# Synthesis Report of the Global Fruits and Vegetables Scoping Study

## Assessing opportunities for philanthropic investment

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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 is een synthese van onderzoek in India, Nepal, Bangladesh, Ethiopia, Tanzania, Burkina Faso en Nigeria. Het rapport 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 is the synthesis of research in India, Nepal, Bangladesh, Ethiopia, Tanzania, Burkina Faso and Nigeria. The report 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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P.O. Box 29703, 2502 LS The Hague, The Netherlands, T +31 (0)70 335 83 30, E communications.ssg@wur.nl, http://www.wur.eu/economic-research. Wageningen Economic Research is part of Wageningen University & Research.



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# 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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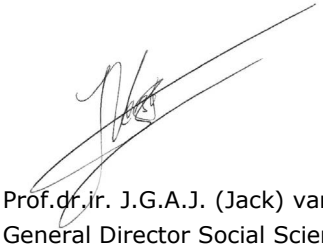

Prof.dr.ir. J.G.A.J. (Jack) van der Vorst
General Director Social Sciences Group (SSG)
Wageningen University & Research

# Executive summary

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 fruit and vegetable supply chains to increase the supply of and strengthen demand for nutritious foods, as well as increased opportunities for increased income, especially for women.

During the **first phase**, we analyzed trends across food systems globally and at the regional level (South Asia, East Africa and West Africa) for fruits and vegetables. We analyzed and described how current levels of production are tracking towards meeting dietary requirements, and how various food system drivers impact on production, supply and consumption of fruits and vegetables. The first phase concluded that:

- Consumption of fruits and vegetables in the three regions of study remains too low to meet recommended targets for reducing the risk of malnutrition. This under-consumption is observed across the three regions and is irrespective of social strata.
- Consumer prices of fruits and vegetables are high and affect the affordability of these healthy foods, notably for less-endowed households.
- Women face specific barriers that prevent them from earning more from fruit and vegetable production, trade and processing. These inequalities are not idiosyncratic to fruits and vegetables, but are reflective of wider trends women face in the agricultural sector.

During the **second phase**, we investigated the food systems in Nigeria, Burkina Faso, Ethiopia, Tanzania, Nepal, Bangladesh, and India, and the prominent role of different key fruits and vegetables in each country. The second phase aimed to identify key barriers, drivers and innovative business models, incentives, and critical investments needed to bring horticultural development to scale to support healthy and sustainable diets, while ensuring women's equitable inclusion through increased access to market opportunities and empowerment.

This synthesis report presents the overall findings of the Phase I study and seven country studies, as well as recommendations for areas of future investment by BMGF and FCDO. A starting point for addressing the lack of consumption of fruits and vegetables is 'reverse thinking': putting the dietary outcomes we want from food systems upfront in responsive food policy-making and legislation, and investments and interventions, and working towards incentivizing systems that create these outcomes.

Investments can stimulate the 'push' of fruits and vegetables, such as by increasing production or diversity in crops available through retail markets, or the 'pull' by stimulating the demand for fruits and vegetables, such as through school feeding programs or consumer nudging campaigns. Push and pull investments and related measures represent different impact pathways that must be carefully designed and based on validated theories of change.

When starting from consumer needs, investments should prioritize the production, supply and promotion of more nutritious and safe fruits and vegetables, such as dark green, leafy vegetables; red, orange or yellow vegetables; and cruciferous vegetables. These priorities can be achieved by focusing on the respective drivers and leverage points of changes in the food systems. Examples are given in this report, such as increasing consumer access to fruits and vegetables (such as papaya, guava and melon) by reducing the seasonality in production and supplies. Another example of an opportunity to achieve systemic changes is through investing in peri-urban food systems to enhance the volume, diversity and quality of supplies to urban consumers, which also positively impacts the economic opportunities of women. And, if the goal is enhancing rural food and nutrition security, investment in diversifying fruit and vegetable production in home gardens that are part of remote, mixed farming systems, is recommended.

