumption, nutrition and gender considerations and represent the diversity of vegetables and fruits produced and consumed across Ethiopia (Chapter 3). Based on this crop choice, associated production areas and supply chains were identified, after which relevant stakeholders in these areas were visited and interviewed. Much of the focus group discussions and interviews with key informants confirmed general analyses of the fruit and vegetable sector and findings of studies on other fruits and vegetables described in the literature. In addition, the focus group discussions and key informant interviews provided insights into interesting cases and novel approaches in the fruit and vegetable sector, which are currently emerging in Ethiopia. These cases are described in boxes throughout the report. In total 10 focus group discussions were held and 30 interviews with key informants were conducted. See Appendix 1 for an overview of the focus group discussions and key informant interviews, including their locations and specific topics addressed.

Information on the consumption of fruits and vegetables in Ethiopia was limited in the literature, focus group discussions and key informant interviews. A small survey was therefore developed and filled out by 50 consumers from supermarkets and wet markets. Fifty percent of these consumers were literate and middle to high income earners, while the rest were illiterate with low income levels. The questionnaire used for this survey is included in Appendix 2.

Results from the various data and information collection methods are integrated throughout this report, using the research questions in Table 1.1 as an entry point.

1.5 Reading guide

Chapter 2 gives a general overview of the fruit and vegetable system in Ethiopia, including current consumption, domestic production volumes, the seed system and the role of women in the fruit and vegetable system. Chapter 3 describes how the three priority fruits and vegetables were selected for the focus group discussions and interviews with the key informants. This chapter also describes the significance of the selected crops, their recent production development and role in different farming systems. Chapter 4 describes the actors and main supply chains in the selected fruit and vegetable systems, and the enabling environment. Chapter 5 and its sub-sections analyses the leverage points and associated research questions as described in Table 1.1. The final Chapter 6 compiles the major findings of the study by reviewing the leverage points, and discusses and concludes the research results.

2 State of play

2.1 Country profile

The current population of Ethiopia is 112 million and with an annual growth rate of 2.6% the population could reach 187 million by the year 2040.[1] As the second most populous nation in Africa after Nigeria, Ethiopia has shown remarkable economic growth, averaging 9.8% a year from 2008/09 to 2018/19[2] (Figure 2.1). The foundation of this growth has been a number of successive policy strategies, i.e., the Plan for Accelerated and Sustained Development to End Poverty (PASDEP) implemented from 2005/06 to 2009/10; the First Growth and Transformation Plan (GTP I) from 2010/11 to 2014/15; followed by the Second Growth and Transformation Plan (GTP II) from 2015/16 to 2019/20. Agricultural-led development was the Ethiopian government's overarching poverty reduction and economic growth strategy. As a result of successive policy plans, the proportion of the population living below the national poverty line fell from 39% in 2003 to 24% in 2016 (NN, 2020). During Ethiopia's recent period of macro-economic growth (2010/11 to 2018/19), the share of the agricultural sector in national GDP decreased from 47% to 33% to make room for the growth of industry and construction (Figure 2.1).

In the beginning of 2021, the Ethiopian government launched the Ten Years Perspective Development Plan (2021-2030) that aims at reducing the population living below the poverty line to 7% in 2030. The plan also aims to reduce the share of the agricultural sector in GDP to 22% and to create close to 14 million jobs per year. The shift from agriculture to industry and manufacturing increases employment opportunity and further enables the country to achieve its goal of increasing production and productivity to increasing export revenues and substituting imports. Raising the productivity of the agricultural sector is among the top priorities of the new plan. The main instruments for achieving this are shifting from rain-fed agriculture to irrigation, scaling-up agricultural mechanization and input intensity, and enhancing the participation of the private sector through direct investment, as well as inclusive farming models such as contract farming.

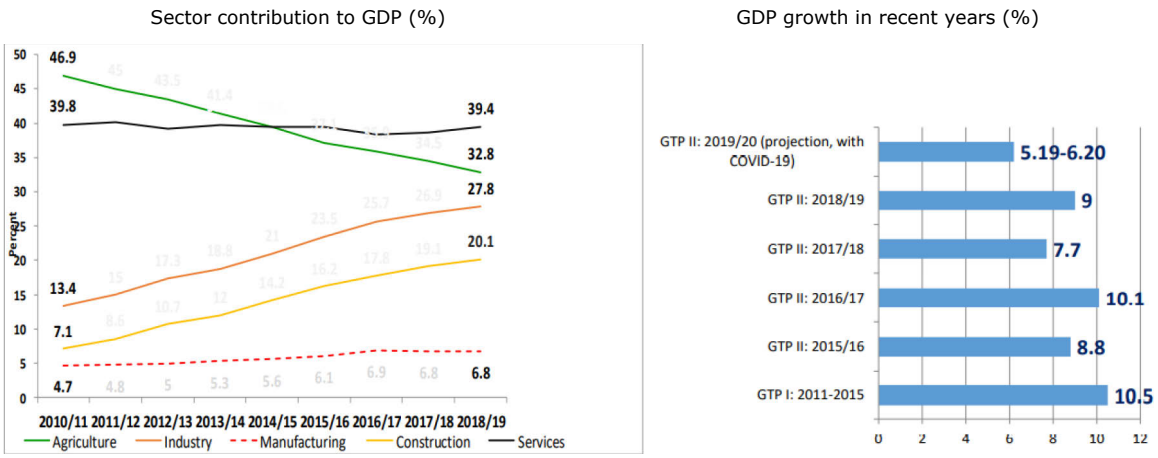


Figure 2.1 *Sector contribution to GDP (%), left panel, and GDP growth (%) in recent years, right panel*
Source: NN (2020).

[1] World Bank (2019), Population growth (annual %) – Ethiopia. Available at: https://data.worldbank.org/indicator/SP.POP.GROW?locations=ET (Accessed: 17 May 2021).
[2] World Bank (2021), The World Bank in Ethiopia. Available at: https://www.worldbank.org/en/country/ethiopia/overview (Accessed: 26 January 2021).

Despite the robust national economic growth in the last decade, growth in the agricultural sector lagged behind growth in the industry and service sectors. Yet, the recent production and productivity increase of major staples, such as maize and wheat, has been impressive, certainly in the context of sub-Saharan Africa. In the last decade, yields of maize more than doubled and that of wheat increased by 61%, with both outpacing population growth (Figure 2.2). As further evidence of a strong strategic priority for cereals, Ethiopia launched a wheat import substitution strategy in 2018/19, which focuses on irrigated and lowland wheat production. The first-year implementation of the wheat self-sufficiency strategy has shown profound steps by adding over 400,000 ha to the wheat production area in 2020/21.

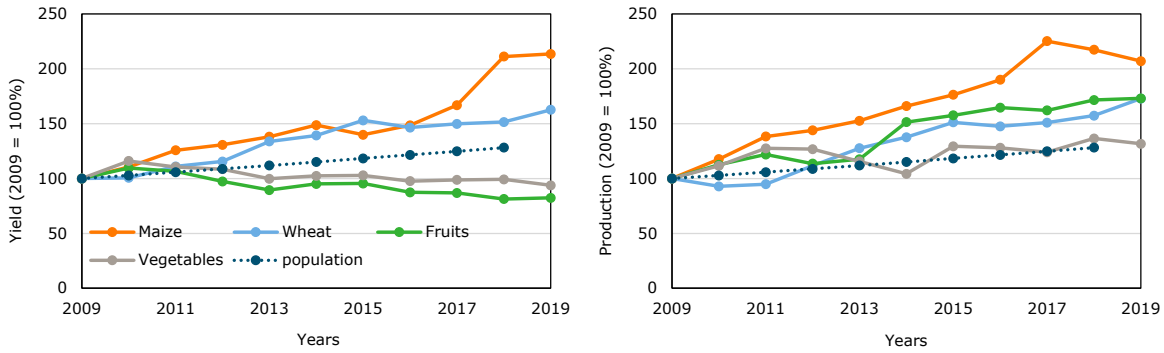


Figure 2.2 *Development of maize, wheat, fruit and vegetable yields (left) and production (right) between 2009 and 2019, and the national population (2009-2018). Productivity, production and population in 2009 = 100%. Note: the vegetable data excludes data on chili because of an unexplained trend break between 2014 and 2015*
Source: FAOSTAT.

In contrast, yields of both fruits and vegetables in Ethiopia decreased compared to 2009 and lagged behind the population growth (left panel in Figure 2.2). Production growth of maize and wheat between 2009 and 2019 was almost entirely driven by productivity growth. In contrast, production growth of fruits was entirely driven by area expansion in the same period. Modest production growth of vegetables was also driven by area expansion and hardly kept up with population growth (right panel in Figure 2.2). Based on the production volume of fruits and vegetables and average fruit and vegetable prices, we estimate that the fruit and vegetable sector contributes about 1% to the national GDP.

Three factors explain the relative slow growth of the fruit and vegetable sector compared to cereals (Hailegiorgis and Hagos, 2016): i) the lack of strategic priority in policy, ii) fragile markets, and iii) high investment needs. The top strategic priorities of the Ethiopian government since PASDEP were food security and the export of products for foreign exchange purposes. Within the portfolio of food security crops, cereals were priority crops because of their importance in the diet and thus national food security. The lack of policy priority for the fruit and vegetable sector can also be observed in the organization of the Ministry of Agriculture, where the sector did not an own department. Only recently, the fruits and vegetables sector has an own department within the Ministry of Agriculture. In addition to the limited strategic policy focus, the lack of market stability has been a major barrier for fruit and vegetable producers. Production decisions are primarily based on historical market dynamics, while a lack of processing and handling technologies means that market price failures are severe and sometimes result in the total loss of production. Compared to most other crops, vegetables and fruits require high investment costs. Especially in perennial fruit production, the lead time before production, which is often a few years after planting, is a financial burden that small farmers cannot overcome. In many cases, farmers do not have access to finance for investments. Even when they are able to invest, the risk of market failure is high and thus limits farmers' motivation to increase the scale of their production.

Improving the health of the population is high on the policy agenda of GTP II, for example, the target to reduce young child stunting levels from 40% in 2014/15 to 26% in 2019/2020. However, the term *nutrition* — as part of a healthy diet that comprises of dairy, fruits and vegetables — is only used four times in GTP II and only in the context of export production. The focus of GTP II is on increasing the current productivity of cereals, pulses and oil seeds to contribute to improved food security and reduced undernutrition.

Additionally, the second National Nutrition Policy (NNP II; 2016-2020) underlines the importance of the agricultural sector to ensure that nutritious food is available for the population. Among other approaches, the scaling of fruit and vegetable production and consumption has been set as a pathway to nutrition security. A progress review of the NNP II in 2019 indicated that targets for the establishment of fruit nursery sites, caged/fenced poultry production at the household level, and nutrition corners at farmer training centers were exceeded by very large margins.

Ethiopia has been successful in realizing a number of Sustainable Development Goals (SDGs) related to nutrition as it achieved larger declines in undernourishment rates compared to Africa as a whole and other countries in Eastern Africa (FAO et al., 2020). See Table 2.1 for a selection of (recent) changes in progress towards the SDGs and global nutrition targets in Ethiopia, Africa and Eastern Africa.

Table 2.1 *Progress towards SDGs and global nutrition targets*

	Prevalence of undernourishment in the total population (%)		Prevalence of stunting in children (<5 years of age) (%)		Prevalence of wasting in children (<5 years of age) (%)	Prevalence of anemia among women of reproductive age (15-49) (%)		Prevalence of obesity in the adult population (> 18 years) (%)	
	2004-06	2017-19	2012	2019	2019	2012	2016	2012	2016
Africa	21.4	18.8	32.3	29.1	6.4	37.7	37.7	11.5	12.8
Eastern Africa	33.4	26.9	38.5	34.5	5.3	30.6	31.2	5.3	6.4
Ethiopia	37.2	19.7	44.4	36.8	7.2	21.7	23.4	3.6	4.5

Source: FAO et al. (2020).

2.2 Consumption of fruits and vegetables

Sufficient intake of fruits and vegetables, 400 g per capita per day, is known to improve cognitive ability, improve mental health and reduce the risk of several non-communicable diseases (WHO/FAO, 2003). Current consumption of fruits and vegetables in Ethiopia is limited and lower than in the rest of East Africa — fruit consumption is particularly low in Ethiopia.[3] Literature sources estimating fruit and vegetable consumption vary depending on the methods used. According to the Food Systems Dashboard, per capita consumption of fruits and vegetables in 2017 totaled 55 g per day in Ethiopia, meanwhile the food balance data from FAOSTAT suggests that the per capita consumption is 60 g per day.[4] This quantitative consumption data supports qualitative findings from our consumer survey in which only 50% and 22% of the respondents indicated that, on a daily basis, they eat vegetables and fruits, respectively. In contrast, 51% and 30% of the consumers indicated that only once a week they eat fruits and vegetables, respectively. Although the survey sample was small and non-representative, with an overrepresentation of urban middle to high income earners, the results suggest a low frequency of fruit and vegetable consumption and support the low intake levels reported by FAOSTAT and others.

[3] Food Systems Dashboard (2021), Food Systems Dashboard. Available at: https://foodsystemsdashboard.org/ (Accessed: 8 March 2021).
[4] FAO (2021), FAOSTAT – Data. Available at: http://www.fao.org/faostat/en/#data (Accessed: 8 March 2021).

Among the challenges limiting the consumption of fruits and vegetables in Ethiopia are the presence of repetitive dietary traditions, inadequate awareness of the nutritional benefits, and limited availability and accessibility of fruits and vegetables. The most prominent vegetables that are regularly consumed are onion, tomato, cabbage and carrot. Fresh fruits are usually consumed in Ethiopia as a snack with limited value addition. The consumption of fresh juices prepared locally, as well as processed fruit juice products imported from the Gulf region, is increasing in major cities and other urban areas. Bananas, avocados, mangos, oranges, and papayas are the most widely consumed fruits, both as a fresh snack or juice.

The Ethiopian diet is mainly composed of cereals (maize, sorghum, teff, and barley), tubers and roots (Enset, potatoes, and sweet potatoes), pulses (peas, chickpeas, beans, lentils) and oil seeds (EPHI, 2013). Despite the large livestock sector, the food supply of animal products is limited in comparison to the total population, and meat consumption is lower than in the rest of East Africa (see footnote 3). Consumption of animal products is especially low in rural areas, with the exception of pastoral areas, where milk is a major component of the diet. However, Ethiopia's growing urbanization has led to changes in consumption patterns from starchy staple foods to higher value products, such as meat and dairy products, as well as vegetables and fruits.

The Ethiopian National Food Consumption Survey (NFCS) of 8,267 urban and rural households, including dietary data from 8,133 women, 8,079 children and 380 men, showed that less than 10% of the respondents reported consuming any food group other than cereals/grains, with the exception of dairy consumption among children (EPHI, 2013). Slightly more than 10% of men reported consumption of non-vitamin A rich fruits and vegetables. The NFCS showed that carbohydrates contributed more than 65% of the total energy intake across all age cohorts and genders (EPHI, 2013). This unvaried diet may reflect the lower availability of a variety of foods during the survey period (June-September), but is also an indication of Ethiopia's cultural eating habits.

As a consequence of the current consumption pattern, Ethiopian children consume one of the least diverse diets in sub-Saharan Africa (Hirvonen and Hoddinott, 2017). Children's diets are poor at all ages in Ethiopia. At age 6-12 months, children consume only one food group, rising to 1.5 groups at age 24 months and staying constant after that. At the household level, food consumption is dominated by cereals and pulses, while the consumption of animal-sourced foods and fruits and vitamin A rich vegetables is rare, especially in rural areas (Bachewe et al., 2017). Bachewe et al. (2017) explained the lack of dietary diversity in rural areas as, at least partly, due to limited knowledge about the health benefits of diverse diets and poor access to food markets. Emana et al. (2017) reported that local horticulture development agents, who need to promote vegetable production, did not have enough knowledge of the nutritional value of most vegetables produced. Furthermore, both interviewed development agents and farmers were not able to specify the health benefits of vegetable consumption. Melesse and van den Berg (2021) reported on the imperfect understanding of food-health relationships among *urban* consumers, despite personal health being an important motive in their food choice.

Based on the national consumption survey of 2005, Tafere et al. (2010) studied how consumption patterns are affected by changing prices. They estimated that the high price elasticity of most food items, including fruits and vegetables, as close to -1.0, indicating that a 10% increase in prices is associated with a 10% decrease in consumption. Rising incomes could therefore influence food consumption patterns. Indeed, Worku et al. (2017) showed that food expenditure in Ethiopia shifted between 1996 and 2011, driven by higher household incomes. The share of cereals in total food expenditure declined from 45.7% in 1996 to 36.0% in 2011. During the same period, the share of vegetable expenditure increased from 3.7% to 6.4%. The higher expenditure on vegetables was associated with increased fruit and vegetable consumption from 31 kg to 45 kg per year per capita. The effect of higher household incomes on fruit and vegetable expenditure and consumption was also observed in the difference between rural and urban households. While fruit and vegetable expenditure was 5.9% of the total food expenditure in rural households, it was 8.1% in urban households. The higher relative expenditure on fruits and vegetables of urban households translates into higher annual fruit and vegetable consumption, 56 kg per adult compared to 42 kg among rural households. Although the data used is relatively old, the results are still relevant. The average per capita income

continues to grow in Ethiopia, for example, the GDP more than doubled in the last decade.[5] Therefore, it is expected that the consumption of fruits and vegetables has continued to increase in the last decade. Indeed, recent studies indicate that with rising income levels and improving health consciousness, the importance of fruits in the diets of households has increased, and richer households consume a more diverse diet compared with poorer households (Abdulazize Wolle et al., 2020). Still, the costs of a healthy diet, including sufficient amounts of fruits and vegetables, are very high and not within reach for the average Ethiopian citizen. Herforth et al. (2020) calculated that such a diet would costs US$3.73 per capita per day (at the 2017 price level), of which 39% would need to be spent on fruits and vegetables.

2.3 Area and volume of fruit and vegetable production

Figure 2.3 shows the development of the harvested fruit and vegetable area, yield and total production in Ethiopia during the last decade. The production of fruits increased more rapidly than the production of vegetables. Current production levels of fruits and vegetables are similar, both at approximately 1 million t per annum (right panel in Figure 2.3). This production increase is completely driven by an increase in the harvested area of fruits and vegetables (left panel in Figure 2.3), as yields of both fruits and vegetables decreased (center panel in Figure 2.3). Current fruit yields (≈ 7 t/ha) are lower than vegetable yields (≈ 8.5 t/ha), while the current harvested fruit area (≈150,000 ha) is larger than the harvested vegetable area (115,000 ha).

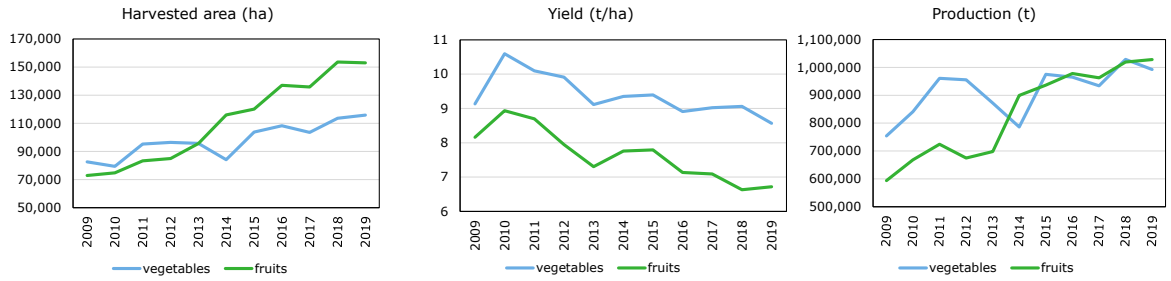


Figure 2.3 *Harvested area (left panel), yields (center panel) and total production (right panel) of fruits and vegetables in Ethiopia between 2009 and 2019. Note: vegetable data excludes data on chili because of an unexplained trend break between 2014 and 2015*
Source: FAOSTAT.

The production of fruits and vegetables varies depending on the different agro-ecological zones of production in Ethiopia. Both fruit and vegetable production contribute to household food security and income generation, varying from backyard farming for household consumption to large scale production targeting local, national and regional markets. According to the Central Statistical Agency of Ethiopia, private agricultural holdings including small privately owned agricultural holdings generate 95% of the annual gross national agricultural output (CSA, 2020).

2.4 Production areas and farming systems

Ethiopia has favorable climate and edaphic conditions to produce tropical, sub-tropical and temperate fruits and vegetables in the lowlands (<1,500 m above sea level), midlands (1,500-2,200 m above sea level) and highlands (>2,200 m above sea level). Traditionally, commercial vegetable and fruit production is concentrated in the Rift Valley area of Ethiopia, primarily due to the availability of irrigation water, market accessibility to Addis Ababa, and closeness to agro-processing industries. Fruit production is more dominant in the south of the Rift Valley, around Arba Minch. However, fruits and

[5] World Bank (2019), GDP per capita (current US$) – Ethiopia. Available at: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=ET (Accessed: 17 May 2021).

vegetables are produced by smallholder farmers under rain-fed conditions throughout Ethiopia, due to the broad agro-ecological conditions across Ethiopia. Excepting the Rift Valley area, fruit and vegetable production in most of the other areas is rain-fed, as most of these areas fall within the high rainfall belts of the country.

Mixed smallholder farmers dominate the agricultural sector in Ethiopia, with 90% of farms smaller than 2 ha. However, in various parts of the country, such as the Southern Nations, Nationalities, and Peoples Region (SNNPR), Tigray and Gambella, land holdings are much smaller, often less than 0.5 ha (IFPRI, 2006). The small farming systems often consist of livestock and a mix of staple foods — ranging from cereals (maize, wheat, teff, sorghum), pulses, oil seeds and vegetables; to enset, the local hunger season crop, and other perennials such as khat and coffee for cash (Mellisse et al., 2018). Fruit and vegetable production in the small farming systems often takes place in home gardens with a limited commercial outreach. Women and the elderly are in control of home gardens from production through to the marketing of any surplus production at nearby local markets. In the Rift Valley, which was originally dominated by livestock farmers, many farming systems tend to be in the range of 2 ha, and farmers close to surface water or shallow ground water have irrigated plots of approximately 0.25 ha (van Halsema et al., 2011). These farmers produce fruits and vegetables for the urban and even regional markets that are located further away and reached through different supply chains (Section 4.2).

Thanks to the policies of the Ethiopian government to stimulate economic growth (Section 2.1), various large scale investments have been made by the private sector in the production of flowers and propagation material (i.e. cuttings) for export, since approximately 2005. In the slipstream of this development other entrepreneurs, ranging from small to large scale farmers, have started to produce fruits and vegetables across the country. This development was further enhanced by investments from the public sector and non-governmental organizations (NGOs), which provided smallholders with access to irrigation water and other inputs. This paved the way for so-called production corridors, which are considered local hubs with favorable and homogenous agro-climatic conditions for the production of fruits and vegetables for local and export markets. Roughly five major production corridors can be identified in Ethiopia (Table 2.2).

Table 2.2 *Production corridors in Ethiopia, their administrative zones, and major fruits and vegetables*

#	Corridors	Zones	Major fruits	Major vegetables
1	**Rift Valley**: lowland, 500-1,000 mm rainfall per year, 200 km south of Addis.	West Arsi, Est Showa.	Grapes, orange, papaya, strawberry, watermelon.	Broccoli, cauliflower, Ethiopian cabbage, head cabbage, kale, onion, tomato, Swiss chard.
2	**Abaya**: low-mid altitude, 300 km south of Addis.	Gamo Gofa, Welayta, Sidama.	Avocado, banana, mango, pineapple.	Chili pepper, head cabbage, pepper.
3	**Tana**: rainfall >1,200 mm per year, 500 km north of Addis.	West Gojjam, South Gonder.	Mango, avocado.	Ethiopian cabbage, head cabbage, onion, tomato.
4	**Jimma:** mid-high altitude, rainfall >1,700 mm per year, 350 km west of Addis.	Benchi Maji, Jimma.	Banana, mango, pineapple.	Cabbage, onion, pepper, tomato.
5	**Ray Valley:** lowland up to 3,600 m above sea level, on the Amharic-Tigrayan border.	Raya Alamata, Raya Azebo.	Banana, grape, mango, strawberry.	Onion, tomato, asparagus.

Source: Authors' research.

All corridors fall within the lowland or midland agro-ecological climate zones of the country. In the highland areas (southeast, central and north) vegetables such Ethiopian cabbage, carrot, beetroot and garlic are grown by smallholder farmers under rain-fed conditions. Most of these areas are fragmented across the country but still have fairly similar production seasons. Table 2.3 shows the major areas for producing highland vegetables in Ethiopia.

Table 2.3 *Production pockets of highland vegetable production in Ethiopia*

#	Area	Zones	Major Vegetables
1	**South Eastern Highlands**: highland >2,000 m above sea level, 800-1,000 mm rainfall, >200 km south of Addis Ababa.	Arsi, Bale.	Carrot, potato, beetroot.
2	**Central Highlands**: Highland, 100-200 km south and north of Addis Ababa.	Gurage, North Shewa.	Beetroot, carrot.
3	**Northern Highlands**: >300 km north of Addis Ababa, rainfall >800-1,000 mm, 500 km northeast of Addis Ababa.	South Wollo.	Carrot.

Source: Authors' research.

2.5 Export and import of fruits and vegetables

The horticulture sector in Ethiopia is often hailed for its success in generating foreign exchange. In a short period, this sector became the third largest agricultural export earner for the country in the year 2017/18, after coffee and oil seeds.[6] The 119 horticultural growers that are members of the Ethiopian Horticulture Producer Exporters Association (EHPEA) export horticultural products with a value of more than US$300 million per year.[7] However, 80% of these earnings were derived from the export of flowers, with the main export markets in Europe and the Middle East. Though growing, the EHPEA members' export of fruits and vegetables is still limited compared to the export value of flowers and cuttings.

The total export from the horticulture sector (flowers, vegetables, fruits and herbs) was close to US$500 million in 2020. The lion's share, however, comes from the export of flowers. Between 2017 and 2020 Ethiopia earned a total of US$91.6 million with the export of fruits and vegetables (Table 2.4). Important export markets for fruits and vegetables are the surrounding countries of Djibouti, Somalia and Sudan. The main products exported to these countries are non-graded fresh fruit and vegetables, such as tomato, onion, banana, mango and avocado. High value, graded, pre-packed vegetables are exported to Europe and the Middle East, to a smaller extent. Most of these products are exported to Belgium, the Netherlands, and the United Arab Emirates. Tomato is at the top of the export list based on the 4-year average, followed by strawberry and cabbage. Strawberry exports are mainly to Europe and the Middle East, while the tomatoes and cabbage are mainly exported to neighboring countries.

Though Ethiopia has potential to supply key markets in the Middle East and Europe, the major export destinations for fruits and vegetables have been neighboring countries, namely Djibouti, Somalia and Sudan. Recently, the export of high value fruits, such as strawberry, avocado, grapes and blueberry to Europe has been increasing. In particular, the export of avocado, especially to Europe, has increased very rapidly (Box II). Avocado exports require a cold chain, which was inaugurated by the Ministry of Transport and the Flying Swans Project. This cold chain initiative intends to address the high cost of cargo transport by adopting inland and ocean freights as alternatives to airfreight (Broek et al., n.d.).

[6] OEC (2019), Ethiopia. Available at: https://oec.world/en/profile/country/eth (Accessed: 7 April 2021).
[7] EHPEA (2021), Overview of the horticulture sector. Available at: https://ehpea.org/overview-of-the-sectors-growth / (Accessed: 7 April 2021).

Table 2.4 *Export of major fruits and vegetables (in US$) from Ethiopia (2017-2020). Crop codes refer to codes used by the Ethiopian Revenues and Customs Authority (ERCA)*

Fruit/vegetable	2017	2018	2019	2020	Total
Tomato (HS-07020000)	8,387,937	8,703,180	7,720,912	4,043,534	28,855,564
Strawberries (HS-08101000)	2,343,463	4,482,521	3,460,433	4,972,832	15,259,249
Cabbage lettuce (HS-07051100)	1,676,204	1,901,127	3,882,909	5,712,302	13,172,542
Carrots and turnips (HS-07061000)	1,068,437	1,465,045	3,716,171	5,651,945	11,901,599
Onion (HS- 07031000)	2,711,582	2,773,525	3,005,523	2,872,015	11,362,645
Orange (HS-08051000)	988,224	807,375	681,021	784,518	3,261,138
Avocado (HS-08044000)	117,934	377,781	856,610	992,731	2,345,057
Garlic (HS-07032000)	746,392	717,223	225,967	127,272	1,816,854
Guavas, mangos and mangosteens (HS-08045000)	524,830	482,570	394,601		1,402,000
White and red cabbage (HS-07049000)	310,420	312,195	275,622	268,284	1,166,521
Papaya (HS-08072000)	143,363	219,166	233,300	279,356	875,185
Cucumbers and gherkins (HS-07070000)	42,463	37,773	26,696	23,764	130,696
Citrus fruit (HS-08059000)			1,105	37,616	38,721
Banana (HS-08030000)		2,041	33,167		35,207
Grape (Hs-08061000)			3,502	8,175	11,677
Total	19,061,271	22,281,521	24,517,657	25,774,359	91,634,808

Source: ERCA.

Based on Peperkamp (2020), Table 2.5 ranks the export potential of major fruits and vegetables from Ethiopia to neighboring countries. Strawberry, tomato and green beans have the best export opportunities based on this assessment.

Table 2.5 *Ranking of export potential for major fruits and vegetables produced in Ethiopia based on production, credibility exporting firm, competitiveness and scalability criteria. Ranking is 1 out 5, with 1 as lowest score and 5 as highest score*

Fruit or vegetable	Production	Track record of exporting firm	Competitiveness	Scalability	Average
Strawberries	3	4	4	4	3.8
Tomato	4	3	3	4	3.5
Green beans	1.5	4	4	4	3.4
Avocado	2	3	4	4	3.3
Onion	4	3	3	3	3.3
Carrot and turnips	2	4	3	4	3.3
Grapes	1.5	3	4	4	3.1
Mango	3	3	3	3	3.0
Sugar beets	1	3	3	3	2.5
Snow pea	1	2	4	3	2.5
Banana	3	3	1	2	2.3
Zucchini	1	2	3	3	2.3
Okra	1	2	3	3	2.3
Orange	1.5	3	2	2	2.1
Capsicum	1	2	2	3	2.0

Source: Peperkamp (2020).

During the last 5 years, Ethiopia imported a total of over 148,000 t of processed horticultural products; these imports have shown a cumulative average growth of 33%. Tomato juice (35%), mixed juice (18%) and pineapple juice (18%) are the top three imported juices to Ethiopia. Among fresh products, Ethiopia imports apple, grapes and oranges. Imports of these fruits have shown an increasing trend recently. The primary market for imported fruit is the high-end market in Addis Ababa and distribution primarily follows the supermarket chains.

2.6 The seed system

Figure 2.4 shows the major characteristics of seed systems in Ethiopia. Most seeds formally produced and distributed in Ethiopia come from the public sector. In 1992, the Ethiopian government created a National Seed Policy to develop an enabling environment that would encourage seed production and marketing from the private sector. The policy allows private foreign seed companies to undertake crop research activities on non-restricted crops. Following the National Seed Policy, several policy additions have promoted the development of the seed sector.

Seed supply in Ethiopia can be broadly categorized into public seed enterprises, private growers and imports. The public seed enterprises include both the national and regional seed enterprises. This group of suppliers primarily focus on cereals, namely maize, wheat and teff. The local private growers are companies that are engaged in seed multiplication, cleaning, packing and distribution. These companies supply both cereals and vegetable seed. The local seed growers get primary seed from research institutes. An important emergence of the local vegetable seed system is seedling supply by private growers. This is practiced by both local and international companies operating in the Rift Valley. Flora Veg operates as one of the major suppliers of tomato, pepper, eggplant and asparagus seedlings. Based on farmer interviews, the demand for such vegetable seedlings is increasing because it reduces farmers risks in the production of seedlings. The specialized knowledge, use of fertile growth media and screen houses reduces pest and disease pressure allows Flora Veg to produce healthy and vigorous seedlings. The third source of seed for vegetables is imported seed. Monarch and Baker Brother seed are the most popular imported seed brands, but recently others such as EASI Seed joined the market. Both open-pollinated varieties (OPVs) and hybrid seed are supplied by this import channel. However, farm-saved seed is the prevailing source of seeds, used by 85% of smallholder farmers.

Table 2.6 *Different categories of seed supply actors and their marketing channels*

Category	Name of actors	Priority	Channel
Public seed enterprises	Ethiopian Seed Enterprise, Amhara Seed Enterprise, Oromia Seed Enterprise, SNNPR Seed Enterprise and Tigray Seed Enterprise.	Primarily focus on staples: maize, wheat, teff and some pulses and oil seed.	Focus on supplying smallholder farmers, reaching them through cooperatives and unions.
Private seed companies	A number of small private growers in the Rift Valley and Tana areas. Bigger companies: Ethio-Veg Fru, Flow-Veg, Florensis. This group supply seedling using imported hybrid seed.	Focus on onion for the first group, and tomato, pepper, eggplant and asparagus for the second group.	Focus on supplying semi-commercial farmers who grow seed using irrigation.
Imported seed	Bakker Brothers, Monarch and EASI Seed.	All vegetables, focusing on tomato, onion, carrot, cabbage and lettuce.	Target smallholders as well as (semi-) commercial farmers. Seeds are supplied through agro-dealers.

Source: Authors' research.

The Ethiopian Agricultural Business Corporation (EABC) is a newly established public corporation that was formed through the merger of five state-owned enterprises, one of which was the Ethiopian Seed Supply Enterprise. EABC is the only one among seven with a full seed supply chain that encompasses the entire range of activities. However, it is focused mainly on food staples. Corteva Agriscience is another significant player in Ethiopia's seed system with a 30% market share. It is the only other company alongside EABC that processes seeds, again with a focus mainly on staples. EABC, Corteva Agriscience and a few global companies are engaged in supplying seeds for a few vegetable crops.

Much of the vegetable seed on the national market is sourced from public breeding programs or imported. Local companies continue to produce OPVs of seed. Most global and regional companies offer a mix of hybrid and OPV vegetable seeds. Smallholders often prefer OPVs as they lend themselves to on-farm seed saving. Vegetable seed is available in packages as small as 1 g or 100 seeds.

For commercially less attractive vegetable crops and basically all fruit trees, public agricultural research institutes are critical for varietal development and the seed supply chain. Moreover, public investment in the development of vegetable and fruit varieties is limited, therefore the seed value chains are fragile. For those vegetables and most fruits, farmers continue to use local varieties or types, and they use local and informal seed sources. A diversity of varieties, in cases adapted to specific locations and farmers' and customer demands, remain dominant. For some of the popular crops (tomato, pepper, onion), a few popular, but not recently released, OPVs are important in the seed market.

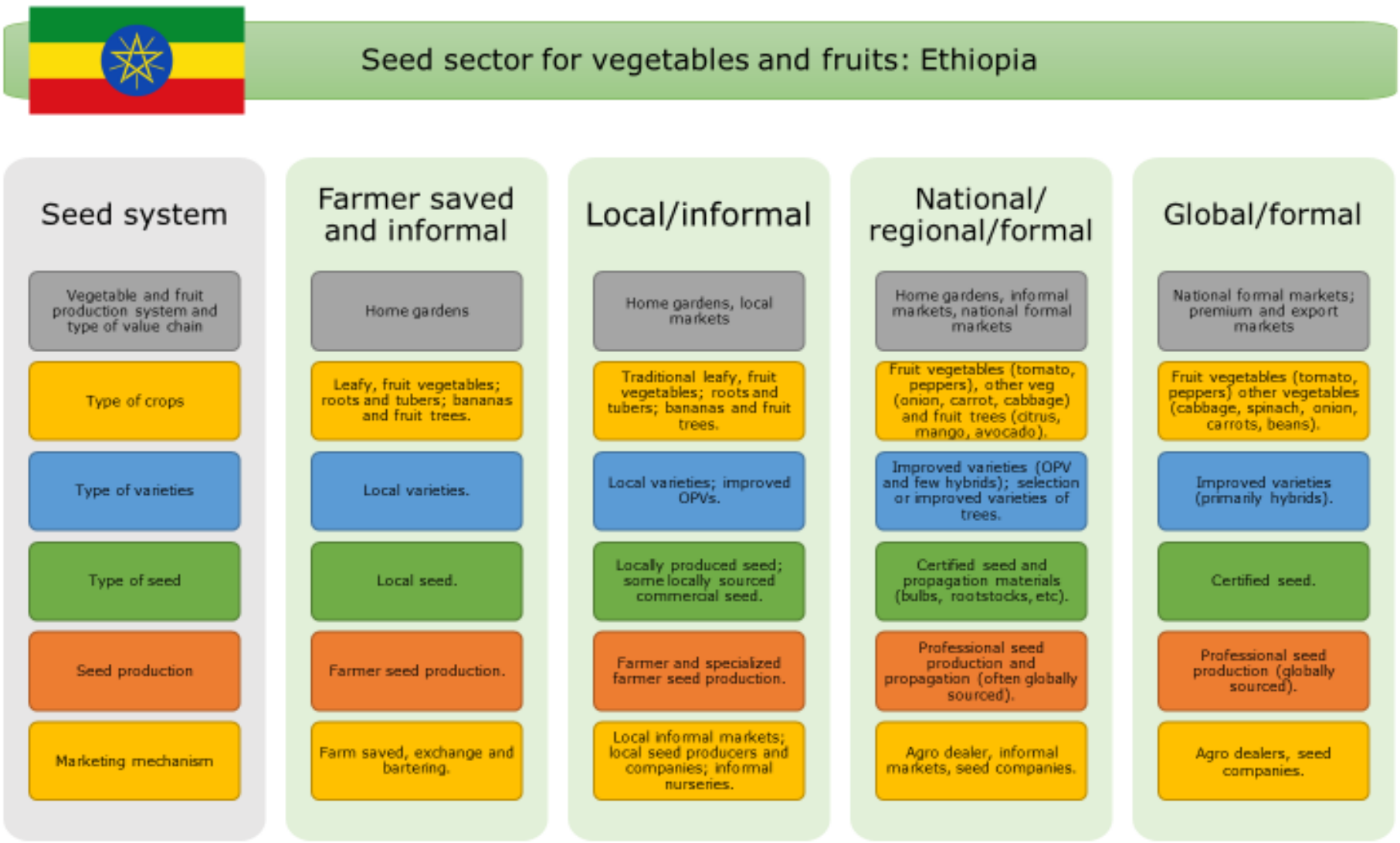


Figure 2.4 *Characteristics of different seed systems in Ethiopia*
Source: based on Louwaars et al. (2013)

Farmers who produce fruits and vegetables in home gardens or who are engaged in the informal marketing of vegetables and fruits use multiple seed sources. They may use farmer saved seed or planting material (fruit trees) from neighbors, informal markets or nurseries. For some vegetables, they may purchase small packs of seed from regional or national seed companies. In such cases, home garden farmers would opt for quality OPVs or hybrid varieties, depending on the investment they are willing and able to make in purchasing vegetable seed. With the wide array of seed systems from farmer saved seed to national public and commercial seed systems, the seed sector in Ethiopia is in an initial but developing stage, particularly for commercially more attractive vegetables. The seed sector predominantly depends on public varieties for major vegetables, as commercial seed systems with superior varieties still need to develop. Therefore, the public sector is still dominant and remains involved in vegetables and fruits, while the role of informal seed systems remains important.

2.7 Gender and women's roles

In Ethiopia, agriculture contributes to 85% of the labor force employment, among whom about half are women. As a multicultural country, the gender roles and division of labor in agriculture varies between cultural settings, locations, and farming systems (Assefa et al., 2018). For example, women plow with oxen in 'Awra Amba', in south Gonder of northern Ethiopia; while it is culturally forbidden for women to plow with oxen in central and southern Ethiopia. In some cultures, such as the Dawuro community of southern Ethiopia, a single woman can own land, but she is not allowed to cultivate it. Instead, if there is no adult male in her family that she can work with, she needs to ask non-family adult men to work the land in the form of sharecropping (Gebre et al., 2019). Gender roles related to the division of labor and decision-making in agriculture differ greatly in Ethiopia. As a result, women and men have different extension service needs. This variance in needs has not received sufficient attention by Ethiopian agricultural extension services and intervention programs. In addition to the gendered division of labor, other dimensions of gender, such as social networks, asset ownership, landholding, and access to extension services affect women's participation and decisions over agricultural technology adoption. Women in rural Ethiopia have limited access to and control over these resources. Female-headed households operate smaller farms than their male counterparts, and due to a combination of resource access disadvantages; they tend to harvest lower yields than male-headed households (Gebre et al., 2019; Aregu, et al., 2010).

There is a general imbalance between workloads and share in the benefits of production. Women work equally or more than men in the fruit and vegetable supply chains, but they rarely benefit from profits and have relatively low decision making power on earned income. Gender mainstreaming efforts in Ethiopia call for increased opportunities, profits and income for women in the food supply chain. There is a risk that the process of increasing commercialization may further marginalize women. Due to gender roles and barriers, women face the risk of being unable to control income from the limited range of commodities that they produce at present. These risks that comes with commercialization need to be understood, and as efforts to increase production and productivity are introduced — there is need to ensure that women enjoy the benefits of the gender specific interventions and improvements in the supply chains. Although both women and men benefit from improved technology availability and adoption, men tend to benefit more due their role as head of the household. The rate of technology uptake in Ethiopia varies between technologies and locations (Bekana, 2020). High and middle income households derive the most benefit from the introduction of new technologies (Assefa, et al., 2018; Aregu et al., 2010) while adoption among poorer households tends to be inhibited by an inability to afford the technology, coupled with the limited availability of credit or savings, and low level of awareness on emerging and relevant technologies. Generally, attention is required to ensure women and the lower income small holder farmers are neither left out nor disadvantaged by technological developments. Women's preferences for crop varieties differ from that of men (Gebre et al., 2019). Women opt to produce types or varieties that are mainly used for domestic consumption, whereas men prefer crop varieties which have high market demand and fetch high prices. Decisions about enterprise mix and technology adoption, including seed selection, are mainly taken by men and in some cases, are negotiated between husbands and wives (Geleta et al., 2017; Aregu et al., 2010).

The participation of men and women farmers in social and productive networks demonstrates the long-established adaptive and survival strategies created and sustained by the concerted effort and leadership of rural communities. Membership of such networks is often determined by gender, age, locality and religion. Men are more likely to belong to productive as well as social associations, whereas women tend to belong to a narrower range of associations reflecting their household and community roles. Involvement in labor-sharing, and revolving credit sharing women's associations is often based on wealth status and the capacity to contribute financially (Drucza et al., 2017; Aregu et al., 2010). The sources of agricultural and non-agricultural information accessed by rural communities generally depend on the household wealth and on gender differences. Men depend more on formal (community organized trainings from extension workers, electronic information services like TV, Radio and mobile phones) information sources, while women mostly exploit informal sources (word of mouth from social contacts and intergenerational cumulative knowledge) of information. Wealth status and gender differences also influence the kind of knowledge and sources of skill available to farmers. Male farmers access formal training sources to improve their skills and knowledge, even in areas where women provide the labor and do most of the value chain activities. The focus of extension services on men is based on the assumption that they will pass the knowledge acquired on to their wives and other family members (Geleta et al., 2017). However, in reality, this does not happen. Hence, women farmers usually have limited access to improved agricultural technologies and interventions promoted by the extension system. This constrains their access to various inputs and services, including knowledge of agriculture technologies limits their participation in market-oriented agricultural activities. This translates to loss in productive potential and not only impacts at the household level but results in cumulative losses in the overall national supply chains and their income potential (Bekana, 2020).

3 Selection of fruits and vegetables

3.1 Introduction

The fruit and vegetable sectors in Ethiopia are large and diverse. This variation is associated with differences in agro-climatic conditions. To focus the discussions with stakeholders and to identify leverage points for interventions in the food system to promote the production, trade and consumption of fruits and vegetables, it is important to focus on specific vegetables and fruits and associated production areas in Ethiopia. The following section explains the three vegetables and three fruits which were chosen to focus the interviews with key informants and focus group discussions.

3.2 Selection criteria

The selection of three fruits and three vegetables for narrowing down the focus group discussions and key informant interviews is based on quantitative and qualitative criteria including:

- Current production and related consumption of fruits and vegetables in Ethiopia: which crops are currently important in the local diet?
- Addressing fruit and vegetable groups associated with different nutrition and health outcomes (Appendix 3): fruits and vegetables are associated with different health outcomes. Current fruit and vegetable consumption may be biased to a few health outcomes only. Therefore, it is also important to consider fruits and vegetables that are not yet widely consumed, but potentially have other health outcomes.
- Possibilities for value addition (including sorting, processing, etc.): fruit and vegetable types differ in the extent of value addition. Do the selected fruits and vegetables allow for adding value?
- Gender inclusiveness: do the selected fruits and vegetables differ in the extent of gender inclusiveness? For example, extensive labor requirements may limit the involvement of women.
- Growth potential: do certain fruits and vegetables have market potential?
- Production corridors (Section 2.4): to avoid focusing on a limited number of production areas, do the selected fruits and vegetables have the potential to be produced in different agro-ecological zones?

Information on production and associated consumption has been derived from production statistics and the expert opinions of sector specialists have been used to assess the other criteria. In terms of area and production, cabbage and onion stand out in terms of area and production as vegetables, while mangos and avocados as fruits.[8]

3.3 Selected fruits and vegetables

Based on the specified criteria and expert opinions, the following six crops (that score differently on many of the identified criteria) were selected for this study:

- **Cabbage**, including head cabbage and Ethiopian cabbage: Ethiopian cabbage is particularly important as a hunger season crop as it is commonly available when there is a shortage of cereals and other major foods. As cabbage is the most important vegetable, it is grown in all production corridors of Ethiopia. It belongs to group 3 (Appendix 3), the cruciferous vegetables.
- **Tomato**: Onion and tomato are both in group 4, with limited health benefits (Appendix 3) and little difference in terms of gender inclusiveness. Options to add value are considered better for tomato than for onion. The Rift Valley and Tana are the most important production corridors for tomato.

[8] Banana is by far the most important fruit in Ethiopia, but the positive health outcomes of its consumption are limited. Green and red chilies and peppers are important crops (area and production wise), but they are considered spices in Ethiopia.

- **Carrot**: Carrot is (still) a minor vegetable in Ethiopia, but with a growing catering industry and the increasing prosperity of the local population consumption is expected to grow, offering opportunities to increase production. In addition, consumption of carrot is associated with well-defined health outcomes, placing it in group 2 of red, orange and yellow vegetables (Appendix 3). Carrot is mainly grown at the higher altitudes in the Rift Valley production corridors (Table 2.3).
- **Avocado**: Avocado is already one of the major fruits produced and consumed in Ethiopia, and it has good potential for expansion for both export and local consumption, and for value addition, for example, through oil extraction and juices. The Abaya and Tana corridors are important production areas. Avocado belongs to group 8, other fruits with limited health outcomes (Appendix 3).
- **Mango**: The production area for mango is similar to avocado and the opportunities for expansion are also similar, though options for value addition of mango are more in juice and dried produce. The Abaya corridor is an important production area for mango, which belongs to group 5, the red, orange and yellow fruits (Appendix 3).
- **Orange**: The production of citrus fruits, including oranges, is much smaller than for avocado and mango, but has a longer tradition and different health outcomes. It belongs to group 6, the citrus group, contributing to vitamin C intake (Appendix 3). Most orange production comes from commercial farms in the Rift valley.

Figure 3.1 shows the development in harvested area, yield and production of the six crops between 2009 and 2019 in Ethiopia. The fruit and vegetable production data shown in Figure 3.1 are based on FAOSTAT and refer to the rain-fed and irrigated production of crops harvested between September and February (CSA, 2019a). This data underlines the results of Figure 2.3, i.e., the recent production increase of fruits and vegetables has been based on an increase in harvested area. Except for cabbages, the yield of the other five crops declined in the last decade (Figure 3.1). Both in terms of harvested area and production volume, cabbage is the most important vegetable. Growth of the avocado area is largest and has almost quadrupled in the last 10 years, and the area cultivated with mango more than doubled in the same period. The areas under vegetable cultivation did not increase as rapidly as those of avocado and mango.

3.4 Role of fruits and vegetables in farming systems

Most of the selected fruits and vegetables in Ethiopia are produced by smallholders with mixed farming systems with land holdings of less than 2 ha. A small proportion of these smallholders have access to irrigation. Table 3.1 shows the total number of smallholders farming fruits and vegetables, based on data of the Central Statistical Agency (CSA, 2019b; Cochrane and Bekele, 2018), and our own estimate of smallholders with access to irrigation water. There is no systematically compiled statistical data available on the area under irrigation, only partial data is available from the Ministry of Agriculture. Different research indicates that the total percentage of irrigated land is approximately 2% of the national agricultural area. Based on information from the different bureaus and research estimates at aggregate level we estimate that only 3% of the 18 million smallholders farming fruits and vegetables have access to irrigation. Discussions with experts and farmers indicated that crop yields under irrigated conditions tend to be considerably higher. Therefore, the contribution of these irrigated smallholders could total 10-20% of the domestic fruit and vegetable production.

Table 3.1 *Estimated number of smallholders (in 1000s) with fruits and vegetables under rain-fed and irrigated production systems*

	Number of smallholders (rain-fed and irrigated)	Estimated number of irrigated smallholders	Estimated number of rain-fed smallholders
Fruits	6,966	208	6,757
Vegetables	10,983	329	10,653
Total	17,949	538	17,410

Source: CSA and authors' own estimates.