Many new business models and initiatives designed to increase the economic benefits of women engaging in fruit and vegetable production, trade and

processing, have been identified in this study. Their successes depend mainly on individual women taking on leadership roles, or community efforts to organize women with the purpose of enhancing their agency and economic empowerment. Philanthropic investments can be made to expand such initiatives, support further experimentation and, above all, invest in robust evaluations to learn from interventions with these goals and support the scaling-up of proven successes.

Fruits and vegetables have been much neglected in low- and medium-income countries by public research and development (R&D) in the past. Private sector actors have mainly promoted the fruit and vegetable crops which have high economic potential, but not necessarily high nutritional value. In cases when supply chains gain volume and economic importance, men have taken over control from women. Public policies for food safety have been formulated, but generally lack enforcement. Increasing the supply of fruits and vegetables may come with trade-offs, such as reduced food safety or the exclusion of women.

The above highlighted complexities of enhancing the consumption of fruits and vegetables, and increasing the economic benefits of supply and production by women, calls for an application of the food system approach to their specific contexts, clearly identifying the leverage points for philanthropic investments. There is no 'one size fits all' solution and interventions have to be well tailored to their historically evolved, socio-economic and political contexts. As well known, 'food = identity' and changes in dietary practices often come with resistance. This report will help to improve our understanding of food systems in which fruits and vegetables are important. Putting these learnings into investments and action will require the engagement of all domestic stakeholders who play a role or benefit from the food system changes which are aspired to.

# List of abbreviations

| | |
|---|---|
| BMGF | Bill and Melinda Gates Foundation |
| CHD | Coronary heart disease |
| CVD | Cardiovascular disease |
| FAO | Food and Agriculture Organization of the United Nations |
| FCDO | Foreign, Commonwealth & Development Office |
| FGD | Focus group discussion |
| IPM | Integrated pest management |
| KII | Key informant interview |
| NCD | Non-communicable diseases |
| NGO | Non-governmental organization |
| OPV | Open-pollinated variety |
| R&D | Research and development |
| SF | Street food |
| SFV | Street food vendor |
| SHG | Self-help group |
| WUR | Wageningen University and Research |

# 1

# Introduction

# 1 Introduction

## 1.1 Background

The Agricultural Development and Nutrition teams at the BMGF, in collaboration with the FCDO in the UK, seek to investigate the potential of vegetable and fruit value chains to increase the supply of and strengthen demand for nutritious foods, as well as increase local and export 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 (De Steenhuijsen Piters et al., 2021). This 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 were formulated in general terms only. To test the validity and feasibility of the identified leverage points in specific contexts, seven deep-dive country studies were performed in Bangladesh, Burkina Faso, Ethiopia, India, Nepal, Nigeria, and Tanzania.

This synthesis report presents the overall findings of the global scoping study and seven country studies, as well as recommendations for areas of future investment by BMGF and FCDO.

## 1.2 Objective of this study

This study aims to gain a better understanding of current trends in the fruit and vegetable sectors, as illustrated by deep-dive country studies on Bangladesh, Burkina Faso, Ethiopia, India, Nepal, Nigeria, and Tanzania.

As a result of this study, BMGF and FCDO intend to identify potential investment options for enhancing the sustainable and inclusive development of the fruit and vegetable sector in these selected countries. The ultimate goal of this study is to understand whether, and in what areas, investments can be made to accelerate systemic changes in the food system for healthier diets and more economic opportunities for women.

## 1.3 Reading guide

In Chapter 2, we present the study approach and leverage points identified during the Phase I of the study. These leverage points have provided guidance to the seven country studies and selection of crops and supply chains. Chapter 3 presents the findings of the seven studies and comparisons between the countries studied, starting with findings on fruit and vegetable consumption, via supply chains and the production of fruits and vegetables. In Chapter 4, we summarize the main conclusions and provide recommendations for areas of future philanthropic investment.