Table 3.2 shows the number of smallholders and the harvested area for the six targeted crops during the period September 2018 to February 2019 (CSA, 2019b). Obviously, farmers may produce more than one fruit and vegetable at the same time and produce vegetables outside this period for which no recent data is available. The area cultivated with fruits and vegetables per smallholder is often very small (<0.02 ha). In addition, Table 3.2 shows the harvested area of the six crops by *commercial* farms in the period September 2018 to February 2019. Although the number of commercial farm holdings is unknown, the cropped area of each fruit and vegetable gives an indication of the importance of commercial farm holdings in the national production of fruits and vegetables. A small proportion of the fruits and vegetables farmed in Ethiopia are produced by these commercial farms, and they only play a major role in the domestic supply of oranges (see Table 3.2).

From the focus group discussions, it is clear that irrigated production of tomato and other vegetables (e.g., onion) may be considerable outside the period September-February. Therefore, the number of smallholders and tomato area shown in Table 3.2 is an underestimation of the actual number of farmers involved and the total production area. Because cabbage and carrot are mainly produced under rain-fed conditions the data in Table 3.2 represents well the number of farmers and the total production area of both vegetables.

Table 3.2 *Number of smallholders and the cropped area of the six targeted fruits and vegetables in the Meher season 2018/19, including the area devoted to commercial farms*

Crop	Number of smallholders	Area (ha)	Commercial farm area (ha)
Cabbage a)	3,918,573	53,627	29
Tomato	195,984	4,322	1,662
Carrot	186,937	2,556	12
Avocado	1,909,095	19,759	217
Mango	1,589,983	19,498	2,624
Orange	606,142	5,417	2,270

a) Includes head cabbage and Ethiopian cabbage/kale.

Source: CSA (2020, 2019a).

The consumer survey carried out in this study confirmed the importance of avocado, mango and oranges. Over 90% of the respondents consumed one or more of one these three fruits. Vegetable consumption is more diverse, but about 75% of the respondents consumed (different types of) cabbages and tomatoes alone, or in combination with other vegetables.

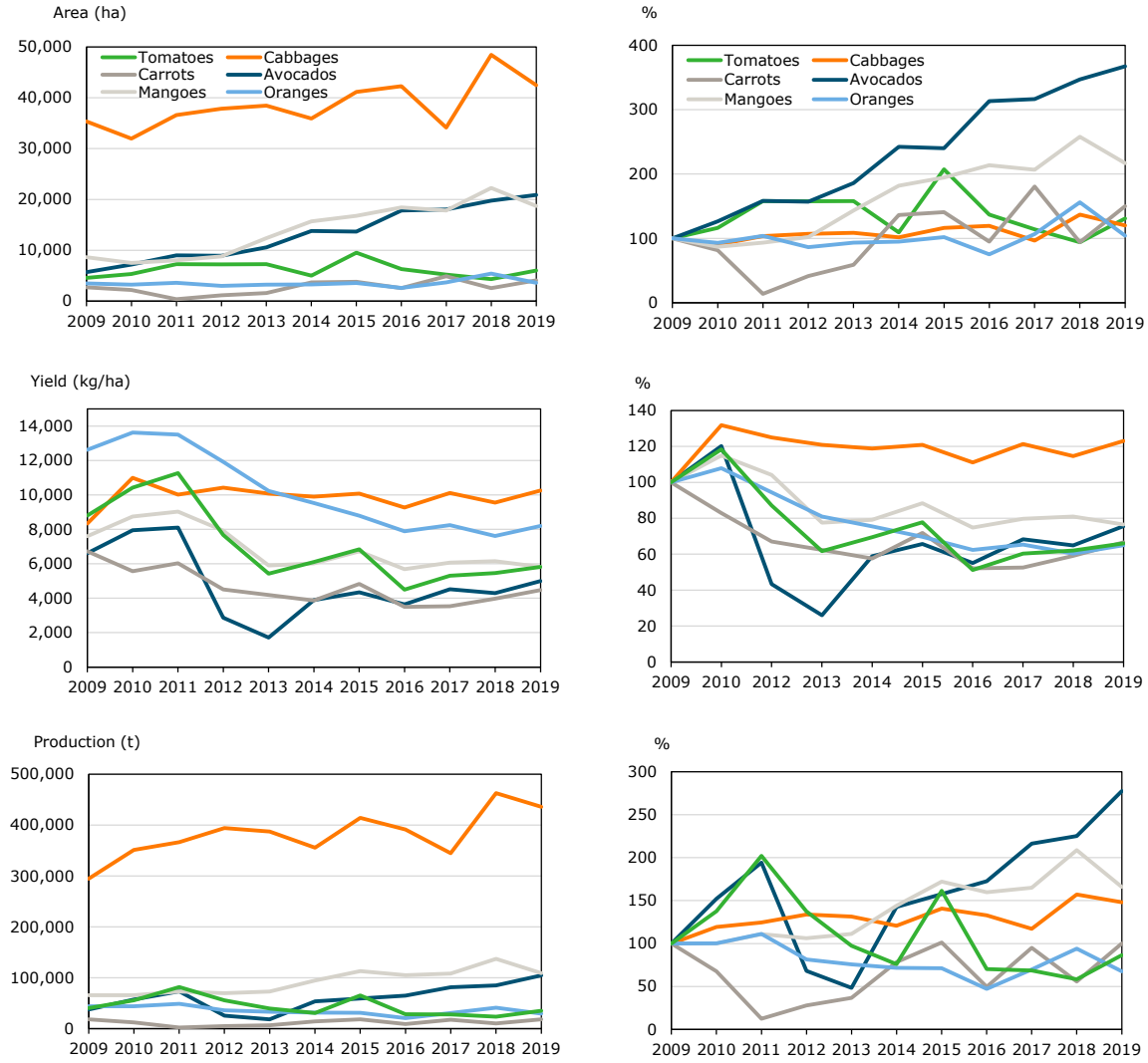


Figure 3.1 *Production statistics of the six selected crops. From top to bottom: the development in harvested area, yield, and production between 2009 and 2019 in Ethiopia. The figures on the right represent the relative change compared to 2009 (2009 = 100%)*
Source: FAOSTAT.

4 Introduction of the selected food supply systems

4.1 Description of actors

Fruit and vegetable producers

Special types of private sector actors are the producers of fruits and vegetables. The Central Statistical Office of Ethiopia distinguishes between (CSA, 2018): i) private agricultural holdings, including small privately owned agricultural holdings producing for self/family consumption and sometimes for sale; and ii) commercial farms, including state and private commercial farms, mainly established for the purpose of profit making by selling agricultural products at local market and/or abroad. The former category generates 95% of the annual gross national agricultural output. The commercial producers can further be classified as small, medium and large depending on farm size:

- Small-scale commercial farmers are small enterprises and business people, often living in urban areas, who lease land from local farmers to produce vegetables. This group of farmers are popular in the Rift Valley and Tana corridor. They mostly produce tomato, onion and cabbage. They use irrigation and operate during the dry season, when vegetable demand is high due to fasting season (Section 5.1.1). Different types of short-term lease and share cropping constructions exist.
- Medium scale commercial farmers are businesses who have their own land secured from the government. They deal with both fruits and vegetables. In many cases medium commercial farms have around 20-30 ha land, but generally the category includes farmers that have up to 100 ha land. Some of the major medium scale commercial farms in the production corridors are: Ethio-Veg Fru, Ethio-Admas, Mulualem Farm and Koga Veg.
- Large-scale commercial farmers are ones who cultivate over 100 ha. They mostly deal with fruits and some agro-processing. Large commercial farmers typically employ over 500 people. The Upper Awash Agro Industry, Africa Juice, Lucy Farm and Amibara Farm are some of the large-scale commercial farms actively operating in the target production corridors.

Farmer organizations

Farmer organizations include cooperatives and unions. Cooperatives are associations of farmers and unions are associations of cooperatives. Unions are larger and have more market power and more resources than cooperatives. They have three potential roles within the fruit and vegetable sector:

1. Input distribution: farmer cooperatives are the sole distributers of fertilizer. In some cases, they also distribute seed and agro-chemicals.
2. Output market: some unions are engaged in the marketing and distribution of fruits and vegetables. For example, Meki Batu union in the Rift Valley and Gamo Union in Abaya area manage a full marketing chain for locally produced products, which serve the domestic market, but also export to the Middle East and neighboring countries. Both Meki Batu and Gamo Union are planning to establish a processing facility within the coming three years.
3. Extension: cooperatives and unions provide extension services to their members. Though the majority of cooperatives and unions in Ethiopia are focused on cereals and major cash crops, such as coffee and oil seeds, some specialized cooperatives and unions play an active role in extension services for fruits and vegetables, such as Meki Batu, Gamo Union, Awash Olana and Merkeb.

Suppliers, processors and traders

There are several private sector actors engaged in the fruit and vegetable supply chain:

- Input suppliers: the private sector is the principal supplier of seed, chemicals and fertilizers (other than urea and Diammonium Phosphate - DAP). Within the input supply chain, a number of private sector actors operate from the import to the retailing of inputs.
- Seedling suppliers are relatively high-tech companies supplying vegetable seedlings to farmers. Currently, they are mainly found in the Rift Valley. There seems to be a shift in demand, from seed to seedling, by smallholder farmers for major vegetables such as tomato, pepper and cabbage. The main reason is reducing the risks of diseases at the seedling stage by buying seedlings rather than

seeds. The company Flora-Veg in Meki Batu, which has a branch at Bishoftu, is supplying farmers with seedlings throughout the country.
- Local collectors: these are local vegetable and fruit collectors, or agents for major buyers in Addis. They act as the main source of information between producers and the main buyers.
- Wholesalers distribute products to retail in major towns. They have agents or collectors in each of the major fruit and vegetable corridors.
- Retailers are fruit and vegetable shops in small towns and major cities. They are the primary outreach to the end consumer. Their number is in the thousands.
- Fruit and vegetable sellers at specialized markets in Addis Ababa. There are 10 major fruit and vegetable markets serving as distribution centers.
- Fresh juice and sala houses: these are small businesses that serve fruit and vegetable-based menus. They are often dominated by women. In some cases, they also retail fresh fruit and vegetables.
- Processing companies are businesses engaged in commercial processing. AfricaJuice, Horizon-Merti, Meaza Mango, Yemi Juice, Pregat Juice are some of the known companies operating in the country. The former two in particular are engaged in processing multiple products for mango, passion fruit, orange and tomato, whereas the others mostly process mango.

Development organizations

Various NGOs and multilateral organizations support actors in the fruit and vegetable supply chains. They provide a variety of services, including technical training and advice regarding physical inputs and marketing strategies. The role of NGOs is often limited to non-financial services because of restrictive government policies in this area. Details of important NGOs operating in the production corridors we visited, the type of work they support, and partners on the ground are highlighted in Table 4.1.

Public sector actors

- The Ministry of Agriculture has a leading role in the fruit and vegetable sector in Ethiopia. Recently, horticulture has been organized to have a separate state minister within the Ministry. The regional Bureaus of Agriculture play a critical role of executing extension services for horticulture. In the recent past, the national priority has been primarily focused on cereals, but the focus seems to be shifting to higher value products that also generate off-farm employment opportunities.
- The Agricultural Transformation Agency (ATA) is part of the Ministry of Agriculture, but a semi-autonomous government institution, developing strategies and system transition pathways. The horticulture sector is one of the priority areas for ATA. The cluster development strategy that advocates cluster and corridor development for inclusive transformation of smallholders is an important program of ATA, implemented by the Ministry.
- The national agricultural research system includes Ethiopian Universities, the Ethiopian Agricultural Research Institute and its regional aliases, such as Amhara Regional Research Institute, Oromia Regional Research Institute, South Agriculture Institute etc. These institutes, among others, are responsible for breeding and variety release.
- The Ethiopian Investment Commission is responsible for attracting commercial investment to the sector. Horticulture is a priority investment sector for Ethiopia. The Investment Commission primarily focuses on commercial farms, not on smallholders. All licensing, incentive packages and access to land facilitation are arranged by the Investment Commission and regional Investment Bureaus.

Table 4.3 *An overview of NGOs operating in the visited production corridors and the main characteristics of their work*

Development organization	Major intervention across the value chain	Focus area	Focus commodity	Partners
SNV Horti Life	Promote productivity using farmer field schools, support in market linkage and seed supply, and modernizing horticultural curricula of TVETs and universities.	Sector development via capacity building focused on input supply and knowledge and skills	All main fruits and vegetables	Ministry of Agriculture at all levels (regional, zonal, woreda) and private sector
IFDC-2SCALE	Promote market access and organizational capacity building for cooperatives and unions operating in the fruit and vegetable sector.	Marketing and organizational capacity building.	All fruit and vegetables, but focus on unions with high potential.	Meki Batu, Awash Olana, Gamo.
Agriterra	Organizational capacity building of unions and cooperatives.	Capacity building.	Selected sectors and unions with high potential.	Gamo Union and Meki Batu.
Bright Future In Agriculture	Capacity building for agricultural technical vocational schools in the horticulture sector.	Strengthening the quality of education and employability of Technical and Vocational Education and Training (TVET) graduates.	Fruits and vegetables.	Six TVET colleges in Amhara, Oromia and SNNPR regions.
ICIPE	Management of fruit disease and pests.	Production.	Mango.	Bureau of Agriculture.
Farm Africa	Farm tools and equipment and ripening for fruits.	Production.	Mango and banana.	Bureau of Agriculture.
GAIN	Improve handling and promote nutrition.	Handling and consumption.	Tomato.	Bureau of Agriculture and Meki Batu.
DFID-PEPE	Promote production of high value fruits and vegetables for processing and export. Support access to finance and market information.	Production, processing and marketing.	All fruits and vegetables.	Private sector enterprises.
Flying Swans	Handling and logistics focusing on export of fruits and vegetables.	Logistics.	All export fruits and vegetables.	Ethiopian Horticulture Producers and Exporters Association and Ethiopian Shipping and Logistics Enterprise.
FAO-UNIDO	Support agro-processing and industrial parks.	Processing, production.	Avocado, tomato, mango.	Industrial Park Corporation, Yirgalem, Bure and Bulbula Industrial Parks.
Vita	Improving production and productivity of mango with some support in market linkages.	Production.	Mango.	Bureau of Agriculture and Gamo Union.

Source: Authors' research.

4.2 The main supply chains

Figure 4.1 illustrates how supply chains of producers, distributors, and end markets of fruits and vegetables are currently organized in Ethiopia (Adugna et al., 2019; Emana et al., 2017; Shafi et al., 2014; Mahtafar and Graylee, 2013).

In general, smallholders' direct sales on local rural markets involves small quantities of fruits and vegetables (Figure 4.2). Women play an important role in the local marketing of fruits and vegetables produced in home gardens, but also in the local marketing of small quantities from commercial fields.

Another supply channel runs from farmers and cooperatives/unions to urban retail and regional export markets. Increasingly, unions have been trying to establish their own retail shops, but they face fierce competition and opposition from other powerful market players.

The most important channel supplying fruits and vegetables to domestic and regional consumers is through local brokers, also called assemblers, agents or collectors. They are the main link between smallholders and wholesalers. Brokers negotiate prices with farmers, and some do some sorting and grading. They often work on the consignment of wholesalers, who supply rural markets, urban retailers and regional markets in neighboring countries such as Sudan, Somalia and Kenya.

A few smallholders produce on a contract basis for commercial farms and domestic processors. Commercial farms mainly serve more demanding international export markets, such as in the Middle East and Europe. Commercial farms may process fruits and vegetables before exporting them (e.g., juice concentrates). Second grade fruits and vegetables are marketed domestically or regionally.

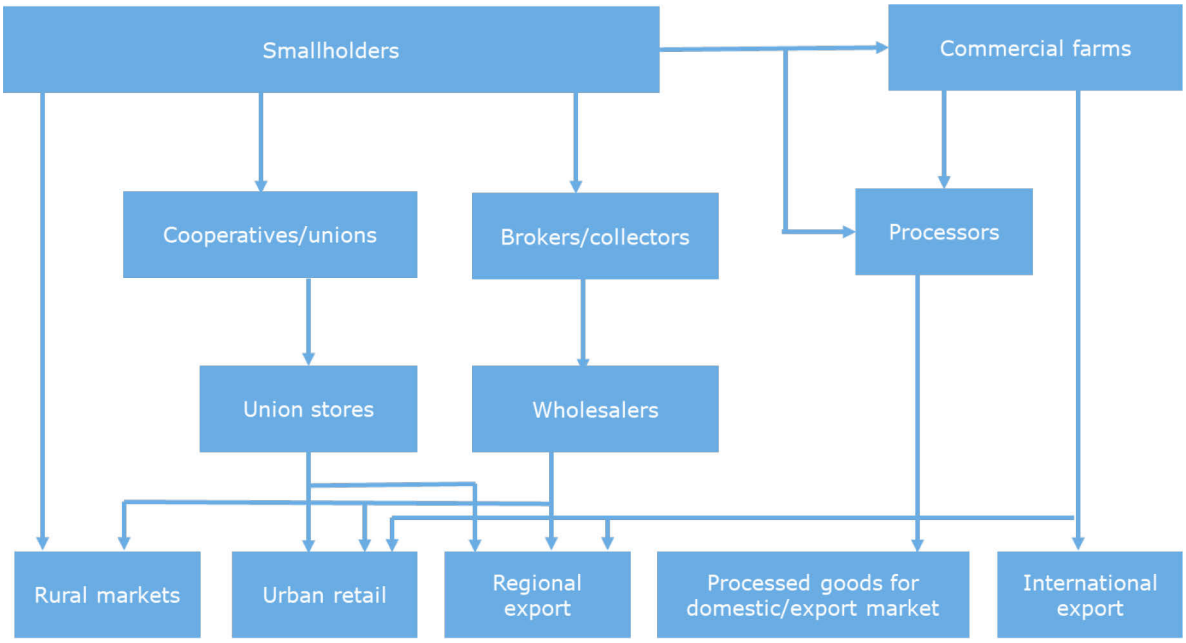


Figure 4.2 *Generalized supply chains of fruits and vegetables in Ethiopia*
Source: based on Mahtafar and Graylee (2013).

Figure 4.3 *Typical rural vegetable market in Ziway*
Photo credit: Huib Hengsdijk.

4.3 The enabling environment

Development of the agricultural sector has been a priority for the government of Ethiopia, as demonstrated in the succeeding development policy strategies PASDEP, GTP I and GTP II. The early 2021 launched 10-year economic development plan also underlines the agricultural sector as an engine for growth together with the industry. The plan, among other priorities, underlines its goal to achieve food self-sufficiency by expanding production frontiers into the lowland areas and intensifying highland production by scaling-up irrigation and water use efficiency. Fruits and vegetables are considered an important sector for local agro-processing and export, as well as for the local market. Many of the instruments employed by the government of Ethiopia to support the policy strategies have been targeted at attracting large scale foreign and domestic investors. Various financial, fiscal and other incentives have been made available by the government of Ethiopia and governments of regional states for investors, including 100% duty exemption for importing capital goods, a one-stop-shop service for licensing and registration, 4-5 year tax holidays, capital remittance, export incentives and enhanced access to finance (EKN, 2015). Fully foreign-based investors are expected to demonstrate a bank deposit of US$200,000 in an Ethiopian bank account. A minimum capital of US$150,000 is required if the investments are in partnership with domestic investors. The various investment incentives have attracted different investors, especially in the floriculture sector. As a result, Ethiopia has become the second largest exporter in Africa of fresh cut flowers, after Kenya, in less than 15 years. In addition, investors in the fruit and vegetable sector have entered the Ethiopian market, but at a smaller scale. Continuing foreign direct investment on the one hand and nurturing a home-grown economy model on the other hand has been the modified strategy launched by the current government.

The policy incentives aimed at smallholder farmers engaged in vegetable and fruit production are related to four intervention areas:

1. Input systems
All imported inputs (fertilizers, chemicals and seed) are free of import duty. Vegetable seed, agro-chemicals, sprayers, farm machineries and non-NPS and urea fertilizers are imported by the private sector and distributed without subsidy, except the tax exemption. Meanwhile, urea and DAP (NPS) are solely imported and distributed by the government on a subsidy basis. In addition, the government is offering fruit seedlings from nursery sites run by the local authorities in different places. While these seedlings are offered for free in Abaya corridor of SNNPR, the Tana and Rift Valley corridors of Oromia and Amhara regions, respectively, offer the fruit seedlings at a subsidized cost.

2. Extension services
The Ministry of Agriculture and its regional Bureaus of Agriculture provide extension services to smallholder farmers for free. While the major focus is still on cereals, pulses and oil seed, horticulture extension is improving. In all of the visited districts in the study corridors, horticulture experts were available to support smallholder farmers. In addition to these extension services, public organizations such as the ATA, Ethiopian Institute of Agricultural Research and Regional Agricultural Research Institutes are working on developing new crop varieties.

Box I: Integrated Agro-Industrial Parks

Based in part on the success of the Industrial Zone Development Programme for leather and textiles, the government of Ethiopia is currently spearheading the development of the Integrated Agro-Industrial Parks initiative to support the commercialization and transformation of the agricultural sector (Brasesco et al., 2019). Domestic agro-industrial development is considered important to decrease dependency on imported products, but also to drive the transition of traditional supply-led subsistence agriculture towards an organized, high-tech, safe and demand-led agriculture.

The government of Ethiopia has plans for 11 Agro-Industrial Parks, which are geographic clusters of independent firms grouped together to create economies of scale. The parks take advantage of opportunities for sharing infrastructure, bulk purchasing and selling, and providing coordinated training and extension services. The primary feature of Integrated Agro-Industrial Parks is the clustering of essential infrastructure, utilities and services required for business operations and growth. The government of Ethiopia is facilitating the initial infrastructural investments, while the private sector is expected to invest in developing new value chains.

One of the private sector partners has started processing organic avocado oil near Yirgalem in SNNPR. According the company's website, Sunvado now offers 30,000 smallholder farmers access to the international export market to boost their income (https://www.tradinorganic.com/global-operations/sunvado/). The company also set up an organic monitoring system with local farm cooperatives so that they could obtain organic certification.

3. Infrastructure
The Ethiopian government has heavily invested in developing infrastructure relevant for smallholder farmers, such as the development of irrigation schemes and construction of feeder roads, and even the building of cool storage in some places. Recently, the government of Ethiopia invested in the development of 11 Agro-Industrial Parks (of which four are currently operational) to add value to locally produced fruits and vegetables, for example, through avocado processing to extract oil (Box I).

4. Output systems
Though not very successful, the government provides support to farmers and farmer organizations to improve access to markets. Two of the unions within the study corridors have been provided a distribution spot in Addis Ababa, at one of the ten fruit and vegetable distribution centers. In addition, the government has been supporting a market linkage between Meki Batu Union and Ethiopian Airlines, which is a state-owned enterprise.

An overall complaint in most interviews and focus group discussions held with stakeholders in this study is the absence of the government as the coordinator, organizer and enforcer of existing

legislation in the fruit and vegetable sector. Over the last decade, responsibilities concerning the fruit and vegetable sector have been switching/split between different government offices. While the Ministry of Agriculture has always been responsible for smallholder production of fruits and vegetables, the now defunct Ethiopian Horticulture Agency and later the Ethiopian Investment Commission have been assigned to deal with the commercial horticulture sector. Just recently, the entire fruit and vegetable sector has been brought under the Ministry of Agriculture. Discussions with experts and informants indicated that the absence of a coherent fruit and vegetable sector strategy under one responsible government body has negatively affected the sector. In this regard, the recent re-organization of the sector under the Ministry of Agriculture seemed to be a positive step. However, two important concerns were highlighted by informants: (1) the extent to which new policies will maintain a balance between commercial and smallholder farmers; and (2) even though the sector is re-organized at state minister level — confirming the significance that the government attached to it — there are still ambiguities within the Ministry, with several overlapping roles that still reside in other departments. For example, post-harvest issues within the Ministry are addressed by three departments — horticulture, crop and mechanization.

Another issue addressed in the interviews and focus group discussions concerned the quality of the extension services offered. Extension services at the lowest administrative level (*kebele*) commonly consists of three staff, specialized in crop, natural resources and livestock. The crop specialists were traditionally heavily inclined towards cereals, pulses, and oil seeds. When it comes to natural resources, most of the efforts are related to land restoration and soil and water conservation with limited strategic prioritization of agro-forestry. Specialized fruit and vegetable extension staff are still rare, while most smallholder farmers have a limited track record when it comes to fruit and vegetable production.

The primary focus of the Ethiopian agricultural sector from the smallholder perspective has been on food security and to achieve food security, the top priority has been cereals. The significance of fruits and vegetables for both food and nutrition security has started to gain attention over the last decade. The Ethiopian Public Health National Strategy underlines dietary diversification and the importance of fruits and vegetables in the fight against stunting. However, coordinated promotion between the health and agricultural extension system, as well as among the different NGOs working in both sectors (health and agriculture), has been weak. In addition, government enforcement of prevailing rules and regulations, and promotion of fruit and vegetable consumption needs to be improved. Though recently, school feeding has become mandatory in selected areas, the inclusion of fruits and vegetables in school meals appears inconsistent.

The overall impression is that the government of Ethiopia is keen on investments in infrastructure related to the fruit and vegetable sector, but that the alignment and synergies of these investments with private sector parties, lower regional and local administrative levels, and between different sectors (e.g., the health and water sector) is weak. On the one hand, the government’s control and interventions do not encourage the participation of the private sector in supply chains and, in some instances, crowds out private investments. Poor alignment of public investments with lower administrative levels results in confusion about the operational responsibilities, maintenance of infrastructure and technical support to producers, etc. On the other hand, private actors do not want to get involved in what is perceived to be within the scope of government services. A general lack of an entrepreneurial approach translates into a tendency of supply chain actors to depend on external aid and support (Brasesco et al., 2019).

In Ethiopia, fruits and vegetables are mainly produced by smallholders, with only a few dedicated commercial farms. In general, yields are low and recent production growth is based on area expansion. Recent government policies pay more attention to smallholder fruit and vegetable farmers, but with a strong focus on infrastructure. The quality of extension services and supply chain coordination are the main constraints related to creating an enabling environment for the fruit and vegetable sector.

5 Validation of research questions

5.1 Fruit and vegetable production

In this section we present data and provide analyses contributing to the first leverage point that an increase in production leads to lower consumer prices of fruits of vegetables (Table 1.1). The underlying research questions are: how does seasonal variation affect fruit and vegetable production and prices? What are the main causes of on-farm losses? What options are available for farmers to increase production and what are the major constraints they face in doing so? What is the role of women in fruit and vegetable production and increasing current production?

5.1.1 Seasonal variation

The majority of Ethiopia has a bimodal rainfall pattern with a main rainy season roughly from June to October (*meher* season) and a minor rainy season from February to June (*belg* season). In highland regions, the *belg* and *meher* seasons tend to merge into one extended growing period. To avoid confusion between these two growing seasons, the Ethiopian *belg* crop season is officially defined as any crop harvested between March and August, while the *meher* crop season is defined as any crop harvested between September and February (CSA, 2018). Thanks to the favorable temperature conditions, the availability of irrigation water allows farmers to produce year-round in most parts of Ethiopia, including in the dry season from October to February. However, night frost may limit fruit and vegetable production in highland areas during certain periods of the year. In fact, small farmers with access to irrigation water prefer to grow vegetables in the dry season because of the lower fungal disease pressure and higher solar radiation resulting in higher crop yields (Brasesco et al., 2019; Emana et al., 2017). These farmers use their land in the *meher* season to grow a staple crop for subsistence purposes, and to grow one or two irrigated vegetable crops in the rest of the year. Some irrigation farmers adapt the growing season for vegetables to meet the increased market demand for vegetables during religious holiday periods, such as Ramadan and the main Orthodox Christian fasting season in April (Emana et al., 2015). The availability of irrigation water allows farmers to spread production over a longer period through staggered planting. However, periods with overproduction and periods with low supply are still common under irrigated production conditions, according focus group discussions with stakeholders in Bahir Dar. The availability of perennials is more linked to the rainy and dry season as flowering and thus production of most fruits is triggered by dry and rainy periods.

Hirvonen et al. (2015) studied the monthly food price changes in rural and urban regions in Ethiopia based on data from consumer price surveys collected by Ethiopia's Central Statistical Agency between 2002 and 2010. In general, the price changes over the year in both rural and urban regions reflect the seasonality of production: food prices are lowest between November and February when *Meher* crops are harvested (Figure 4.3). Prices were highest during the months when less food is available, roughly between April and August. A sharp price hike is observed in September corresponding with Ethiopian New Year and Orthodox Christian religious festivities (*Meskel*). Furthermore, price changes are more pronounced in urban areas than in rural areas, indicating that trade is not able to balance changes in supply and demand. This data is relatively old and refers to food prices in general, not specifically to fruit and vegetable prices. In the last decade, the production of staple crops has increased dramatically through higher yields (Figure 2.2), which may dampen food price fluctuations. In addition, the vegetable supply may have become more evenly distributed over the year because of the increased production of vegetables under irrigated conditions. Still, price fluctuations, associated with mismatches between supply and demand, holidays and the religious festivities, will occur throughout the year.

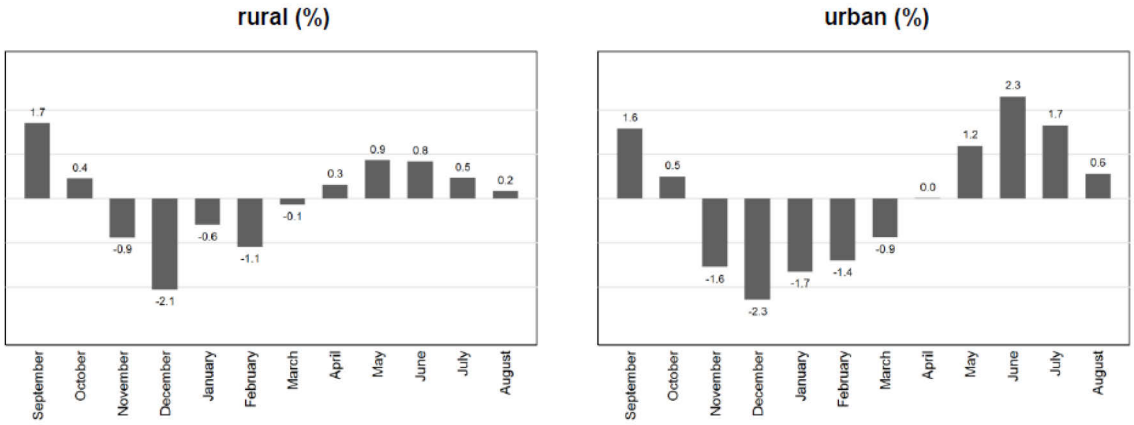
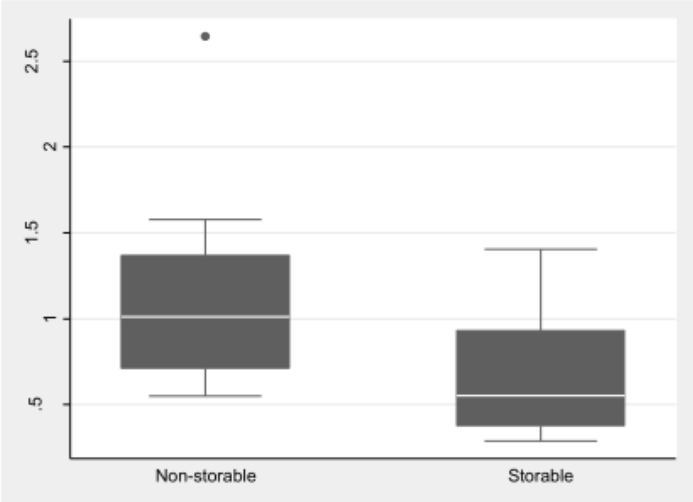


Figure 5.1 *Monthly food price changes in rural (left panel) and urban regions in Ethiopia, expressed as the percentage difference from annual average*
Source: Hirvonen et al. (2015).

Mahtafar and Graylee (2013) studied seasonal price fluctuations of fruits and vegetables and compared the monthly price volatility of perishable vegetables (that must be sold within 7 days after harvesting such as tomato, kale, and peppers) *vs* less perishable vegetables (e.g., potato and onion) in Ethiopia between 2007 and 2012 (Figure 5.2). Seasonal price fluctuations of some vegetables were associated with poor supply planning and anticipation of demand across seasons. For example, higher tomato prices in October/November were related to low levels of planting during the rainy season due to the prioritization of other crops. Furthermore, Mahtafar and Graylee (2013) showed that the standard deviation of average monthly prices for perishable fruits and vegetables was significantly larger than for less perishable crops. This suggests that perishable crops are subject to higher price volatility, indicating that increased storage for perishable crops (i.e., cold storage) could reduce price volatility. In short, poor supply planning to anticipate demand across seasons and perishability determine price fluctuations of fruits and vegetables.



	Mean Std dev of monthly prices
Storable crops	0.6761
Non-storable crops	1.1267

*Significant diff at 10% level

Figure 5.2 *Standard deviation of monthly prices (ETB/kg) for perishable (non-storable) vs. non-perishable (storable) crops 2007-2012*
Source: Mahtafar and Graylee, 2013.

In our consumer survey, 88% and 82% of the respondents indicated that prices of fruits and vegetables, respectively, show seasonal fluctuations. Seasonality was the second largest factor, after price, that affects the consumption of fruits and vegetables according to the survey results (Section 5.10.1).

During the field visits, we also collected information on product prices in peak and lean seasons. Table 5.1 shows the variation in prices between the lean and peak season of selected fruits and vegetables at a wholesalers' market in Addis Ababa. Carrot and orange show the largest seasonal variation because they are produced in relatively narrow agro-ecological niches, under rain-fed conditions, compared to the other fruits and vegetables, which are produced under a broader range of agro-ecologies, including irrigated conditions (e.g., tomato). The broader range of agro-ecologies for some vegetables results in less seasonal supply peaks and shortages. In addition, both tomato and cabbage are major components in the local diet, resulting in year-round stable consumer demand that producers anticipate. The effect of a stable demand and supply is a low variation in prices at wholesale level.

Table 5.1 *Price differences during the lean and peak seasons of selected fruits and vegetables at wholesale level*

Commodity	Tomato	Kale	Head cabbage	Carrot	Orange	Mango	Avocado
Peak season (ETB per kg)	12	18	13	20	40	15	20
Lean season (ETB per kg)	22	30	20	45	90	27	35
Variation (%)	83	67	54	125	125	80	75

Source: Authors' research.

5.1.2 Options to increase fruit and vegetable production

Farmers have four options to increase fruit and vegetable production:
1. Expand the cropping area;
2. Increase the production frequency, i.e., increase the number of growing seasons per year;
3. Increase productivity, i.e., increase the production per unit of area and time; and
4. Reduce farm losses.

1. Expansion of the cropping area
In Ethiopia, land is owned by the state and cannot be sold or held as collateral for bank loans. In this situation, smallholders only have land use rights to plots, which are organized at the local level. This set up ensures farmers have the right to use the land indefinitely, lease it out for a maximum of three years to other farmers, and transfer it to their children, but they cannot sell it permanently or mortgage it (Brasesco et al., 2019). This is particularly relevant for perennial fruits that have a long-term return on investment and require security of land rights. For vegetables, there are cases in which young entrepreneurs and relatively economically strong farmers lease plots on a 3-year term. This practice is very common in the three production corridors visited for this study. In general, structural redistribution of land is restricted, access to new productive land is therefore almost non-existent. As a result, land holdings become smaller as the rural population grows and existing land is redistributed among family members. Exceptions are only made for large scale agricultural investor, for whom long-term lease constructions are available. Expansion of land to increase production is therefore limited for smallholders.

2. Increasing production frequency
Increasing the production of vegetables through increasing the cropping frequency is only possible if farmers have access to irrigation water. Awulachew (2010) estimated the total irrigable land potential in Ethiopia at 5.3 million ha, while the available irrigated area was about 640,000 ha across the country (Awulachew, 2010; Figure 5.3). This was a crude estimate and the irrigated area has increased since then, hence the untapped irrigation potential in Ethiopia is uncertain.

During the field interviews for this study three important remarks were made by the key informants concerning the irrigation potential. Firstly, the government has recently shifted its attention to rehabilitate and scale-up irrigation schemes targeting cereals such as wheat and agro-forestry. Secondly, in places where water is extracted for irrigation the competition for water is increasing. In many places, irrigation farmers reported limited water access during at least part of the growing season. This can be caused by poor water management, as well as by dropping groundwater and lake levels when they are over-exploited (Eshete et al., 2020; Getnet et al., 2014). Thirdly, despite significant investment in reforestation among other through the national campaign to plant billions of trees, many water bodies have been seriously affected by land degradation (Eshete et al., 2020).

Furthermore, recent expansion of the irrigated area has not been well aligned with the need to train farmers in using irrigation water effectively for producing high value vegetables and fruits. Farmers' lack of skills and knowledge in this regard has resulted in disappointments, neglect of the irrigation infrastructure, overuse and inefficient use of other production inputs, and the overall sub-optimal use of irrigation water for producing fruits and vegetables (Eshete et al., 2020; Etissa et al., 2014; van Halsema et al., 2011). Inappropriate use of agro-chemical inputs has increased the concern of water pollution, as raised in our focus group discussions and in cases reported in the literature (Loha et al., 2020; Mengistie et al., 2017; Teklu et al., 2016).

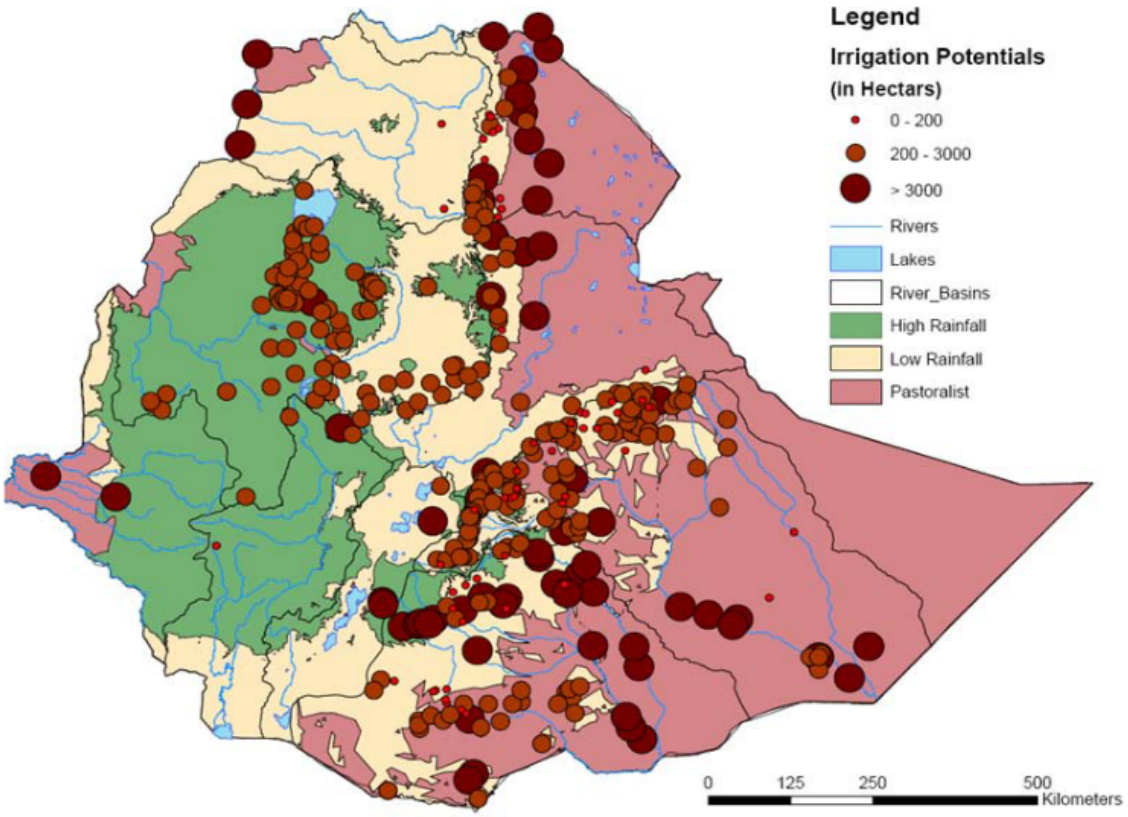


Figure 5.3 *Irrigation potential across Ethiopia*
Source: Awulachew (2010).

3. Increasing crop productivity

Increasing the productivity (yields) of fruits and vegetables implies producing more on the same plot within the same period. Increasing the crop yields depends on the availability and quality of inputs and the skills of farmers to apply these inputs efficiently and effectively. Average yields of both fruits and vegetables have decreased in the last decade (Figure 2.2), suggesting that both inputs and the knowledge and skills of farmers are constraining productivity increases.

To assess the potential for increasing vegetable and fruit yields in Ethiopia it is helpful to look at the yield gap of specific crops. The yield gap is the difference between the yield potential (Yp) without limitations due to water or other abiotic and biotic stresses (the most relevant benchmark for irrigated systems), and actual crop yields (Ya). Eco-physiological crop simulation models are commonly used to estimate Yp.[9] Because such models are lacking for fruits and vegetables, or not parametrized for the prevailing conditions in Ethiopia, we use yields obtained under experimental research conditions in Ethiopia as benchmark for Yp. Based on FAOSTAT, Beshir and Nishikawa (2012), Tabor and Yesuf (2012) and Gebre (2007), Figure 5.4 shows the actual yields and yields obtained under experimental research conditions in Ethiopia for major fruits and vegetables, except cabbage. Figure 5.4 suggests that the relative yield gap (i.e., (Yp – Ya) / Yp * 100%) is >79%. Locally in Ethiopia, the relative yield gaps will be larger or smaller because Ya and Yp differ from those shown in Figure 5.4. For example, de Putter et al. (2012) showed that average irrigated yields of tomato and onion were 25.5 t/ha and 21.7 t/ha, respectively, in a sample of smallholders in the Rift Valley. In other situations, Yp may be higher than the results of the experiments shown in Figure 5.4. The stagnant and decreasing yields of fruits and vegetables at national level (Figure 2.2) suggest that the yield gaps shown in Figure 5.4 are generally in the right order of magnitude. More research is needed to actualize the information and to allow more location-specific and seasonal-specific conclusions on the size of existing yield gaps.

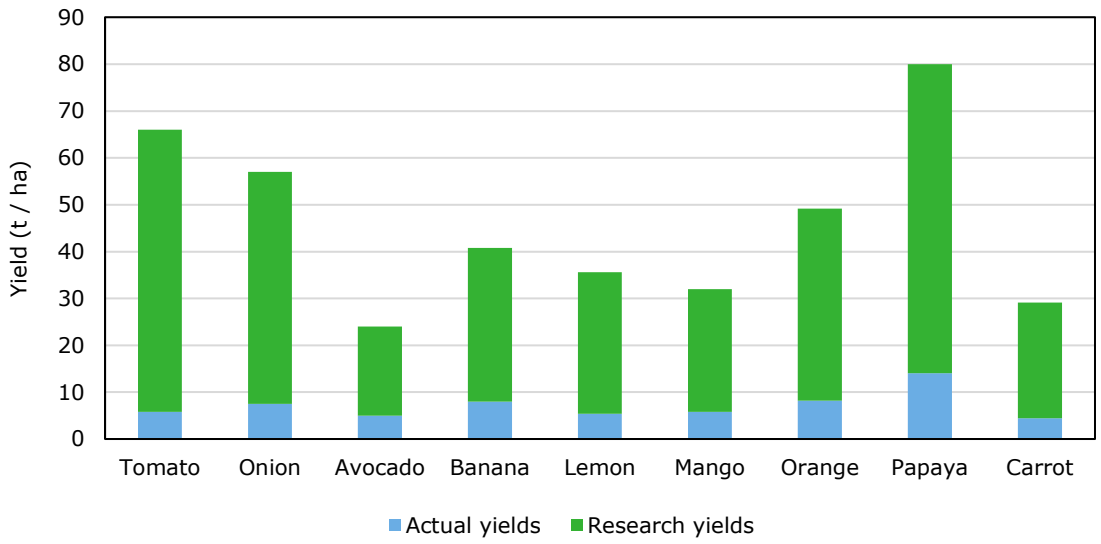


Figure 5.4 *Actual yields and yields obtained under experimental research conditions in Ethiopia for a selection of fruits and vegetables*
Source: FAOSTAT; Beshir and Nishikawa (2012); Tabor and Yesuf (2012); Gebre (2007).

4. Reduce on-farm losses
In general, it is accepted that post-harvest losses are larger at the producer end than the consumer end in low and middle income countries (Hodges et al., 2010; Parfitt et al., 2010). Available information from Ethiopia indeed suggests that pre-harvest, harvest and post-harvest practices are sub-optimal and result in considerable on-farm losses, as well as losses further on in the chain due to the reduced shelf-life of fruits and vegetables (e.g., Bereda, 2016; Emana et al., 2017). Section 5.1.4 describes in more detail the losses that happen in different crops and stages on the farm.

5.1.3 The main barriers to increased production

The realization of each of the four options to increase production of fruits and vegetables is hindered by various barriers at different stages in the food system. Based on information from the literature and interviews carried out in this study, the barriers have been grouped into constraints rooted in the enabling policy environment, input systems, production systems and market system (Figure 5.5). The shown barriers in Figure 5.5 are interrelated — a barrier at one level or component in the food system

[9] Global Yield Gap Atlas (2021), Global Yield Gap Atlas. Available at: www.yieldgap.org (Accessed: 16 March 2021).

can only be broken down effectively when related barriers at other levels are also addressed simultaneously. For example, the poor quality of fruit or vegetables in the market systems can be caused by the poor control of pests and diseases during production. The insufficient control of pests and diseases during production may be caused because appropriate pesticides are not available. Finally, the low availability of pesticides may be the result of bureaucratic and lengthy registration processes for new pesticides in the enabling environment. As this example shows, different actors need to play a role to remove barriers, each with their own responsibilities and operational space. This makes it difficult to arrive at integrated solutions to effectively remove barriers to increased fruit and vegetable production.

Based on interviews with farmers, the most important production constraint is the limited access to inputs, followed by poor access to finance and water. For female-headed households, the major constraint is poor access to land, followed by limited access to finance and inputs.

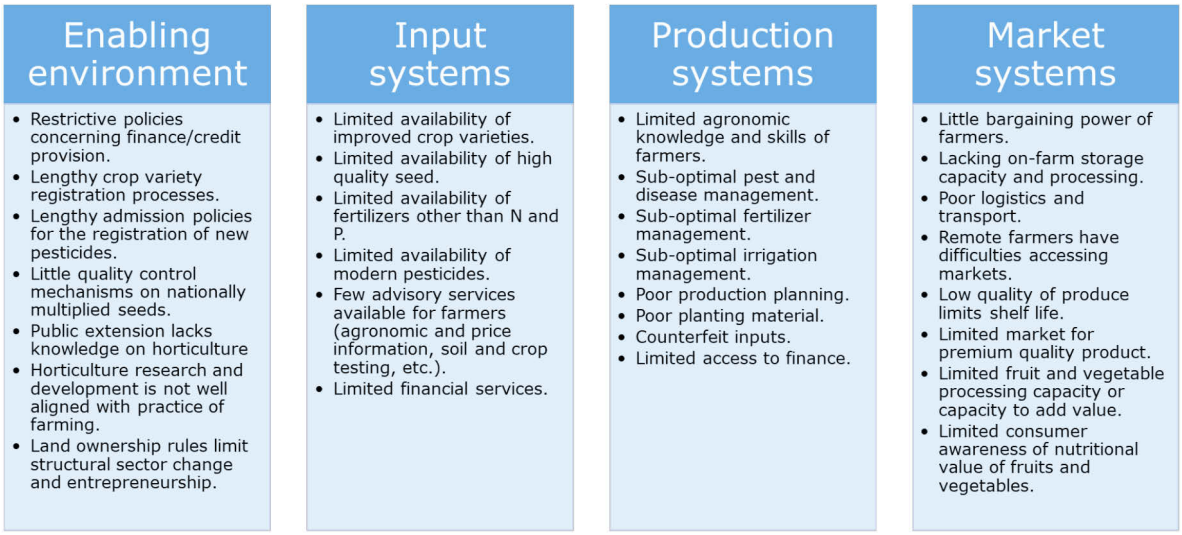


Figure 5.5 *Major barriers to increasing fruit and vegetable production in Ethiopia, categorized according to constraints arising from the enabling environment, input systems, production systems and market systems*
Source: Authors' research.

5.1.4 On-farm losses

No quantitative information is available on the currently incurred *pre*-harvest production losses. However, Figure 5.4 gives an indication of the production potential of various fruits and vegetables that are currently not achieved due to the use of poor planting material, sub-optimal input use, pests and diseases and overall poor crop management. The literature on post-harvest losses mainly focuses on losses happening during harvesting and processes further on in the supply chain. For example, FAO (2011) estimated losses during the harvesting operations of fruits and vegetables in sub-Saharan Africa at 10%, and losses due to handling, storage and transportation between the farm and distribution at 9%. Larger off-farm losses were estimated for processing and packaging at 25% and distribution at 17%. Though these losses happen off-farm, there are indications that a major cause of such losses is poor product quality due to production practices, including the harvest and post-harvest management practices of farmers (Bereda, 2016; Brasesco et al., 2019; Emana et al., 2017; Hussen and Yimer, 2013; Yigzaw et al., 2016) Various stakeholders engaged in the focus group discussions and informant interviews in our study confirmed that in many cases poor product quality at the farm level is a root cause of losses faced in other stages of the supply chain. Section 5.3.3 describes in more detail the losses further along the supply chain. Here, we focus on the losses that happen before the products leave the farm gate.

Emana et al. (2017) examined pre- and post-harvest losses in the tomato supply in the Rift Valley and found that 3.7% of harvested tomatoes (on a fresh weight basis) were physically damaged, damaged by pests and diseases, wilted, or damaged due to deformity or color. The authors did not measure the amount of tomatoes that were not harvested and left in the field because of these and other damages. The major cause of damages after harvest was due to pest and diseases, which accounted for 26% and 25% of all observed damages, respectively. Not surprisingly, 61% of the respondent farmers classified pests and diseases as a major reason for production loss. More surprisingly, 55% of the farmers indicated that the harvest process itself was a major reason for losses. This may be related to poor selection of harvested produce (over-mature, rough handling, non-selective picking, etc.) and the use of large wooden crates to transport the produce from the field to the farm. The average weight of crates filled with tomatoes is over 60 kg, which increases the risk of physical damage of the produce during transport, especially considering the quality of the unpaved roads in rural production areas (Abera et al., 2020; Figure 5.6).

Figure 5.6 *Tomatoes in wooden crates near the border of the harvested plot*
Photo credit: Yared Sertse.

Avocado farmers in the Rift Valley also indicated major losses during harvesting (Bereda, 2016). A common harvesting method of these farmers is to shake the trees or branches so that fruits drop on the ground. Obviously, this method results in a high percentage of physically damaged fruits and a large percentage of immature fruits that cannot be sold. Over 47% of the harvested fruits could be unmarketable using this harvesting technique. Lower harvesting losses were observed when harvesters took the time to climb the trees and collect the fruits, but still 28% of the harvest was unmarketable. The lowest harvesting losses were observed using picking poles (<10% loss), but this is not common practice. Furthermore, packing and transporting the harvested avocado fruits in fertilizer bags and baskets, which is common, increases physical and brushing damage after harvest. These practices have been confirmed in focus group discussions with avocado and mango farmers in the Rift Valley. The estimated post-harvest losses by farmers ranged from 10% for avocado and 25-50% for mango, which is often harvested in the same way as avocado. The main underlying reason for

the applied harvesting method of shaking trees and branches is the use of local avocado and mango tree varieties that get 15-20 m tall, which makes hand picking impossible. Mango farmers in the focus group discussions mentioned that post-harvest losses in the new and shorter apple mango tree variety are much lower because harvesting is easier. Another disadvantage of the local avocado and mango varieties is that they are prone to pests and diseases. Hardly any of the mango and avocado farmers in the focus group discussions used pesticides to control pests and diseases. In the focus group discussion with mango farmers, white scale was mentioned as the most prevalent disease, which has a devastating effect on the sector as no preventive or curative pesticides are available.

5.1.5 Increasing production by women

Women's participation in the fruit and vegetable supply chain can broadly be categorized into to four stages: pre-production, production, marketing and consumption. The pre-production stage involves making decisions about what kinds of fruits and vegetables to plant, the plot size and the purpose of the fruit and vegetable production (i.e., for home consumption or market). In most of the focus group discussions and interviews with informants, the common practice was that men initiated and steered production decisions for bigger sized plots (>0.25 ha), which are often used to produce crops for the market. Women usually lead decisions for smaller sized home garden production that mostly is used for home consumption and petty trading.

Based on farmer interviews and field observations, the contribution of men and women to different production activities has been assessed for each crop (Table 5.2; Figure 5.7). However, the labor division between men and women may differ locally. For example, while most of the workers at the seedling nursery site in Tana area were women, there were a significant number of men at a fruit nursery site in Abaya area. Likewise, while farmers in the Rift Valley prefer women's labor for tomato trellis, in Abaya there was a preference for men's labor. Similarly, in the Abaya corridor most of the trees are tall and hence require climbing, which is done by men; whereas the avocado trees in the Tana area are a dwarf type and as a result, women actively participate in the harvesting. This demonstrates that even the crop variety may determine the gender roles in production tasks.

Table 5.2 *The role of men and women in the field operations of six crops based on interviews and field observations*

Farm activity	Tomato	Cabbage	Carrot	Mango	Avocado	Orange
Tilling/ploughing	Men	Men	Men	Men	Men	Men
Seedling	Both	Women	Men	Women	Women	Women
Planting	Women	Women	Women	Women	Women	Women
Weeding	Men	Women	Women			
Spraying	Men	Men	Men	Men	Men	Men
Trellis	Women/men					
Harvesting	Men	Women	Women	Men	Men	Men
Overall farm management	Both	Women	Both	Women	Women	Women

Source: Authors' research.

In relation to the marketing and consumption decisions, the volume of production is often the determining factor. In smaller quantity sales, women are in charge and informants noted that the men rarely ask for sales income. For larger quantity sales, men decide when to harvest and to bring the product to the market. In most cases, savings from sales of large quantities of fruits and vegetables are deposited in the men's account though there are cases in Abaya corridor where both family heads have a joint saving account. Most of the informants, including the women only focus group, indicated that though income is saved in the men's account, women have access to the money when needed for the family. Informants indicated that consumption decisions regarding how much to keep for the household, and what to eat when, are primarily made by women.

Figure 5.7 *Typical division of labor tasks between men and women in the field: women transplant the onion seedlings and the men supervise and control the irrigation*
Photo credit: Huib Hengsdijk.

As can be seen in Table 5.2, there are several barriers to women's participation in the production of fruits and vegetables. First, land preparation, mostly done with an oxen plough, requires physical labor that is more challenging for women than men. Promoting small semi-automated tractors for soil tillage may help women to engage more in field preparation operations. Second, most of the existing fruit trees are tall and pruning and harvesting operations require climbing 7-10 m trees. The development of innovative harvesting tools, as well as promotion of improved smaller fruit varieties like the Hass Avocado may enhance women's participation in fruit harvesting. Likewise, field activities such as weeding require physical labor — innovative, less heavy weeding tools and/or herbicides can help women to engage more in this activity.

The development of family extension programs, i.e. agriculture and nutrition extension services provided to household based farms, to enhance women's participation in key decision making in relation to production, harvesting, marketing and financial savings management of larger volumes of fruits and vegetables is something that can be considered. Though Ethiopia has made progress at the national level towards gender inclusiveness with 50% of ministerial positions and the house of people's representatives occupied by women; at the household level, major steps are still required to achieve gender equity. Systemic interventions that duly account for the socio-cultural make-up of Ethiopian societies are important to make such steps. Examples of this include establishment of women groups, active engagement of women in extension service community meetings, promoting the participation of women in farmer cooperatives, reducing gender bias in the provision of extension services and promoting increased access and control of profits by women in the household.

Women's participation in the fruit and vegetable supply chain has various implications for pre-production, production, marketing and consumption. A gender analysis of these value chains shows that women's and men's roles in a household are divided by tasks. Women undertake processing, seedling raising and community activities as an extension of their reproductive roles. This household

labor is unpaid and carried out together with household care roles. Women's overall participation in fruit and vegetable value chains is labor intensive, with relatively lower access to, and control over household resources and profits from fruit and vegetable agribusinesses. Women play an important role in sustaining the fruit and vegetable value chain, from early planting to marketing. However, they face barriers which inhibit the extent of their adoption of intensification practices aimed at increasing production, profits and nutrition security. To improve women's adoption of and benefit from intensification strategies, there should be gender focused interventions. These interventions should support, encourage and give priority to increasing the production, processing and marketing of agricultural products and minimizing differences among women and men.

5.2 Cost price and net returns of vegetable production

This Section addresses leverage point two: a reduction of the cost price will make the production of fruits and vegetables more profitable for farmers (Table 1.1). Underlying research questions include: What are the current production costs of fruits and vegetables? What are the most important cost components, and what is the impact on farmers' income if prices of fruits and vegetables drop?

5.2.1 Cost and returns of producing vegetables

Obtaining reliable data on the costs and benefits of production for the targeted fruits and vegetables in focus group discussions and interviews was difficult because farmers do not keep a record of production costs and returns systematically. Therefore, we first discuss the results of two studies that collected detailed information on the production costs and revenues of smallholder onion and tomato production. Subsequently, we supplement this information with qualitative and quantitative information collected in interviews for this study. We focus on vegetables as reporting on the costs and returns of perennial fruits is even more complex, especially during the first years after planting when trees have not yet reached full production.

Based on the findings of Beshir and Nishikawa (2012) and de Putter et al. (2012), the costs and returns of irrigated onion and tomato production are quantified (Table 5.3).[10] In both studies, family labor is valued against prevailing market prices for hired labor to improve the consistency in data and to allow comparison. Data from both studies is from the Rift Valley, where vegetable farmers achieve higher crop yields than the national average yields of onion and tomato. Average plot size varied between 0.25 ha and 0.5 ha in both studies.

Both studies show similarities, especially with regards to onion production costs. Labor is the most significant cost component, at about 40% of all costs. High yields are associated with relatively high external input levels in both studies, up to 45% of expenditure was on fertilizers, crop protection agents and irrigation. The returns on investment (i.e., gross revenue/total costs) of onion in both studies is about 3.1. The tomato data also shows similarities, but Beshir's and Nishikawa's (2012) data lacks the labor costs, resulting in 50% lower total costs compared to de Putter et al. (2012). The average returns on investment of tomato in both studies is about 2.4.

In this example, the cost price, i.e., the cost per unit of produce, is about 2.5 ETB/kg for onion, and less than 2 ETB/kg for tomato. The latter is an underestimation given the incomplete data of Beshir and Nishikawa (2012), see before.

[10] Gross returns = marketable yield times average market price obtained by farmers. Net returns = gross returns minus the production costs as specified in Table 5.3. Costs for land are not included in either study.

Table 5.3 *Production costs and returns of irrigated smallholder onion and tomato farmers in the Rift Valley. US$1≈ ETB17.4 (2012). Cost components are also expressed as a percentage of the total costs. Data from Beshir and Nishikawa (2012) is from 2009 and has been adapted for the price level of 2012*

	Onion				Tomato			
	(de Putter et al., 2012)		(Beshir and Nishikawa, 2012)		(de Putter et al., 2012)		(Beshir and Nishikawa, 2012)	
Costs:	**n=17**		**n=35**		**n=20**		**n=34**	
Seed/seedling (ETB/ha)	6,353	12%	4,442	9%	2,134	4%	3,254	14%
Fertilizers (ETB/ha)	8,245	16%	6,278	13%	6,612	14%	6,250	27%
Crop protection (ETB/ha)	7,779	15%	4,716	10%	9,144	19%	3,643	16%
Irrigation (energy) (ETB/ha)	7,215	14%	5,263	11%	7,595	16%	4,212	18%
Other (ETB/ha)	1,655	3%	6,206	13%	6,348	13%	6,113	26%
Labor (ETB/ha)	20,942	38%	20,354	43%	16,720	34%	a)	
Total costs (ETB/ha)	52,189	100%	47,261	100%	48,553	100%	23,472	100%
Marketable yield (kg/ha)	20,429		19,600		24,350		20130	
Farm gate price (ETB/kg)	7.7		7.7		4.1		3.3	
Cost per kg of produce (ETB/kg)	2.6		2.4		2.0		1.2	
Gross revenue (ETB/ha)	157,303		151,704		99,835		66,308	
Net revenue (ETB/ha)	105,114		104,443		51,282		42,836	

a) Data is missing.

Source: Based on Beshir and Nishikawa (2012) and de Putter et al. (2012).

The data in Table 5.3 is illustrative of the costs and returns of vegetable production under irrigated conditions. However, in practice costs differ greatly among farmers, depending on crop management and local conditions, which determine both the costs and returns of production. For example, whether farmers use their own seedlings or purchase seedlings, weather conditions, disease and pest pressure during the season, and the skills of farmers in effectively applying inputs all affect the costs and returns of crop production. As a result, the production costs (and net returns) have extremely large standard deviations. For example, while average production costs of tomatoes were ETB48,553/ha, minimum and maximum costs of 20 farmers varied between ETB15,835/ha and BDT149,080/ha, respectively (de Putter et al., 2012). The magnitude of the production costs gives a basis for assessing the risks that vegetable farmers face compared to cereal farmers (Section 5.6.1).

Information from the focus group discussions and interviews confirms many of the implications of the data in Table 5.3. However, both studies did not account for the costs of land and land preparation. Farmers indicated that the costs of land (in the case of land leasing) and land preparation are considerable, accounting for up to 15% of the total incurred costs for producing cabbage. For land preparation, most farmers still use oxen, except in the Rift Valley, where mechanized tillage has been introduced. According to farmers, this technology is twice as expensive as oxen ploughing, but it is labor-saving. This is especially relevant in the Rift Valley, where hired labor is more common than in the Tana and Abaya corridors. Labor scarcity may increase the transition to mechanized field preparation.

Of the six vegetables and fruits addressed in this study, tomato was the most labor intensive, followed by cabbage and carrot, according to farmers. The peak labor requirements in fruit production are during the planting and during harvesting (when the fruit trees are productive). However, farmers indicated that there is also a distinct difference in labor requirements between the old and new fruit varieties. The new varieties of avocado and mango need more labor for watering, fertilization, weeding and pruning, while the old varieties barely require any labor input outside the harvesting period.

5.2.2 Effects of cost reduction strategies

While farmers generally have little control over the product price, cost reduction strategies (i.e., approaches to reduce the cost price per unit of produce) improve the profitability of their enterprises.

Reducing the unit cost price may require some farmers to limit the current amount of inputs they use per unit of land, such as fertilizers or pesticides. For other farmers, it may mean production intensification (i.e., increasing the amount or quality of inputs to increase crop productivity), for example, by using better quality and more expensive seed or more pesticides to control pests and diseases. In the context of Ethiopia, where fruit and vegetable productivity are generally low, intensification needs to be the dominant strategy to reduce the cost price. In various focus group discussions carried out for this study, stakeholders complained about counterfeit inputs and the low effectiveness of the inputs they used. Though it is hard to prove such statements, this could (partly) explain the low adoption of external costly inputs in fruit and vegetable production. As described in Section 5.1.4, most fruit farmers in our focus group discussions do not use external inputs at all.

Reducing the costs per unit of land through lowering the use of inputs to a bare minimum is not sustainable and will not be effective as crop yields will be extremely low. It is important to realize that cost reduction strategies are not about decreasing or increasing the amount or quality of inputs, but about optimization of input use for a targeted yield level. In this respect, it is equally important to examine *which, how* and *when* inputs are applied during the growing season (i.e., the overall crop management from field preparation, sowing and planting, nursing and harvesting of the crop). For all these operations, the proper knowledge and skills of farmers is a prerequisite. For example, significant agronomic knowledge is needed to decide *which* pesticide to apply for controlling a specific insect pest, the proper dose and method (the *how*) and the timely application of the pesticide under conducive weather conditions (the *when*). Only with sufficient operational information, profound knowledge, and skills — built up over the years — may famers achieve true cost price reductions. Equipping farmers with proper knowledge and skills is a means to realize cost price reductions and to increase farmer profits at *ceteris paribus* conditions, i.e., unchanged product price.

Part of the knowledge base required to sustainably achieve cost price reductions is the use of crop rotations. Currently, farmers hardly consider the effects of continuously cropping the same crop type (or family of the same crop) on soil health and crop performance. Vegetable production in many places of Ethiopia is still recent, but soil-borne diseases are slowly building up and may have devastating effects on crop productivity in the long-term. Hence, sound agronomic knowledge is not only needed to improve tactical decision making in fruit and vegetable production, but also for strategic decision making concerning crop choice and rotation, which impacts the potential building up of soil-borne pests and diseases and allows to farmers to design agronomically sound crop rotations.

In fruit production, cost price reductions can be realized by generating income from intercropping in the first years of plantation, when the fruit trees are still not productive. For example, intercropping avocado with papaya. The papaya bears fruits after one year, which generates a cash flow until the avocado trees start producing fruits after about 4 years. In other places, we have seen coffee intercropped with avocado and mango. This seems a very good step, but the agronomic compatibility, disease and pest issues should be studied properly before intercropping is applied.

Based on the limited data provided in Section 5.2.1, it is difficult to quantify the potential effects of cost price reductions. However, considering the current limited use of inputs of mediocre to low quality (i.e., farm-saved seed, outdated pesticides, etc.), it is most likely that higher yield gains are possible when more and better quality inputs are applied (i.e., improved varieties, more selective pesticides). The yield gains are expected to be higher relative to the increase in production costs.

The increased labor demands of fruit and vegetable intensification are challenging given the limited time that women have. Their household gender roles have to be addressed to allow them to take up the emergent household tasks. There is a need for increased agronomic knowledge among women agribusiness actors to improve their tactical decision making in the management of fruit and vegetable production. Women are culturally not allowed to make decisions about overall farm management, and this curtails their input into strategic decision making concerning crop choice and rotation.

5.3 Fruit and vegetable supply chains

This section addresses leverage points three and four: more efficient value chains can lead to lower fruit and vegetable consumer prices; and more secure fruit and vegetable markets increase value chain efficiency, farmer income and reduce wastage (Table 1.1). Underlying research questions include, how do value chain efficiencies result in lower farm gate prices and/or consumer prices? What are the risks, costs and types of coordination for the different fruits and vegetables? How can farmers benefit from more secured markets? What examples are there of more secure markets that are beneficial to farmers?

5.3.1 Increasing value chain efficiency

Adugna et al. (2019), studying vegetable markets in the Lake Tana region, showed that across all value chain actors, from assemblers/collectors, wholesalers to retailers, the largest cost was product loss. Even for less perishable vegetable products like onion, post-harvest losses were a significant transaction cost. Transportation costs were considered the second most important cost component up to the retail level. Adugna et al. (2019) also showed that the share of the farm gate price in the consumer retail price of onion varied between 50% and 75%, depending on the value chain. The largest share of the farm gate price in the retail price was through the direct sale of onions to consumers and the lowest share was in value chains in which more actors were involved. In papaya supply chains in the Rift Valley, a similar range was observed — farmers' share in the retail price was as high as 72% through direct sales and as low as 27% in more complex value chains, when the papaya is sold as juice to consumers (Shafi et al., 2014).

Based on field visits, Table 5.4 gives a summary of the price development of selected fruits and vegetables across the most common supply chains (Figure 4.1). Obviously, the price information shown is context and time specific, but it allows us to calculate and illustrate indicative margins of fruits and vegetables that various actors achieve in the supply chain. In general, retailers' margins for fruits are higher than for vegetables, which is probably related to the high risk of waste at the retail end. In contrast, margins for vegetables are generally highest for wholesalers.

Table 5.4 *Prices of selected fruits and vegetables and margins achieved by different actors across the supply chain*

Commodity	Tomato	Kale	Head cabbage	Carrot	Orange	Mango	Avocado
Farm gate price per kg (ETB)	10	6	4.5	18	30	9	10
Wholesale price per kg (ETB)	13	18	13	30	50	15	15
Retail price per kg (ETB)	20	25	15	40	80	25	27
Total margin (%)	100	317	233	122	167	178	170
Wholesale margin (%)	30	200	189	67	67	67	50
Retailers margin (%)	54	39	15	33	60	67	80

Source: Authors' research.

Three important points in relation to the existing value chain need to be highlighted: i) the weak organization of producer groups; ii) the limited trust among actors that results in an agency model of operation; and iii) the absence of efficient inbound and outbound farm logistics. In general, fruit and vegetable growers in Ethiopia are not well organized to negotiate contracts with major buyers, most farmers are not organized at all. Even when farmers are organized in unions, union management capacity to proactively negotiate contracts with major market actors and comply with terms at a later stage remains weak. The fact that serious buyers require reliable suppliers, added to the reality of disorganized producer groups, imply that most of the major traders and processors have their own agents on the ground. These agents (collectors) are often more powerful than the unions and cooperatives in determining the market price. The local agents operate either as trade facilitators or sometimes act as local suppliers. Information gained during the focus group discussions indicated that there is a high degree of manipulation of prices by these groups of actors. Even if farmers knew there

are better prices; they do not have the channels to reach those markets. The third point, related to poor availability of inbound and outbound farm logistics, is important because it heavily restricts market access, as well as contributing to high transaction costs in value chains. Inbound logistics include the cost and timely availability of logistics to deliver the required inputs. Farmers in the focus group discussions indicated that the high cost of the timely supply of inputs, partly due to the lack of foreign exchange and partly due to inefficient logistics, results in high production costs. On the other hand, the absence of outbound logistics, such as pack houses, cold rooms and cold transport has resulted in significant post-harvest loss and become a cost driver. In addition, the field visits observed the absence of standard measurement systems for fruits and vegetables. Most fruits and vegetables are sold in boxes and bags, whose exact weight is unknown (Figure 5.6). The uncertainty about the exact weight contributes to the risk of the buyer and may add to the transaction cost, ultimately adding to the consumer price of fruits and vegetables.

5.3.2 Coordination in the value chain

Adugna et al. (2019) studied the structure and performance of vegetable marketing in the Lake Tana basin, including the barriers that traders face to enter the vegetable market. About 84% of 107 surveyed traders responded that the procedure to obtain a trade license is easy, suggesting that there are barriers to engage in vegetable trading. Fruit and vegetable value chain studies in the Rift Valley also showed that the majority of collectors, traders and retailers did not have a valid trade permit, suggesting that supply chain actors are often not organized. This lack of organization could limit their access to credit and joint transportation services, as well as limiting their ability to voice their needs to policy and decision makers (Reardon et al., 2019; Emana et al., 2015; Shafi et al., 2014). Business risks associated with the perishable nature of fruits and vegetables appeared to be a much larger market entry barrier than trade licenses, according to almost 90% of the vegetable traders in the Lake Tana area and 77% of papaya traders in the Rift Valley (Adugna et al., 2019; Shafi et al., 2014). The lack of sufficient capital was also considered an important barrier for 78% of the traders in Lake Tana and for 66% of the papaya traders in the Rift Valley. Poor information access and tough competition from established firms was also considered a big barrier by 56% and 51% of the respondent traders in the Lake Tana area, respectively.

The lack of value chain coordination places farmers in a disadvantaged position in the supply chain. In particular, the lack of price information undermines their bargaining position with traders, who are better equipped to get up-to-date price information from nearby and distant markets. Due to this price information asymmetry, traders are able to negotiate more favorable prices (Adugna et al., 2019). Different studies suggest that traders collaborate and make mutual price agreements, or at least exchange price information (Adugna et al., 2019; Emana et al., 2015). The spreading of mobile communication in rural areas may affect the asymmetry in price information, but it is still uncertain whether it will improve the bargaining power of farmers. Based on information from the field, it seems that many farmers have 3G mobile phones. Farmer ownership of smartphones is still very limited, but some traders already have smartphones. They use the camera function of smartphones, for example, to exchange information on the product quality with potential buyers. Specialized e-trading platforms or direct farmer to consumer sales through WhatsApp or Facebook — as emerging in Asia — have not yet been introduced in Ethiopia.

Three questions were raised to farmers in relation to value chain coordination: 1) how do they make production decisions? 2) What are their sources of market information? 3) Are they working in a pre-arranged contract? As described in Section 5.1.1, there is a significant overlap in the fruit and vegetable harvesting season in Ethiopian for both rain-fed and irrigated cropping. This implies that during the harvesting period, prices may collapse even below the cost of production. In a few cases, farmers leave their production on the field and do not harvest it. Farmers indicated that production decisions are often based on historical market performance and there is hardly any organized information sharing among the different production clusters regarding the planted area in each corridor and how that could affect the future market. Uncoordinated production, based on historical average prices, result in overproduction in some periods and price drops; while in other periods market shortages occur driving up consumer prices. During the field visits in March 2021, farmers

mentioned that in the Summer 2020 (July-August) tomato prices were ETB 25 per kg compared to current prices, which had dropped to ETB 10 per kg.

The focus group discussions and key informants stated three main market information sources: local markets, brokers and contacts in the main cities. Farmers regularly monitor all three information sources, particularly as the produce is getting closer to harvesting. However, most often the information is highly dynamic and misleading. Brokers and local traders tend to suppress prices by releasing unsolicited information that supports their negotiation position. The information coming from other sources tends to be inaccurate because of the high price fluctuation within hours and days. It is also important to consider that produce price significantly differs across the value chain. Farm gate and retail prices may differ by up to 100%, implying that retail prices do not reflect farm gate price.

Importantly, access to market information and development differed across the production corridors and affects the position of farmers in the supply chain. Compared to the Lake Tana and Abaya corridor, there are many brokers in the Rift Valley. Although farmers in the Rift Valley are also price takers, i.e. they must accept prevailing market prices as they lack the market share to influence market price individually, the degree of price manipulation by brokers seems less compared to the Abaya and Tana corridors, where the number of agents and brokers is smaller. Combined with the better accessibility of the Rift Valley to reduced transport costs, the position of farmers in the Rift Valley to negotiate prices and sale conditions is better than in the more remote and less developed areas, such as Lake Tana and Abaya.

The Agricultural Transformation Agency has recently been advocating a Cluster Development Strategy, an approach whereby neighboring farmers are supported to grow similar crops with the same level of intensification. In this way, technical know-how among farmers can be more easily transferred, production planning can be better aligned among farmers, and the negotiation position of farmers in relation to buyers can be strengthened. The Agricultural Transformation Agency Cluster Development Strategy is currently being organized by the Bureau of Agriculture on the ground. Fruits and vegetables are among the priority crops. The farmers organized under a cluster will have access to finance, inputs and technical knowledge.

5.3.3 Post-harvest losses beyond the farm gate

In our consumer survey, 46% of the consumers indicated that rotting fruits and vegetables were the major problem they faced when purchasing both products. Bruising and skin damage were a problem for 30% of the fruit consumers and for only 17% of the vegetable consumers. Eleven percent of the vegetable consumers did not face quality problems, compared to only 2% of the fruit consumers. This data suggests that post-harvest quality problems and losses at the consumer end are more prevalent in fruits than in vegetables.

FAO (2019) estimated post-harvest losses in the entire mango supply chain in Bahir Dar woreda at 32.2%, including harvesting, but with the highest losses at retail level (11.8%). Yigzaw et al. (2016) analyzed and documented losses at 31 specialized retail fruit markets in Bahir Dar. The retailers sold seven fruits in decreasing order of importance: mango, banana, avocado, papaya, orange, pineapple and guava. Only papaya and guava were supplied from nearby areas, the rest was transported from distant areas, as far as 1,236 km (Arba Minch), by trucks without cooling units. Carts and laborers are common means for short distance fruit transport. Packing material during transport and storage aggravates losses. Ninety-four percent of the retailers responded that fruits arrive in wooden crates, 16% in sacks, 3% in plastic crates, and 10% in a heap. About 55% of the retailers ranked the unavailability of appropriate storage as the primary cause for post-harvest fruit losses. Mechanical damage (due to rough handling) was ranked as the primary cause by 45% of the retailers. The poor quality of the product (due to pests, disease, immaturity) was not considered a main reason for losses at the retail level. On average, the turnover time of fruit at the retailers was only 3-4 days, in which time about 20% of the fruits were lost before selling. At retail level, losses for avocado and mango were estimated higher (23-24%) than of orange (16%). However, the data showed a large variation also in relation to the season: higher post-harvest losses were experienced in the dry season from January to April compared to the wet season from June to September. Although the majority of the

retailers disposed of over-mature fruit as waste, 35% of the them used it for animal feed and while others sold it to nearby farmers for seed extraction.

Box II: Koga Veg's out grower scheme

Koga Veg was founded by Durabilis — an international impact investment company from Belgium — in 2013 with an objective to boost rural economic development in the area around Bahir Dar. Koga Veg introduced peas and other export crops as a means of increasing farmer income. In 2020, Agri Veg sourced Hass avocados from about 100 out growers in Merawi Koga irrigation area. These avocados were exported to Europe using a reefer container from Bahir Dar, then by train from Mojo to Djibouti, as a pilot for the National Cool Logistics Network — a completely new logistic solution for Ethiopia.

Koga Veg took the lead in introducing the improved Hass avocado variety to out growers. The company targeted the international market by providing the required inputs (correct variety of seeds, fertilizers and plant protection products) and training farmers to comply with global good agricultural practices (GAP) standards, as well as apply plant protection according to international safety standards. Koga Veg also produces high quality seedlings (tomato, watermelon and pepper) that local farmers can purchase.

Photo credit: Sihin Tesfaye.

FAO (2019) and Emana et al. (2017) estimated post-harvest losses in the entire tomato supply chain in the Rift Valley and in Bahir Dar to be between 30 and 40%. transportation. Interestingly, the perceived losses by actors in the supply chain were higher than measured losses (Emana et al., 2017). For example, collectors and wholesalers estimate their losses four to two times higher, respectively, than measured by the researchers. Disease and pest damage was the major reason for post-harvest loss at all levels of the value chain. However, sunburn and undesirable coloring scored highly, identified as the main cause of post-harvest losses by 35-45% of respondents, while mechanical damage was only for identified as the reason for poor quality produce by 15% of respondents. Perceived reasons of loss differed among actors in the value chain: producers mentioned pests and diseases and harvesting method as major reasons; collectors identified the damage during transport; while retailers blamed the (lack of) a market as a major reason. Nevertheless, results from the study suggest that losses of tomatoes at the retail level are smaller than for fruits (Yigzaw et al., 2016).

The lack of good transportation, packing material and storage facilities, and poor agronomic and harvesting practices were considered major causes of production losses in the focus group discussions and informant interviews in Bahir Dar. This supports the findings from the literature.

Based on self-reported losses of different types of urban retailers, Minten et al. (2020) estimated retail losses of banana, onion, tomato, potato and orange for major rural–urban, but not nationally representative value chains. Losses at retail level varied between 2.6% and 11.8%, with the lowest losses in onion and the highest losses in banana. Modern retailers were characterized by relatively lower losses compared to the traditional retail sector. This is likely due to a combination of the more stringent quality requirements in the procurement system; better packed and protected products; and better refrigeration, storage and sales facilities. The authors argue that these more rigid requirements by modern retailers might lead to an increase of losses upstream. This is likely not an issue yet in the early roll-out of modern retail — such as in Ethiopia — given the dominance of traditional marketing channels available to farmers. However, it might become a bigger problem with the increasing market share of modern retail.

5.3.4 Secured markets

One way to provide small farmers access to more secure markets is through contract farming. Typically, in contract farming, farmers commit to supplying an agreed quantity of a product that meets quality standards set by the buyer against an agreed price. Commonly, the buyer supports farmers with technical advice or inputs needed in the production process. The benefit to buyers is that they can scale up supply quickly with the production of contracted smallholders, and thus can achieve economies of scale in the supply chain. The potential benefit to smallholders participating in contract farming is that they receive a guaranteed price for their product (if it meets the quality standards), access to (subsidized) quality inputs and technical advice from the buyer on crop cultivation and how to intensify production.

Box III: Ethiopian Airlines

The largest airline in Africa has recently increased local sourcing as part of maximizing impact and corporate social responsibility. The company signed a contract with Meki-Batu Union in 2019 for the supply of vegetables, including onion, green beans, egg plant, asparagus, tomato, etc. Beyond giving access to a guaranteed market for farmers under Meki-Batu, Ethiopian Airlines also offers a 15% premium price for the Union. Thanks to the different efforts of development organizations in the past, Meki-Batu is Fair Trade compliant. In addition, the Union has the appropriate infrastructure — cold rooms, pack house and pilling and packing machines. These facilities make it an appropriate partner for big companies like Ethiopian Airlines. The picture shows women cleaning and peeling onions at the Union's pack house.

Photo credit: Jean-Marie Michielsen.

There are several examples of large commercial horticultural companies that involved smallholders in contract farming, such as out grower schemes for the production of green beans for export in the Rift Valley and passion fruit in the Awash Valley (Holtland, 2017). For a variety reasons, the impact of these projects on farmers' income and the impact on the companies has been low. Many of the past out grower schemes were not commercially viable, despite investments from development partners and government authorities (Woolfrey et al., 2021). These out grower schemes, often implemented by large horticultural companies, appeared to be more significant as a political gesture than a productive strategy (Cramer et al., 2018).

However, there are still farmers involved in contract farming, including for avocado oil processing and the export of avocados from Bahir Dar to Europe (Box II). Farmers in the Rift Valley are also producing and selling vegetables through the Meki-Batu Union's contracts with Ethiopian Airlines (Box III) and several hotels/restaurants. In addition, the sourcing of avocados for oil processing, from tens of thousands of farmers in the Rift Valley and Abaya corridors, by Sunvado is in an early stage of development (Box I). For Ethiopian Airlines, the added value is in the cleaning, peeling, cutting and packing of vegetables by union members. The Meki-Batu Union also aims to open its own retail shops in urban areas. However, monopolies and cartels of current actors in supply chains hamper the access of unions to consumer markets. Similar stories were voiced in our interviews with Vita – Green Impact Fund, supporting mango value chain interventions (Table 4.1). It is very difficult for farmer unions to enter other parts of the supply chain because of countervailing powers.

5.4 Communication between actors

In this section, leverage point five is addressed: intermediary actors communicate consumer needs to producers to develop jointly innovative food products (Table 1.1). The underlying research questions are: how do traders and processors connect to consumers? How are these groups organized to support each other? Are there examples of downstream actors responding to consumer needs and developing innovative food products? What are the conducive conditions for information sharing and what role does trust play?

5.4.1 Linkages between traders and consumers

There are currently no formal forward and backward linkages in the supply chains. This is associated with the poor organization of both market actors and consumers. As a result, information and knowledge about quality standards in fruits and vegetables is only limitedly available within the supply chain. For example, a majority of consumers know the term *organic* vegetables, but 83% of the 200 consumers interviewed at four supermarkets in Addis Ababa were not aware of potential pesticide residues in or on vegetables (Mengistie, 2020).

Quality standards and grades for different fruits and vegetables, if there are any, are done informally by market actors. Limited grading of fruits and vegetables is done on size and color. Informal markets, such as roadside sellers, deliberately sell buckets with a mix of mature and unripe tomatoes as many customers do not have a fridge. The mix of mature and unripe tomatoes allows customers to consume the mature ones directly, while the unripe tomatoes can be consumed at a later stage. Consumers also care more about product price related to its availability and accessibility, than product quality or safety (Abera et al., 2020). Low consumer awareness on product quality may be related to the way vegetables are utilized, i.e., vegetables are mainly cooked and used in sauces that hide many quality defects. For example, overripe tomatoes are often sold to hotels and restaurants to be used in sauces and pastas (Abera et al., 2020). Consumption of fresh vegetables or fruits, where quality defects show up more prominently, for example in salads, are not part of the traditional diet.

Four major distribution channels can be distinguished for traders and processors of fruits and vegetables in Ethiopia: street vendors; specialized fruit, vegetable and juice shops; supermarkets; and wholesale markets. Each trader group serves specific consumer groups, which determines their customer relationships.

Mobile street vendors
In the past, most street vendors were mainly active in the production areas, but there are now various fruit and vegetable street vendors in Addis Ababa and major cities. These vendors use mobile carts and wagons with weighing scales. They are cheaper compared to retail shops. In most cases, the street vendors sell more ripe fruit and vegetable products. Banana, mango and avocado are the most popular assortments of fruit sold by street vendors. There are no processed products sold by this group. Wholesalers and sometimes retail shops maintain close contact with street vendors as they serve a critical channel for potentially perishable products. Street vendors often sell to passing by consumers and hence do not maintain a steady relationship with their clients.

Fruit, vegetable and juice shops
These are the most popular distribution channels in the main cities. They serve a larger assortment of products: fresh fruits, vegetables, juice, salads and packed fruits. As they are often based near residential or main public areas, this group has strong connections with their customers. They also give options for customers to sort products according to their preference. The fact that the shops also serve juice and salads means that products rejected by the customers will be used for on-the-spot consumption. The shops usually buy products from distributers at the main fruit and vegetable markets within the cities. As they usually have loyal customers, this group of traders have more regular feedback about their product offerings, quality and price.

Supermarkets
Supermarkets are for the high-end consumer and primarily used by people living in Addis Ababa. Almost all the major supermarkets offer fresh and processed fruit and vegetable products. They often sell to loyal customers in the local and international community. Their customers are sensitive to product quality. Therefore, supermarkets source first grade products. However, compared to smaller retail shops, the transaction speed is slower and hence products may not necessarily be fresh. Two important developments of this channel should be highlighted. First, there are emerging specialized fresh food only supermarkets, such as the fast growing 'Fresh Corner' supermarket chain in Addis Ababa. The company manages over 10 shops in Addis Ababa and sells fruits, vegetables, diary, meat and spices. The second development is the increasing trend towards imported fruits in supermarkets, notably oranges, mandarins, apples and grapes. The supermarkets source produce from distributors or their own agents in the production areas. While processed products are delivered on a consignment basis, fresh products are often sold for cash. With the exception of the specialized supermarkets, such 'Fresh corner', most supermarkets do not have a structured customer feedback mechanism other than on-the-spot feedback.

Wholesalers
Wholesalers are primarily based in Addis Ababa and are organized into associations. Sometimes they are vertically integrated into distribution, wholesaling and retailing. They have strong connections with their customers, who are mostly retailers and middle-class consumers seeking value for money. There are 10 major wholesale markets in Addis Ababa. These markets have a strong influence on the price of fruits and vegetables in the country. Only fresh fruits and vegetables are available at the wholesale markets. In some cases, the wholesalers also offer on-site delivery for bigger buyers. They also offer their contact details to their buyers to maintain relationships.

5.4.2 The role of women

Details of women's participation at the production stage have been discussed in Section 5.1.5. In this section the role of women in downstream parts of the value chain are emphasized. In this regard, one can evaluate the role of women in (1) local collection, aggregation and supply to national market, (2) distribution, (3) wholesaling, (4) retailing, (5) processing, and (6) service provision, such as brokering. Women's participation is the highest in the retail business. Our observations from the field and market visits indicated that most of the local aggregation, distribution, wholesaling and brokering of fruits and vegetables is dominated by men. At the processing level, women are highly involved in sorting, packing and related activities. For example, women operate as street vendors, or in fruit, vegetable, and juice shops selling to random passers-by and repeat customers. The selling of juice allows the women to reduce post-harvest losses by converting over ripe fruit into juice and gives them higher profit margins. This basic value addition increases profit margins for women traders and contributes to their economic empowerment.

The government of Ethiopia has a Ministry of Women's and Children's Affairs, which tries to stimulate the participation of women in the fruit and vegetable sector and to give them a voice in decision making. For example, the state-based cooperative office only licenses farmer groups when 40% of the members are women and at least 25% of the leadership team consists of women. However, these targets have not yet been achieved in most cases. Generally, women's participation as members of cooperatives is low and they are almost absent from leadership positions. Membership of agricultural cooperatives remains a privilege of the head of the household, mostly men. For example, the share of women's membership in agricultural multipurpose and seed multiplication and storage cooperatives in Central-Eastern Oromia ranged from 14-22% and is still below the targeted levels (Brasesco et al., 2019). In contrast, women outweigh men as members of local saving and credit cooperatives, 85% of the members of such cooperatives are women, which may be an indication of women's lack of access to other types of financial institutions (Brasesco et al., 2019).

5.4.3 Information sharing

Due to the rapid and unconsolidated growth of the sector in recent years and the dominant smallholder structure in fruit and vegetable production, vertical and horizontal integration of the

supply chain is still rare (Brasesco et al., 2019). Actors with money or fortune seekers, who have little knowledge and skills, have grabbed the opportunity that the emerging fruit and vegetable sector in Ethiopia offers. Short-term profits are the main drivers for sector engagement for these actors and outweigh their interest in building long-term, trusting business relationships among value chain actors or the sustainability of the entire sector. Since there is little or no meaningful interaction and relationships between producers and retailers, the gap is filled by non-value-adding actors that set low farm gate prices to boost their own profit margins. Such actors take advantage of the absence of price standardization, farmers' scarce access to market information, and the weak bargaining position of farmers who need to sell their perishable produce for which they lack storage capacity. Theoretically, production and market information is available at the local agricultural offices, but supply chain actors doubt the accuracy of the available data (Abera et al., 2020). Record keeping of production and product prices by actors in the fruit and vegetable value chain is lacking. The lack of trust among actors in the supply chain, in combination with verbal purchase and sale agreements, mean that the market is burdened with financial settlement problems and frequent disputes (Brasesco et al., 2019).

The above constraints were confirmed in the focus group discussions and key informant interviews of this study. Three important types of information were mentioned by the farmers, information related to inputs, production and markets.

The primary source of seeds and agro-chemicals are local shops, while fertilizers (urea and NPS) are supplied by unions and cooperatives. The most important input information sought by farmers are (1) quality, (2) price, and (3) availability. The primary source of information about inputs is hearsay among farmers. Farmers know the brand and types of quality inputs based on their past experience and from their peers. In some cases, extension workers also serve as sources of information. However, in relation to price and product range there is only a limited choice as most shops buy inputs from the same source. Inputs at union shops are about 10% cheaper than in the regular shops. However, the unions rarely stock inputs except fertilizer. Agro-shops provide some agronomic advice such as on the preparation of pesticide spray solution, precautionary measures for seedling of seed, planting of seedlings etc. Other than these local sources, farmers hardly access other information sources on inputs.

Production information includes (1) weather information, (2) input application, (3) disease and pest management, and (4) weed control. Primary sources of production information are from farmers' own experience and extension workers. Though the Agricultural Transformation Agency, through its hotline number — 8028 — is providing information on weather, input application and agronomic advice on disease and pest management, the focus of this advice has been on cereals. There have been initiatives led by development organizations to improve existing extension information, for example, with a digital extension service delivered by Meki Batu Union, but this never materialized. In general, farmers complain about the availability and quality of production advice, especially when farmers are facing new pests and diseases, such as in the Abaya corridor where farmers are struggling to control a new disease in mango.

Market information includes (1) forecasted supply and demand, (2) prices, (3) quality requirements, and (4) buyers' information. This set of information is most critical and often missing at farmers' level. The fact that the same commodity is produced at the same time across different production corridors means that there are regular price collapses during harvesting windows. Though market information could be organized and made available by the Ministry of Agriculture at the national level, there are no concrete and coordinated efforts to do this. Farmers are usually price and quality takers. The brokers and local traders, in communication with the national buyers in Addis Ababa, determine the price and quality. In relation to quality, there are no universally accepted standards. This results in a high degree of manipulation by traders and brokers. When the market is under supplied the farm gate rejection is low. When the market is well supplied the traders become pickier and give several quality related reasons for rejection.

5.5 Increasing the volume and diversity of fruit and vegetable crops

In this section, leverage point six is addressed: an increased quantity and higher diversity of produced and traded fruits and vegetables leads to more fruits and vegetables of different varieties in the food environment (Table 1.1). The underlying research questions are: has the introduction of new fruits and vegetables contributed to a higher consumption of fruits and vegetables? What are the trends in fruit and vegetable consumption, and what factors affect these trends?

5.5.1 Consumption trends

Consumption of rain-fed fruits and vegetables, such as cabbage and carrots is more seasonal than the consumption of crops that are predominantly produced under irrigated conditions, such as tomato and onion. Domestic and foreign trade is not able to balance local shortages and surpluses of rain-fed fruits and vegetables well. Table 5.5 summarizes the consumption (trends) of the six major fruits and vegetables at farm household level and beyond the farm gate, as reported by the focus group informants.

Table 5.5 *Consumption (trends) of six fruits and vegetables on-farm and beyond farm gate*

Product	On-farm consumption	Overall consumption	Factors behind trend
Mango	Medium but decreasing	High but decreasing	High mango fly infestation is reducing quality and consumer confidence.
Avocado	High and increasing	High and increasing	Highly polarized as a health product and considered a staple food in Abaya corridor.
Orange	Low and decreasing	Medium and increasing	Availability of locally produced orange is declining. However, recent demand has been increasing due to COVID-19 as orange is a vitamin C source. Increased demand has been met with importing high-quality orange.
Tomato	Medium and stable	High and stable	Tomato is one of the basic vegetables in the Ethiopian diet. Its demand is stable and remains high among urban consumers, but in the rural areas demand is at a medium level, with few applications in the household diet.
Carrot	Medium/low and stable	Medium and stable	Carrot consumption is stable and more popular in urban areas, primarily in the catering industry.
Cabbage	Very high and increasing	Very high and increasing	Cabbage is a hunger season crop in the rural areas. It is consumed alone or with cereals. Urban demand is also high and increasing due to increasing awareness of the health benefits.

Source: Authors' focus group discussions.

Traditionally, **cabbage —** particularly Ethiopian cabbage/kale — is a 'hunger season' crop as it is available during the rainy season before major cereals and other crops are harvested. Because of its role, cabbage is the most important vegetable in Ethiopia in terms of production and area (Figure 3.1). Cabbage is consumed by all income classes and consumption is highest during the rainy season when the produce is readily available from street vendors to high-end supermarkets. With increasing incomes, one would expect that the importance of this poor man's crop in the local diet would decrease. However, with growing consumer health awareness and the status of cabbage in the traditional diet, cabbage may remain the most important vegetable in Ethiopia for some time.

Unlike cabbage, which is consumed as the sole vegetable with cereals or alone, **tomato** is often used as an ingredient to make sauces (that include pulses, spice and other ingredients). In addition to fresh consumption, tomato paste and juice are available mainly to high-end consumers. The Upper Awash Agro Industry has been processing tomato paste juice for decades. In general, tomato consumption remains high with minimal change in consumption during the harvesting and lean seasons.

Compared to the other two vegetables, the consumption of **carrot** is relatively low, but stable. The use of carrots among rural households is limited, and demand is mainly from the middle and higher income groups and the catering industry. Carrot is often used as an ingredient for other cooked vegetable-based dishes such as head cabbage and green beans.

Avocado is a fast-emerging fruit with increasing popularity among all levels of consumers. The health benefits of avocado have been widely promoted by the government and NGOs. In some areas (Welaita Sodo area of Abaya corridor) the fruit is a staple food. In addition, the government sees strong processing and export prospects for avocado. However, during the lean season only the middle and high income class can afford it. Avocado is consumed in the form of juice, salad, and whole. Avocado and avocado based juice is highly popular in juice bars, which have gained popularity in urban areas among well-educated and health-conscious young people with relatively high incomes.

The overall consumption of **orange** has been declining over the last decade, mainly because of deteriorating fruit quality and its high price. Limited efforts in breeding and variety development mean that the old generation of trees are less productive, while the sour taste of older orange varieties is less accepted by consumers nowadays. However, the demand for orange has dramatically increased during the COVID-19 pandemic. Traditionally orange is well known among Ethiopian households to treat the common cold. Over 2020/21, high-end supermarkets and major fruit shops have imported better quality orange and mandarin on a large scale. These products are mainly affordable to the upper middle and high income classes. However, the market accessibility of orange for the common Ethiopian consumer is highly affected by seasonal availability.

As compared to the other two fruits, **mango** has a broader span of availability throughout the year and consumption is more stable. It is consumed across all households, though low income families can only afford it during the harvesting season when prices drop. Mango consumption has been declining recently, after a sharp increase over the last decade. The increasing threat from mango fly is shaking consumer confidence because of the deteriorating fruit quality. In many cases, people reported live insects inside the fruit.

The recent expansion of the catering industry, aimed at serving foreign tourists, may increase the demand for better quality fruits and vegetables to be used in salads and desserts. However, it is uncertain how fast the tourism sector will recover from the COVID-19 pandemic. Although tourism and the associated catering industry is still small in Ethiopia, further growth of the industry is expected and may result in a steady increase in demand for better quality produce, with possible spillover effects into domestic consumption of quality fruits and vegetables.

5.5.2 The introduction of new fruit and vegetable varieties

Generally, consumer behavior with regards to fruits and vegetables is determined by (1) the level of awareness about the nutritional value of products, (2) consumer purchasing power, and (3) the availability of quality products at affordable prices.

In general, rural and urban consumers have limited knowledge of the nutritional value of fruits and vegetables (Melesse and van den Berg, 2021; Emana et al., 2015).

Consumer purchasing power is a more important determinant of year-round consumption of fruits than vegetables. Vegetables such as tomato, cabbage and to a lesser extent carrot are basic food items and their consumption is less susceptible to income and price fluctuations. On the other hand, fruits are considered a luxury and especially consumed during the harvesting window when prices are low. In the lean season, when prices are high, only the middle and higher income consumers can afford to purchase fruits.

Product quality depends on the types of varieties, as well as other factors. Over the last decade there has been a significant increase in mango consumption and production area in Ethiopia until the recent recurrence of diseases and pests. A new mango variety with the commercial name, 'Apple Mango', has not only led to strong consumption, but also to an increasing level of processing. This mango variety

has more flesh and less fiber and corn. Other than that, avocado and orange consumption seems to have increased lately because of growing health consciousness, as well as the availability of improved varieties (Hass avocado). The consumption trends for orange are mixed. On the one hand, the variety development seems slow and there is a decreasing trend in the consumption of old local varieties. On the other hand, sweet and deep yellow imported orange is taking over the domestic market. As compared to fruits, vegetables are more basic and hence demand is less elastic for new varieties.

Outside the six targeted fruits and vegetables, there is a new breakthrough in market penetration of watermelon over the last decade. The year-round availability and the sweet red flesh variety has become popular both in the catering industry and at the household level. Similarly, the recent surge of Ethiopian cabbage of the 'Guraghe' type is improving the availability of the product during the off season, resulting in year-round consumption.

5.6 Fruit and vegetable prices compared to cereals

In this section, leverage point seven is addressed: prices of fruits and vegetables are always higher compared to other food groups (Table 1.1). The underlying research questions are: why are consumer prices of fruits and vegetables higher compared to other food items? What are the price differences between fruit and vegetable types and what explains these differences?

5.6.1 High prices

Bachewe et al. (2017) suggest that the high prices of fruits and vegetables in Ethiopia are associated with production shortages. Using price data from a large number of markets in Ethiopia, they showed that the real prices of all nutrition-rich food groups increased significantly between 2007 and 2016. This increase was up to 80% for Vitamin A rich, dark green leafy vegetables and about 40% for other fruits and vegetables. This price increase for fruits and vegetables contrasts sharply with (1) staple crops (grains, roots, and tubers), which showed a relatively stable price level, and (2) oils, fats, and sugar, which showed a substantial price decrease in the same period. Because the consumption of fruits and vegetables is highly income elastic in Ethiopia, price increases of fruits and vegetables potentially limit consumption (Tafere et al., 2010).

The observed price increase of fruits and vegetables by Bachewe et al. (2017) has consequences for the affordability of fruits and vegetables for consumers in Ethiopia. Using expenditure and price data collected by the Central Statistical Agency of Ethiopia, Hirvonen et al. (2018) showed that the average Ethiopian household would have to spend 11% of its income to meet the international recommendation of two servings of fruits and three servings of vegetables per person per day. For the poorest households, this share increases to 27%, indicating that meeting these guidelines is currently out of reach for the poorest households in Ethiopia. Similar analyses by Herforth et al. (2020) support this conclusion, as they calculated the costs of a healthy diet at US$3.73 per capita per day (2017 price level), of which 39% would need to be spent on fruits and vegetables (Table 5.6).

Table 5.6 *The cost of fruits and vegetables and the proportional cost of a healthy diet in several countries, based on the 2017 price level*

	Cost (in US$) of a healthy diet (mean across 10 guidelines)	Cost (in US$) of the least costly fruits and vegetables (mean across 10 guidelines)	Share of the cost of a healthy diet accounted for by fruits and vegetables (%)
Bangladesh	3.41	1.17	34
Burkina Faso	3.66	1.08	30
Ethiopia	3.73	1.46	39
India	3.27	1.26	39
Nepal	4.13	1.72	42
Nigeria	3.57	1.21	34
Tanzania	2.62	0.86	33
Globally	**3.77**	**1.46**	39

Note: These results are based on analysis of the 2017 ICP dataset to find the lowest cost foods in each country. National datasets may have additional foods that may be lower or higher cost at different times and places in the country. The proportion of the cost of a healthy diet is based on the mean cost of ten different national food-based dietary guidelines. The mean cost may differ from the median cost, which was reported in the SOFI 2020.

Source: Herforth et al. (2020).

An underexposed consequence of the high prices of fresh fruits and vegetables is that these hamper the development of contract faming and processing of fruits and vegetables. High local prices of fruits and vegetables may result in side selling in contract farming arrangements and the inability to develop a competitive fruit and vegetable processing industry (Woolfrey et al., 2021; Holtland, 2017). Indeed, side selling in contract farming projects has been a problem in some initiatives in the past. Hirvonen et al. (2018) concluded that more investments and research attention into the production of fruits and vegetables was urgently needed to improve supplies and, hence, their affordability.

5.6.2 Price differences among fruit and vegetable types

During the field visits, prices were gathered from actors at different positions within the value chain: (1) farm gate (2) wholesale (3) retail (Table 5.4). There are considerable price differences across the supply chain. Based on this data, high farm gate prices of vegetables, such as tomato and carrot, are at the expense of the margins of other supply actors, i.e., wholesalers and retailers. Alternatively, products with low farm gate prices, such as kale and head cabbage, allow wholesalers and retailers to make large margins. The local key informants suggested that three factors determine price variation across the supply chain (1) the degree of perishability of the product (2) the availability of market information and (3) the existence of organized farmers' organizations and established buyers.

Highly perishable products, such as cabbage, kale and mango, show large price differences between the farm gate and consumer end (Table 5.4). In these supply chains, consumers pay the product price, but also the accumulated costs for post-harvest handling and loss.

Farmers indicated that the price risk of tomato is relatively low as it is harvested several times — on average six times in a growing season — over a longer period than the other crops. Under normal circumstances, unlike other vegetables such as onion that are harvested once, tomato prices vary between the multiple harvests, reducing price risks.

5.6.3 Price differences compared to cereals

Consumer prices of fruits and vegetables are determined by the production costs and different actors in the supply chain that add value to the produce, or at least take their margin. While we illustrated the production costs of onion and tomatoes in detail in Section 5.2.1, in this Section we compare these costs with the production costs of major cereals in Ethiopia, based on data from Elias et al. (2017), who analyzed the effect of extension services on the profitability of maize, teff and wheat production in north western Ethiopia.

Overall, the total production costs of the three cereals do not differ much, with the lowest costs for maize, which may partly explain its popularity among cereal farmers (Table 5.7). As in vegetables, labor costs are also a major cost component in cereal production, but six to eight times lower than in onion and tomato production (compare Table 5.3 and Table 5.7). In particular, the costs for oxen are high in cereals (specified as *other costs* in Table 5.7). The share of fertilizer costs in the total costs of cereals, approximately 15%, compares with that in vegetables, but the absolute value of fertilizer costs are four times higher in vegetables (Table 5.3). Cereal farmers hardly have any costs for crop protection and irrigation. Overall, the total production costs of cereals is four to five times lower than the production costs of tomato and onion (compare Table 5.3 and Table 5.7).

While farm gate prices of cereals are higher than of tomatoes, the gross revenues of cereals are 7-12 times lower than of vegetables (compare Table 5.3 and Table 5.7). The highest average returns on investment (gross revenue / total costs) of cereals is about 1.4 (for maize), much smaller than in onions where it was 3.2. In addition, returns on labor investments in cereals (labor costs/net revenue) are very low (< 1), while it is 4-5 in vegetables. The much higher returns on labor input may partly explain the interest of farmers in producing vegetables.

It is also interesting to compare the differences in cost price and farm gate prices between vegetables and cereals. Remarkably, the cost price of vegetables is smaller than of cereals, while at the same time the difference between the cost price and farm gate price is larger. This implies that profits per unit of produce are much larger in vegetables than in cereals. Another reason why vegetables are an interesting commodity to engage in for farmers.

The production cost data and crop revenues shown in Section 5.2.1 and this Section illustrate differences between vegetables and cereals. However, production practices and yields of the same crops in the same area can differ widely (Section 5.2.1; de Putter et al., 2012). In addition, we have compared irrigated vegetable systems that perform well above the national benchmark of rain-fed vegetable productivity, while the considered cereal systems represent the more general performance level of cereals in Ethiopia. However, the data supports the common understanding that production costs (per unit of land) — and thus the financial risks — as well as the potential returns on investments, are much higher in vegetables than in cereals. More interestingly, the data indicates that vegetable farmers take a much larger profit margin per unit of produce compared to cereal farmers, suggesting that this represents a risk margin. While the examples shown for vegetables in Table 5.3 are favorable in financial terms, in practice, farmers may face problems in marketing their harvest and need to sell against much lower prices. Additionally, farmers may face pests and diseases, water shortages, or other shocks (including the COVID-19 pandemic), that may all reduce yields or financial outcomes of the enterprise.

Table 5.7 *Production costs and revenues of smallholder maize, teff and wheat farmers in north western Ethiopia in 2012. Cost components are also expressed as a percentage of the total costs*

	Maize		Teff		Wheat	
Costs:	**n=79**		**n=152**		**n=57**	
Seed/seedling (ETB/ha)	90	1%	324	3%	1,049	9%
Fertilizers (ETB/ha)	1,448	16%	1,420	12%	2,033	17%
Crop protection (ETB/ha)	0	0%	33	0%	33	0%
Irrigation (energy) (ETB/ha)	0	0%		0%		0%
Other (ETB/ha)	3,945	44%	7,211	63%	6,349	54%
Labor (ETB/ha)	3,448	39%	2,438	21%	2,284	19%
Total costs (ETB/ha)	8,931	100%	11,426	100%	11,748	100%
Yield (kg/ha)	2530		1572		1925	
Farm gate price (ETB/kg)	5.1		8.7		6.5	
Cost price per kg of produce (ETB)	3.5		7.3		6.1	
Gross revenue (ETB/ha)	12,903		13,676		12,513	
Net revenue (ETB/ha)	3,972		2,250		765	

Source: Elias et al. (2017).

5.7 Women's participation in fruit and vegetable production and supply chains

In this section, leverage points eight and nine are addressed: women's participation in fruit and vegetable production and supply chains leads to the higher income and empowerment of women; and increases in women's income results in higher consumption of fruits and vegetables (Table 1.1). The underlying research questions include: are there examples of the successful integration of women in production and supply chains? What explains the success of such examples? What business models work best for women's inclusion and leadership? When the incomes of women increase will this income be controlled by women?

5.7.1 Examples of women's participation in fruit and vegetable production and value chains

A survey of under 31 of the 100 fruit retailers operating in Bahir Dar showed that 15 were run by women, suggesting an equal participation of men and women in the marketing of fruits (Yigzaw et al., 2016). In their study characterizing tomato value chains in the Rift Valley, Emana et al. (2017) showed that among their sample of 22 retailers almost 90% were women. However, at the wholesale level (n=34) almost 97% were men. The authors conclude that women are mostly involved in small vegetable retailing in urban settings. Furthermore, they assume that women lack capital to engage in the wholesale of vegetables, but also that the time consuming requirements for engagement and networking possibly prevent women from participating as wholesalers. Similar findings were also reported in the focus group discussions and key informant interviews for this study. When it comes to volume trading of fruits and vegetables at the farm gate, men have a dominant role. Women market smaller quantities at local markets, which are either produced in home gardens or commercial fields.

The role of women in selling fruit and vegetables to assemblers/collectors is underdeveloped, although they have a dominant role in urban retail and the selling of smaller quantities at rural markets. Inequalities in the division of labor in the fruit and vegetable sector varies depending on education levels, religious and cultural background, adherence to social norms, exposure to training and good practices, and gender awareness. A patriarchal socio-cultural set-up, particularly present in rural areas, is one of the key causes of women's limited power and agency (Brasesco et al., 2019).

5.7.2 Commercial pathways

There are no signals that further commercialization of fruits and vegetables will automatically result in greater economic empowerment or decision making power of women. Incentives and regulations, as in the case of gender equity quotas in the formal recognition of farmer groups, will be required to empower women and to provide them with opportunities to engage in the commercialization of fruits and vegetables and, more importantly, to benefit from it (Section 5.4.2). However, there is no guarantee that the situation of women will change in the short term without developing other incentives or enforcing supplementary legislation.

The higher income of women is particularly important for urban households, where women are primarily responsible for food purchases, based on the observations of buyers at the main fruit and vegetable markets in Addis Ababa. Women remain heavily in charge of their household's food choice and utilization (Melesse and van den Berg, 2021). The higher incomes of urban households is already resulting in changes in food consumption towards more fruits and vegetables (Abdulazize Wolle et al., 2020; Worku et al., 2017). Most likely, an increase in women's incomes would increase the speed of this food consumption transition.

5.7.3 Business models

Business models that work best for women's inclusion and leadership are those that that are gender sensitive and help women to overcome gender barriers. This can be achieved through strategies, such as improved access to capital, training and agricultural technology, with the aim to increase crop

yields and increase profits. Gender sensitive supply chain developments are designed to enable women to benefit more equally from agri-food supply chains. They should support women's associations and cooperatives that are already engaged in the production and marketing of fruits and vegetables to diversify their activities and sources of income. The tomato supply chain in Ethiopia is a good example, with a high engagement of women and market demand for tomatoes year-round. This supply chain employs large numbers of women in production, processing and small-scale market retail, while the transportation and wholesale distribution, including intermediation, is male dominated. At the end of 2015, the Flexi-Multi-Partner Mechanism (FMM) initiative was created with a focus on upgrading products and processes along the tomato supply chain. Five women's associations, established under the umbrella of an Irrigation Scheme Association, were initially identified for FMM support, and three were selected to be engaged in tomato processing, totaling 100 members. FAO's role was to facilitate the partnership and collaboration between public institutions, a national NGO (Women in Self Employment – WISE). In addition, FAO was also responsible for overseeing the establishment of three processing units; providing access to equipment; and organizing capacity development activities for public institutions, women's associations and service providers in several domains (woreda and regional levels). The project built on the engagement of public institutions to address gender issues hampering agriculture and rural development. FMM invested in the capacity development of institutions at different levels to promote gender equality in the value chain and women's sustainable enterprise development. This was crucial to addressing gender specific barriers by increasing women's access to land, facilities, inputs, and coaching to improve tomato production and post-harvest operations. As a result, it contributed to loss reduction and facilitated the establishment of three tomato processing units. These interventions proved to be very effective in terms of developing the capacities, self-confidence, and commitment of women supporting the operations of the processing units (FAO and CARE Inc., 2019).

In addition to the entry points described in the literature and summarized previously in this report, three potential business models and entry points were highlighted in discussions with various actors during the field visits. First, backyard farming has recently been gaining strong momentum. Unlike commercial production, women are usually in charge of backyard production. This implies that strengthening this system will provide opportunities for gender inclusion and women's leadership. Four important factors can be improved to enhance backyard farming: (1) farmer organization, (2) the use of appropriate varieties, (3) knowledge and awareness, and (4) market linkages. Organizing women who own a certain backyard plot size under a cooperative, providing them with appropriate input packages, training and market access may have a strong impact on their livelihoods. In this regard, the SNV Horti-Life project is currently promoting farmer field school systems for vegetable production. The project works both on backyard and commercial plots. It provides a full input and extension package to participating farmers and its primary aim is to transfer knowledge from farmers to farmers. Their backyard system is intended to promote both women's inclusion and nutrition education.

Second, women's wholesaler cooperatives may enhance the inclusion and leadership of women. Currently, the wholesale market in Addis Ababa is heavily dominated by men for two main reasons: (1) the market starts operating very early in the morning (4 a.m.)-women do not spent much time outside the house after dark because of insecurity and they also require the permission of their husband. In addition, early in the morning women are mostly engaged in household activities like cooking and cleaning; these gender roles affect their participation in the market place.; and (2) the many laborious tasks involved hinder women participation-the activities in the wholesale markets involve carrying heavy loads and moving them from one transportation means to another to reach market place. The wholesalers are the most influential of all actors along the supply chain, with comprehensive information about supplies from different corners of the country through their agents and brokers. Most of them also have forward linkages with major buyers (hotels and restaurants), or in some cases their own fruit and vegetable retail channels. This implies that improving the participation of women within this part of the value chain will greatly increase opportunities for them to gain a better income. For this to be realized, four major investments would be necessary to: (1) facilitate a suitable working place for women's wholesale cooperatives, (2) facilitate market linkages with farmer organizations and other suppliers, (3) facilitate simple tools and technologies to reduce the heavy workload, and (4) provide business coaching. Such investments will not take place overnight but requires short and long term system approach, extensive community engagement work and attitudinal changes.

5.8 Public enforcement of standards

In this section, leverage point 10 is addressed: public enforcement of standards enhances food safety for consumers of fruits and vegetables (Table 1.1). The underlying research questions are: what are current food standards, and how are they enforced? Do farmers trust standards? And how are standards appreciated by other actors in the food system?

5.8.1 Food standards and consumer trust

Food regulation in Ethiopia is a shared responsibility of the Ministry of Health, Ministry of Agriculture and Rural Development, Ministry of Trade and Industry, and Quality and Standards Authority of Ethiopia (Temesgen and Abdisa, 2015). Coordination and cooperation among these government regulatory agencies is weak and a comprehensive food law that clearly defines and streamlines the activities of each regulatory body is lacking (Temesgen and Abdisa, 2015). In the last decade, public efforts have focused on the development and implementation of food regulation management systems in the agri-food chain, i.e., the multiple Codex Alimentarius guidelines and National Codex.[11] However, progress on these is unclear with respect to fruits and vegetables. If food standards have been defined, they are certainly not yet enforced at a large scale. Overall, the food control system in Ethiopia is underdeveloped and is not able to support the production, supply and distribution of safe food to consumers (Derra et al., 2020).

Although systematically collected information on the extent of food-borne illness is lacking in Ethiopia, the insufficient application of the most basic hygiene measures in the entire food supply chain is a major risk for contaminated foods (Ayana et al., 2015). Indeed, Endale et al. (2018) showed that almost half of the fruits and vegetables (lettuce, cabbage, carrot, tomato, green pepper, banana, orange, and spinach) sold at the local markets of Dire Dawa were being contaminated with medically concerning parasites. Alemu et al. (2019) showed similar results for markets in Arba Minch, where 25% of the vegetables sold (tomato, cabbage, carrot, lettuce, green pepper) were contaminated with at least one parasite species. With 35% of the tomatoes contaminated, it was the most commonly contaminated vegetable. Vegetables directly supplied by farmers to retailers were three and a half times more likely to be contaminated with parasites compared to vegetables supplied by large scale vendors. Food safety problems in Ethiopia are not limited to the biological contamination of food. A recent study showed that all food samples (not including fruits and vegetables) collected from a local market at Jimma contained residues of at least one pesticide (Mekonen et al., 2014). Approximately one-third of the samples had pesticide residues above Maximum Residue Levels set by the Codex Alimentarius. Additionally, various banned pesticides, such as DDT and endosulfan, or those not authorized for use in specific crops were identified. The use of banned pesticides has also been observed in vegetable production areas, but consumer awareness of possible pesticide residues on vegetables is low (Loha et al., 2020; Mengistie, 2020; Mengistie, et al., 2016).

In general, consumer awareness of fruit and vegetable quality affected by production and post-harvest handling seems low (Abera et al., 2020; Mengistie, 2020). However, food safety was considered more important than the nutritional value of food in the food choice of urban consumers (Melesse and van den Berg, 2021). Strong consumer organizations could play a role to enforce food safety regulations from the government and to demand public food standards, but such organizations are not yet developed in Ethiopia (Ayalew et al., 2013).

Alternatively, the private sector continues to implement its own standards. Although no information is available on the standards that supermarkets apply to source fruits and vegetables, relatively low losses have been observed at supermarket level (Minten et al., 2020). Most likely, supermarkets already set some kind of quality standards in the sourcing process. For companies that export fruits and vegetables from Ethiopia, meeting international food regulation standards is their license to operate, including in the non-food sector in Ethiopia (i.e., floriculture). Therefore, private sector standards, such as organic production certificates and global GAP standards are being implemented and enforced by the few fruits and vegetables companies that export from Ethiopia, such as Koga Veg and Sunvado.

[11] See for more information on the Codex Alimentarius: http://www.fao.org/fao-who-codexalimentarius/about-codex/en/

In short, the absence of nationally accepted consumer standards means that informal food safety standards are socially determined from customer experience and social referrals based on trust. With the emerging supermarket revolution in urban areas, the private sector will develop its own standards. Initially, these standards maybe directed towards aesthetic and uniform quality characteristics, but in later stages, food safety aspects will also need to be addressed to satisfy consumer demand.

5.9 Public extension and consumer nudging

In this section, leverage point 11 is addressed: consumer nudging and public extension improves fruit and vegetable awareness and consumption preferences (Table 1.1). The underlying research questions are: what policies and strategies have been formulated and implemented to improve dietary quality among consumer groups? Do these policies and strategies aim specifically at fruits and vegetable? Is there evidence of their impact? Have these policies enabled women to address systematic constraints that they face, and to successfully access sufficient nutrition?

5.9.1 Policies and strategies

Ethiopia has a national nutrition strategy document, the second National Nutrition Policy (NNP II), which identified various nutrition sensitive goals and interventions, and has developed an extensive set of relevant indicators to measure impact of the strategy on improved nutrition. The agricultural sector is noted as an important contributor towards realizing the national nutrition goals. The strategy underscores mother and child nutrition as a primary target. Fruits and vegetables, poultry and dairy are highlighted as important agricultural products to reach this target. Over the last decade, the public health extension system has increasingly advocated the consumption of fruits and vegetables. In contrast, the agricultural extension system is still largely dominated by cereals, pulses and oil seeds; though there have been some improvements lately (Section 4.3).

Though it is difficult to prove causal relationships between the health extension system campaign for balanced nutrition and changes in fruit and vegetable consumption, household consumption of fruits and vegetables is increasing. However, this is largely limited to the urban middle class communities (Worku et al., 2017). In rural areas and urban low income households, consumption remains limited to the basic vegetable products, such as tomato and Ethiopian cabbage. Consumption of fruits in rural areas is largely limited to areas where they are grown, whereas for the urban low income class consumption is restricted to during harvesting season when prices fall.

In addition to public advocacy interventions, development organizations are actively engaged in building awareness on nutrition security with a prime focus on maternal and child nutrition. For example, GAIN is supporting the fruit and vegetable, diary and soybean sectors as instruments to enhance nutrition security. Similarly, the SNV Hort-Life project promotes household consumption of vegetables to improve nutrition security.

Discussions with farmers during the focus group sessions reveal that sometimes the priorities of the health and agricultural extension workers do not reconcile and lack consistency. The health extension workers tend to promote the nutritional benefits of fruits and vegetables for community health; while the agricultural extension workers promote fruits and vegetables from the perspective of increasing production and productivity for the market. There is no joined planning by the two extension systems, though they are reaching the same households.

5.9.2 Systemic constraints for women

At the national level, the government and development partners are pushing for more inclusive policies related to the SDGs. The government has made profound efforts in addressing maternal health and child malnutrition. World Bank data indicates that significant results have been achieved, such as maternal mortality due to communicable disease and pre- and post-natal nutrition related deaths has declined from 66% in 2000 to 44% in 2019. Similarly, the rate of stunting among children of below 5 years of age, has declined from 57% in 2000 to 37% in 2019 (see also Table 2.1 for other changes in SDG

indicators). Likewise, significant results have been realized in educating girls. World Bank data also indicates that girls' enrollment in primary education is 47%, up from 35% in 2000. One can infer that the solid education of mothers will have a positive impact on household nutrition security.

Hence, at the macro scale there are clear improvements in the nutrition status of girls and women. The affordability and availability of fruits and vegetables, especially for those households living remotely without cool storage, may be the most important constraint for women to consume a more nutrient dense diet. Since women are in charge of food purchases, these constraints also affect other members of the household. Furthermore, the lack of knowledge on the health benefits and how to prepare newly introduced vegetables may hinder women from diversifying vegetable consumption. This constraint seems less limiting for the consumption of recently introduced fruits compared to vegetables (Section 5.5.2), which may be related to the higher consumer appreciation of fruits (Section 5.10.1) and the fact that fruits do not require preparation.

5.9.3 Illustrative examples

The following are some examples of developments that make fruits and vegetables more accessible, as well as initiatives and projects to raise awareness about the health benefits of fruit and vegetable consumption and nudge consumers towards healthier choices:

1. Farmer field schools: is an approach used in SNV's Horti-Life project aiming to move a number of 'on the shelf' vegetable varieties and technologies to farm households by using lead farmers and their plot as a field school. Horti-Life is the flagship project of SNV in Ethiopia and works with over 40,000 farmers per year and 80 rural SMEs in 79 districts in all main horticultural areas. The project creates linkages between farm level activities and government institutions as well as commercial service providers.
2. Mobile street vendors: this retail concept has seen a recent surge within the fruit and vegetable marketing chain. In the past, there were only fruit and vegetable retail shops but over the last five years (2015-2020), the number of mobile vendors has been increasing. This group often sell over ripe fruits and vegetables. Their prices are affordable, and their primary customers are the low income households that cannot afford the more expensive fruits available in other markets.
3. School feeding programs: these programs have been effective in raising school attendance of both girls and boys in Ethiopia and reducing the number of school dropouts, especially among girls (Gallenbacher, 2018; Girma, 2018). Current programs heavily rely on cereals and pulses and do not meet the daily nutrition requirements of children (Assefa et al., 2020). The incorporation of more fruits and vegetables in the menu, combined with nutrition education, would increase the health impact of such programs, children's knowledge of the health benefits of fruits and vegetables, and help to promote nutrition awareness beyond the school premises.

5.10 Consumer awareness and the acceptability of fruits and vegetables

In this section, leverage point 12 is addressed: increased food safety, consumer awareness and responses to consumer preferences lead to the higher acceptability of fruits and vegetables (Table 1.1). The underlying research questions are: what are consumer motives and barriers to (not) consume (specific) fruits and vegetables? Are motives and barriers the same across household members and gender?

5.10.1 Consumer motives and barriers

Food safety was considered more important than the nutritional value of food in the food choice of urban consumers (Melesse and van den Berg, 2021). However, this study did not explicitly address food safety concerns related to fruits and vegetables. Therefore, it is uncertain to what extent the introduction of food safety standards for fruits and vegetables will contribute to their higher acceptability and consumption. In general, food safety standards in Ethiopia are low, while

contaminated food and food-borne diseases are widespread. Food safety problems in vegetables may be less experienced by Ethiopians because they are predominantly consumed in cooked form.

Consumer awareness about *health* aspects of food is growing, especially under the urban better-off part of the population. In fact, personal health is the most important motive of urban individuals' food choice (Melesse and van den Berg, 2021). Increasing public knowledge about the nutritional aspects of food increases dietary diversity and the likelihood that consumers will increase their consumption of fruits and vegetables (Melesse and van den Berg, 2021). Yet, consumption of fruits and vegetables in Ethiopia is appallingly low, as shown in our consumer survey and further described and supported with other information and data in Section 2.2.

In the consumer survey, affordability was the major barrier to increased fruit and vegetable consumption for approximately 45% of the respondents. This suggests that the prices of fruits and vegetables are relatively high compared to the average household income level, see also Section 2.2 (Abdulazize Wolle et al., 2020; Worku et al., 2017). Reducing the cost of production and distribution (cost price reduction), which ultimately results in lower consumer prices, has the potential to raise consumption (Section 5.2.2). In addition, per capita income seems a more important driver of fruit and vegetable consumption in Ethiopia than food safety standards and consumer awareness and preferences.

Related to the seasonality of fruits and vegetables, the non-availability of fruits and vegetables was the second major barrier to increasing consumption of fruits and vegetables for 25% and 19% of the respondents, respectively. The slightly better availability of vegetables could be due to irrigated vegetable production, which reduces the seasonality of availability. In contrast, fruit production depends more on seasonal weather conditions (Section 5.1.1). Better spreading of fruit and vegetable production over the year could contribute to overcoming seasonality problems. Access to irrigation and staggered planting are important means to produce vegetables year-round. In addition, improved domestic trade and regional trade with neighboring countries (Sudan, Somalia, Kenya) could improve the year-round availability and reduce the seasonality of fruit and vegetable availability in Ethiopia.

The poor quality of fruits (14% of the respondents) and vegetables (19% of the respondents) was also identified in the survey as an important barrier for consumers to increase consumption. Currently, post-harvest quality and loss are major problems that fruit and vegetable consumers face (Section 5.3.3). Many of the post-harvest loss problems are born on-farm by poor crop management and, especially for fruits, poor harvesting practices (Section 5.1.4). Better crop management and greater care during harvesting and in the logistics processes, from the farm to the retail level, improve product quality and potentially contribute to the increased acceptance of fruits and vegetables by consumers.

In contrast to fruit, 15% of the respondents in the survey indicated that the taste of vegetables was a barrier to increasing their consumption. Apparently, the taste of fruits is more appreciated than that of vegetables. Thus, improving the availability of vegetables alone is not sufficient to increase their consumption. This distinction between fruits and vegetables is also observed in the response to the question on whether consumers are open to consuming new types of fruits and vegetables. Seventy-five percent of the consumers surveyed were willing to try new types of fruits, but only 65% were willing to try new types of vegetables. Apparently, new fruits are more easily accepted than newly introduced vegetables. Increasing consumers' nutritional knowledge on vegetables could contribute to their increased acceptability and consumption (Melesse and van den Berg, 2021).

6 The main findings

6.1 Leverage points

This report has been structured according 13 leverage points for intervention in the food system to promote the production, trade and consumption of fruits and vegetables. In the following synthesis of the research we further assess these leverage points.

Leverage point	Findings
1. Increase in production leads to lower fruit and vegetable consumer prices	Increased production does not necessarily lead to lower consumer prices of fruits and vegetables. Supply shortages and the associated high consumer prices of fruits and vegetables are among others influenced by the seasonality of different fruits and vegetables. However, increasing the supply of fruits and vegetables that are in short supply during some parts of the year may reduce consumer prices. The constraints that limit smallholders' engagement in the production of fruits and vegetables include limited access to capital and inputs, production risks (especially under rain-fed conditions) and price risks.
2. Reduction in cost price will make production of fruits and vegetables more profitable to smallholders	Cost price reduction, by increasing yields and optimizing input use, will make fruit and vegetable production more profitable for smallholders. However, the profitability of current fruit and vegetable production is already high for farmers with access to irrigation water. This could act as an incentive for smallholders to further commercialize their production and achieve cost price reductions, but they would need support in overcoming knowledge barriers and access to finance challenges.
3. More efficient value chains can lead to lower fruit and vegetable consumer prices	Post-harvest losses are high in fruit and vegetable supply chains, adding to the risk of chain actors and therefore increasing transaction costs. The profit margins of irrigated vegetable smallholders are generally higher than that of other actors in the supply chain, which could be related to the higher risk profile of vegetable production compared to other actors.
4. More secure fruit and vegetable markets increase value chain efficiency, farmer income and reduce wastage	Contract farming and direct sales to retail are still very limited. The few initiatives involving contract farming in the past have not been very successful. With the increasing rise of modern supermarket retail and targeted agro-industrial processing, direct sales and contract farming will likely increase and could contribute to more secure incomes for farmers, but not necessarily higher incomes. Strict quality requirements of modern retail could increase wastage in the supply chain. One of the conditions for an economically viable agro-processing industry is that prices of sourced fruits and vegetables decrease, which potentially could reduce farmers' income.
5. Intermediary actors communicate consumer needs to producers and (jointly) develop innovative food products	There are little or no meaningful interaction and relationships between smallholders and consumers. The void is filled by non-value-adding actors that set low farm gate prices to boost their own profit margins. Due to the lack of trust among actors in the supply chain, in combination with informal sales agreements, the market is burdened with financial disputes, which are not conducive for the joint development of innovative food products or more market-oriented production.
6. More and higher diversity in fruit and vegetable crops produced and traded leads to more and more diverse fruits and vegetables in the food environment	There is no evidence that a more diverse supply of fruits and vegetables leads to higher fruit and vegetable consumption. Consumers seem to be more open to accepting new fruits than vegetables. The recent introduction of watermelon and a new mango variety has been well received by consumers. However, it is unknown whether such increased diversity in supply has resulted in more fruit consumption or that it has substituted other fruit consumption.
7. Prices of fruits and vegetables are always higher compared to other food categories	The profit margin per unit of vegetable is higher than for major staples, suggesting a risk premium for vegetable farmers. Further on in the fruit and vegetable chains other actors also take their risk premium, increasing consumer prices compared to staples that are more storable and face less losses.

Leverage point	Findings
8. Women's participation in fruit and vegetable production and value chain operations leads to higher income and empowerment of women	Currently, women already carry out many laborious tasks in fruit and vegetable production, but do not equally benefit compared to men. The challenge is to involve women in the many new employment opportunities that an emerging fruit and vegetable sector will offer. These jobs will be less laborious and provide opportunities for more equal rewards.
9. Higher income by women leads to higher consumption of fruits and vegetables	Higher income of women is particularly important for urban households, where women are primarily responsible for food purchases and preparing the meals. Higher income of urban households is already resulting in changes in food consumption towards more fruits and vegetables. Most likely, increases in women's incomes may increase the speed of this food consumption transition.
10. Public enforcement of standards will enhance food safety for consumers of fruits and vegetables	Clear and enforceable food standards for fruits and vegetables are lacking. The development and enforcement of standards for fruits and vegetables will contribute to enhanced food safety, an undervalued policy area in Ethiopia. However, the development of standards that improve food safety goes beyond the fruit and vegetable sector and should address all foods.
11. Nudging and public extension will improve consumer awareness of the health benefits of fruits and vegetables and consumption preferences	Over the last decade, the public health extension system has increasingly advocated for the consumption of fruits and vegetables. However, the priority of the Ministry of Agriculture has only recently moved more towards smallholder production of fruits and vegetables for the domestic markets. More coherence in policy among public institutions is needed to promote fruit and vegetable consumption and facilitate affordable prices for consumers.
12. Increased food safety, consumer awareness and responses to consumer preferences lead to higher acceptability of fruits and vegetables	It is uncertain whether improved food safety of fruits and vegetables contributes to their higher acceptability among consumers. Current low intake levels are much more related to affordability and the availability of fruits and vegetables. Consumer voices are little heard in the value chain, but they are also little voiced due to the absence of organized consumer groups.
13. Improved availability, affordability and acceptability leads to an intake of fruits and vegetables that meets the recommendations	Currently, the affordability and availability of fruits and vegetables are major determinants of consumer intake. With growing per capita incomes, affordability will become less of a constraint to fruit and vegetable consumption, as already observed in urban areas. However, it is uncertain how fast consumption will increase and to what extent recommended intake levels will be reached without additional nudging and awareness campaigns about the nutritional value of fruits and vegetables.

6.2 Discussion and conclusions

Levels of consumption of fruits and vegetables in Ethiopia are very low, resulting in insufficient levels of micronutrients such as vitamin A and zinc in Ethiopian diets (Bachewe et al., 2017). Investments in the fruit and vegetable supply chains in Ethiopia have the potential to positively contribute to several food system outcomes, especially related to food and nutrition security and women's economic empowerment.

So far, many of the government interventions in the fruit and vegetable sector focused on commercial production for export. Public financial incentives and other incentives have been especially effective in attracting investors that are specialized in fruits or vegetables, mainly focusing on the export market. These investors have the required sectoral knowledge, technical skills and capital, as well as their own upstream and downstream arrangements in the supply chain. Smallholders operating in mixed farming systems, who want to engage in fruit and vegetable production, lack this know-how and the assets to increase production and produce quality. Until recently, government support for smallholders focused mainly on the physical hardware side, i.e., building irrigation infrastructure and storage. More recently, however, public-private partnerships have been created to establish agro-industrial parks to support fruit and vegetable processing for value addition. The cluster farming approach has also been promoted with appropriate input and public financing schemes. The recently launched Ten Years Development Plan (2021-2030) policy aims to further strengthen the smallholder fruit and vegetable sector to support local agro-processing and produce quality products for export and local markets.

The alignment of public interventions at lower administrative levels (regions, districts, villages), as well as with other initiatives led by the private sector and development actors, needs to be improved to make the many public interventions a success. In addition, according to multiple interviews with stakeholders and focus group discussions for this study, the success of these interventions in building a strong and competitive fruit and vegetable sector remains weak. This is because the 'soft side' of such interventions (i.e., the development of knowledge, skills, information systems and the organizational capacity of supply chain actors) need to be further strengthened to ensure the fruit and vegetable sector really benefits. Strengthening fruit and vegetable research and extension services is a first step to improve farmers' capacity to develop economically viable and competitive fruit and vegetable enterprises.

Based on interviews with stakeholders and fruit and vegetable production statistics, it seems that fruit and vegetable supply cannot satisfy the market demand in Ethiopia during a large part of the year. Consequently, consumer prices of fruits and vegetables are high, limiting the accessibility of fruits and vegetables for the majority of the population with low incomes. However, farmers hardly complained about the profitability of their fruit and vegetable enterprises, which are generally substantially more profitable than cereal farming. Vegetable production is a risky, but a financially smart investment if farmers have secure access to irrigation water. For perennial fruits, the picture is different because of the considerably longer lead time to production and profit. A downside of the high fruit and vegetable prices is that farmers, who were predominantly subsistence farmers in the recent past, have little incentive to increase production further since they already earn much more than previously. The entrepreneurial mindset of many fruit and vegetable farmers and other actors in the value chain needs to be further developed and stimulated. Other actors with money or fortune seekers, who have little know-how and skills, have grabbed the opportunity that the emerging fruit and vegetable sector offers. Short-term profits are the main drivers for sector engagement for these actors and outweigh their interest in building long-term, trusting business relationships among value chain actors or the sustainability of the entire sector.

With the rapid urbanization, growing incomes and recovery of the catering industry after COVID-19, it is expected that demand among urban consumers for fruits and vegetables will continue to grow. This could open the door to creating more value addition targeting urban consumers, i.e., higher quality and more diverse products. However, the high price of fruits and vegetables is the most significant factor constraining their consumption for the majority of the population. Another downside of the high fruit and vegetable prices is that it will be difficult to develop a large scale processing industry for fruits and vegetables, which is competitive. The sourcing of sufficient and cheap produce for processing is a challenge in situations where farmers can easily sell their fresh produce against higher consumer prices. Therefore, the success of the agro-industrial parks is still to be awaited and will depend on strategies to increase production so that prices of the sourced fruits and vegetables drop. In turn, this may reduce the incomes of fruit and vegetable farmers who are not able to effectively reduce the cost price of their production.

A first step to lower consumer prices is to reduce the cost price of production of fruits and vegetables. Current productivity levels of fruits and vegetables are low and decreasing. This could explain the relatively higher increase in fruit and vegetable prices compared to starchy staples in the last ten years (FAO et al., 2020). Given the large yield gaps that exist for fruits and vegetables (Figure 5.4), using better quality inputs in the proper amounts to close the yield gap is the low hanging fruit that can be pursued in the short term. Since 2010, Ethiopia has shown a remarkable performance in increasing the productivity of staples, thanks to increased and better use of inputs (Figure 2.2; Abate et al., 2015). Realizing such productivity increases in fruits and vegetables will not be as easy since Ethiopian farmers have a lot more knowledge of and experience in the production of wheat, maize and teff. Moreover, the production of fruits and vegetables is more complex and exposes farmers to a range of new challenges, from controlling new pests and diseases, joint irrigation scheme management and proper harvesting techniques, to improved post-harvest management and engaging in new marketing channels. Most farmers engaged in fruit and vegetable production have only a short track record. The effects of new perennial fruit varieties on yield performance will only show after the lead in period, when the trees are at full production. Knowledge and skill building at individual and group level is important, as the technical aspects of staple crops, on the one hand, and fruits and

vegetables, on the other hand, differ and their respective supply chains are also different. Better knowledge and skills of farmers could also contribute to lower on-farm losses. These losses are extremely high at farm level and the effects of poor product quality at farm level trickle down to cause additional losses further in the supply chain. Reducing such losses will not only depend on technical know-how but also on the introduction of new technologies, such as smaller fruit trees that are easier to harvest and better handling, collection, storage and transport of the harvested produce.

Increasing the production of fruits and vegetables alone will not be sufficient to increase consumption. Consumer awareness about the health benefits of fruits and vegetables is growing, but it is still low. Public campaigns and other efforts are required to improve the nutritional knowledge of consumers to enhance the consumption of fruits and vegetables. School feeding programs that include fruits and vegetables could be one of the options to get the young used to consuming daily fruits and vegetables and learning about the health benefits of fruit and vegetable consumption.

An emerging horticultural sector also offers possibilities to aim at more inclusive growth and equal opportunities for women. The high labor requirements in fruit and vegetable production and the supply chains offer many on-farm and off-farm employment opportunities. Currently, women are mainly involved in unpleasant and laborious on-farm activities, such as planting and weeding. In addition to carrying out these activities, women also have to manage daily household tasks, such a collecting water and firewood, taking care of the children, cooking, etc. Back-breaking on-farm activities in vegetable and fruit production will not offer many women a means to step up and out of poverty. However, rural areas offer few alternative income generating employment opportunities for women. Any income earned by women could strengthen their position within the household, and facilitate them to negotiate the distribution of household tasks with their partner. Public awareness and empowerment campaigns will be needed to support this process.

With the further development of the fruit and vegetable sector, less laborious and more remunerative employment opportunities will emerge for both men and women. For example, jobs in advisory roles, the retail of agro-chemicals, post-harvest grading and sorting, processing, transport and marketing will emerge. Many women are already active in the retail of fruits and vegetables, so there is potential that they could have a future role in the retail of agro-inputs. Currently, women have leading management positions in many of the flower farms in Ethiopia, jobs that did not exist 15 years ago. For women to gain full benefit from horticultural sector growth and development, they need to be empowered, their entrepreneurial skills must be developed, and their access to capital facilitated, to allow them to set up businesses. A fair distribution of economic gains needs to be central to supply chains that are more inclusive, efficient, productive, profitable and sustainable (Brasesco et al., 2019).

The most important conclusion is that fruit and vegetable supply chains in Ethiopia are little consolidated. There are still many non-specialized, mixed farming systems with small vegetable and fruit plots, lacking the size and capital to scale and specialize production. Further on in the supply chain also many small and individually operating collectors, traders and retailers operate that hardly interact and communicate with each other. The sector is very much supply driven and still needs to make the step towards a more demand-driven supply. Vertical and horizontal integration of supply chains is needed to consolidate and build trustworthy relationships among actors in the supply chain. This means more specialization and better cooperation among the same type of chain actors (e.g. farmers) but also across different types of actors in the chain (e.g. farmers and traders). Building trust among actors is a precondition for working towards a more sustainable and inclusive fruit and vegetable sector that is able to provide high quality and safe products contributing to a healthy diet. A strong government that, jointly with the private sector, sets and enforces food safety and quality standards can support this process.

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Appendix 1 Details of focus group discussions (FGD) and key informant interviews (KII)

#.	Corridor	Specific location	Type of survey	Type of participants	Specific fruit and vegetable	Participants
1.	Addis Ababa		KII	Trader	Onion and tomato	Kedir
2.	Addis Ababa		KII	Ministry of Agriculture	General fruits and vegetables	Meseret Shiferaw
3.	Rift Valley		FGD	Melka Weji Farm	Papaya and avocado	9 actors
4.	Rift Valley		KII	Meki Batu Union	Onion, green bean, tomato	Awel
5.	Rift Valley		KII	Trader	Onion	Gete Feyisa
6.	Rift Valley		FGD	Lucha Dembel Farmers' Group	Head cabbage, tomato, onion	7 actors
7.	Rift Valley		KII	Meki Farmer Service Centre: input shop	General fruits and vegetables	Chaltu
8.	Rift Valley	Bora Woreda, Alem Tena	KII	Ethio-Admas Farm	Mango and avocado	3 actors
9.	Rift Valley	Wolaita Sodo	FGD	Smallholder farmers	Avocado, mango, banana, papaya	8 actors
10.	Abaya	West Abaya	KII	Group of four friends farming on rented land (joint business)	Tomato	5 actors
11.	Abaya	Arbaminch	FGD	Small business (traders)	Mango, avocado, apple, banana	6 actors
12.	Abaya	Ocholo Lante, Arbaminch	FGD	Farmers engaged in mango production	Mango	10 actors
13.	Yirgachefe, SNNPR		KII	Flora-Veg Commercial Farm	Seedlings for tomato, chilli (pepper), cabbage	Beyene Yalew
14.	Yirgachefe, SNNPR		KII	Yirgachefe Agriculture and Natural Resource Bureau		Habtamu Senbete
15.	Yirgachefe, SNNPR		KII	Smallholder farmers	Avocado	3 actors
16.	Tana	Merawi, Semen Mecha	FGD	Agriculture Bureau	Potato, cabbage, red onion, green pepper, tomato and carrot, avocado, banana, mango, orange and watermelon	4 actors
17.	Tana	Merawi, Semen Mecha, Adbra Block, Koga Irrigation	FGD	Smallholder fruit and vegetable farmers	Onion, cabbage, tomato, green pepper, potato, avocado, mango	17 actors
18.	Tana	Merawi, Semen Mecha	KII	Agriculture Bureau — Senior Agronomist	General fruits and vegetables	Feleke Wondifraw
19.	Tana	Merawi, Semen Mecha	KII	Private business — Zewdie Juice House, but also has own avocado farm	Avocado, mango, papaya, pineapple, banana Juices and fruit punch with bread	Zewdie Alemu
20.	Tana	Merawi, Semen Mecha	KII	Private business — Agernnesh Juice House	Avocado, mango, papaya, pineapple, banana fresh fruit, juices and fruit punch with bread	Agernesh Fetene

#.	Corridor	Specific location	Type of survey	Type of participants	Specific fruit and vegetable	Participants
21.	Tana	Merawi, Semen Mecha	KII	Koga Irrigation Users', Traders' and Farmers' Cooperative Union	14 unions under the cooperative By collecting from farmers they sell avocado, potato, red onion and cabbage to universities, hotels and cooperatives. Unions providing seed, fertilizer and pesticides at a fair price	Yeshiwas Yideg and Tsega Egzyabher
22.	Tana	Merawi, Semen Mecha	KII	Private business/avocado farming	Avocado production and export	Necho Worku
23.	Tana	Merawi, Semen Mecha	KII	Agrobig NGO	General fruits and vegetables	Ayichew
24.	Tana	Merawi, Semen Mecha	KII	Bikolo Fruit Tree Nursery and Seedling Multiplication Center	Supplying farmers with grafted seedlings of fruits, produce avocado and fruit for export and local market	Tilahun Mulugeta
25.	Tana	Merawi, Semen Mecha	KII	Private farmer	Production of avocado, banana, mango, tomato, red onion, potato, cabbage and green pepper. Export of avocado through farmer's cooperative and Koga Veg (last year 35,700 kg has been exported)	Abebaw Abe
26.	Tana	Bahar Dar	KII	Bahar Dar City Administration Agriculture Bureau	Avocado, mango, papaya, banana, guava, orange, tomato, cabbage, potato, Ethiopian cabbage, green pepper	Molaligne Mengistu Yeshi Gedamu
27.	Tana	Bahar Dar	KII	Private farm	Seedling multiplication of avocado, production of mango, tomato, cabbage, green pepper (produces organic vegetables by using biogas by-product and vermin compost)	Kassahun Emagnaw
28.	Tana	Bahir Dar, Addis Alem Kebele, Zeber	KII	Family farm	Mango, banana, papaya, tomato, green pepper, Ethiopian cabbage and carrot	4 actors
29.	Tana	Bahir Dar, Addis Alem Kebele, Zeber	KII	Private farm	Tomato, cabbage, red onion and green pepper	Demelash Yehuala
30.	Tana	Bahir Dar, Sebatamit Kebele	FGD	Smallholder farmers	Mango, avocado, tomato, papaya, red onion, Tomato, cabbage and Ethiopian cabbage	8 actors
31.	Tana	Bahir Dar, Sebatamit Kebele	KII (women only group)	Smallholder farmers	Tomato, cabbage, red onion and green pepper	Abebu Edeg Kare Adugna
32.	Tana	Bahir Dar	KII	Private business (Koga Veg)	Sugar snap, snow peas, avocado (from cooperatives), vegetable seeds, onion, carrot	Bantamlak
33.	Tana	Woreta Town, Fogera Woreda	KII	Fogera Woreda Bureau of Agriculture	Red onion, tomato, potato, carrot, mango, guava, papaya and avocado	Demisse Mulalem
34.	Tana	Woreta Town, Fogera Woreda	KII	Private business (juice house)	Avocado, mango, pineapple, papaya, guava, watermelon and strawberry, juice retail, fruit punch and fresh fruit retail	Tilahun Melkie
35.	Tana	Woreta Town, Fogera Woreda	FGD	Smallholder farmers/Shena Cooperatives	Red onion, green pepper, cabbage, mango	8 actors

#.	Corridor	Specific location	Type of survey	Type of participants	Specific fruit and vegetable	Participants
36.	Tana	Woreta Town, Fogera Woreda	KII	Ethiopian Institute of Agricultural Research, Fogera National Rice Research Training Center	Red onion, tomato, garlic, broccoli, fossella, avocado, mango, banana, watermelon	Shewaye Abera
37.	Tana	Woreta Town, Fogera Woreda	KII	Private business — retail shop	Retailing hybrid seed, fertilizer and pesticide	Hashim Husien Sulieman Husien
38.	Tana	Woreta Town, Fogera Woreda	KII	Fogera Woreda Agricultural Development Office	-	Melaku Alamirew
39.	Tana	Woreta Town, Fogera Woreda	FGD	Smallholders	General fruits and vegetables	5 actors
40.	Abaya	Located in Arbaminch, working in Gamo, South Omo, Bench Maji	KII	Vita/RTI - Green Impact Fund	Mango production farmers	MDemoze Ayele

Appendix 2 Consumer questionnaire

Questions regarding fruit:
What type of fruit do you consume commonly?
How often do you eat fruits excluding packed fruit concentrates?
Wat are the most common quality problems you encounter in fruits?
How do you think the consumption trend of fruits be promoted?
Are there fluctuation in the prices of fruits seasonally or during holidays?
What are the factors affect the consumption of fruits?
How open are you to consume new varieties of fruits?
Do you think consumption will be increased if the varieties fruits increase?
What kind of channels do you prefer to purchase fruits?
What health benefits are known associated with consumption of fruits?
What hinders you to consume more fruits?
Questions regarding vegetables
What type of vegetable do you consume commonly?
How often do you eat vegetables?
Wat are the most common quality problems you encounter in vegetables?
How do you think the consumption trend of vegetables be promoted?
Are there fluctuation in the prices of vegetables seasonally or during holidays?
What are the factors affect the consumption of vegetables?
How open are you to consume new varieties of vegetables?
Do you think consumption will be increased if the varieties vegetables increase?
What kind of channels do you prefer to purchase vegetables?
What health benefits are known associated with consumption of vegetables?
What hinders you to consume more vegetables?

Appendix 3 Fruit and vegetable sentinel groups

Fruits and vegetables grouped according to associations with nutrition and health outcomes.

	Sub-group	Health association
1	(Dark) green leafy vegetables	Contribute to iron, vitamin C, vitamin A and folate intake. Positive association with lower risks for coronary heart disease (CHD), stroke, all-cause mortality, but negative association cardiovascular disease (CVD).
2	Red, orange and yellow vegetables	Contribute to vitamin A and folate intake. Positive association with CHD and all cancer.
3	Cruciferous vegetables	Positive association with all cancer and all-cause mortality, but negative association with CVD.
4	Other vegetables	No reported health associations
5	Red, orange or yellow fruits	Contribute to vitamin C, vitamin A and folate intake. Positive association with CHD.
6	Citrus fruits	Contribute to vitamin C and folate intake (and helps to improve iron/zinc bio-availability). Positive association with CHD, stroke, CVD, and all-cause mortality.
7	Apples, pears	Positive association with CHD, stroke, CVD and all-cause mortality.
8	Other fruits	No reported health associations

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