# 2

# Approach

# 2 Approach

## 2.1 Introduction

This global scoping study on fruits and vegetables has been conducted by an interdisciplinary team at Wageningen University and Research (WUR). The study began in May 2020 and was divided into two phases. During the **first phase**, we analyzed trends across food systems globally and at the regional level (South Asia, East Africa and West Africa) for fruits and vegetables. We analyzed and described how current levels of production are tracking towards meeting dietary requirements, and how various food system drivers impact on production, supply and consumption of fruits and vegetables. The first phase concluded that (De Steenhuijsen Piters et al., 2021):

- Consumption of fruits and vegetables in the three regions of study remains too low to meet recommended targets for reducing the risk of malnutrition. This under-consumption is observed across the three regions and is irrespective of social strata.
- Consumer prices of fruits and vegetables are high and affect the affordability of these healthy foods, notably for less-endowed households.
- Women face specific barriers that prevent them from earning more from fruit and vegetable production, trade and processing. These inequalities are not idiosyncratic to fruits and vegetables, but are reflective of wider trends women face in the agricultural sector.

During the **second phase**, we investigated seven country-specific food systems with prominent roles for fruits and vegetables, and focused on both private and public sector pathways to increase supply and demand for vegetables and fruits. The second phase aims to identify key barriers, drivers and innovative business models, incentives, and critical investments needed to bring horticultural development to scale to support healthy and sustainable diets, while ensuring women's equitable inclusion through increased access to market opportunities and empowerment. We recognize that, in addressing gender issues, it is not enough to focus on women alone; they must also be viewed in the context of their relationships with men and how they influence each other, creating barriers to, but also opportunities for, development.

## 2.2 Defining fruits and vegetables

Fruits and vegetables can be categorized into eight different groups (Table 2.1), based on their content of specific nutrients and attribution to risks for diseases. The foods categorized as fruits or vegetables vary and studies differ in whether legumes and starchy vegetables, like sweet potatoes, are included in the vegetable group, or whether banana is included in the fruit group. In addition, many of the studies and meta-analyses on associations between fruit and vegetable consumption and health outcomes include only very few studies in LMICs. Lastly, only the direct associations were reviewed, although it is recognized that fruit and vegetable consumption might also improve health and reduce risk of chronic disease indirectly, through substitution of unhealthy foods (high in saturated or trans-fat, sodium, and with a high glycemic load) in the diets.

***Table 2.1*** *Fruits and vegetables categorized according to associations with intake of selected nutrients and health outcomes*[1]

| | Sub-group | Health association |
|---|---|---|
| 1 | (Dark) green leafy vegetables | Contributes to iron, vitamin C, vitamin A, and folate intake. Reduces dietary risk for coronary heart disease (CHD), stroke, and all-cause mortality, but negative with cardiovascular disease (CVD). |
| 2 | Red, orange and yellow vegetables | Contribute to vitamin A and folate intake. Reduces dietary risk for CHD, and total cancer.[2] |
| 3 | Cruciferous vegetables | Reduces dietary risk for total cancer and all-cause mortality, but increases dietary risk for CVD. |
| 4 | Other vegetables | No specific richness in relevant nutrients; no or unknown dietary risk for non-communicable diseases (NCDs). |
| 5 | Red, orange or dark yellow fruits | Contribute to vitamin C, vitamin A and folate intake. Reduces dietary risk for CHD. |
| 6 | Citrus fruits | Contribute to vitamin C (and help to improve iron/zinc bioavailability) and folate intake. Reduces dietary risk for CHD, stroke, CVD, and all-cause mortality. |
| 7 | Apples, pears | Reduces dietary risk for CHD, stroke, CVD and all-cause mortality. |
| 8 | Other fruits | No specific richness in relevant nutrients; no or unknown dietary risk for NCDs. |

[1] Fruits and vegetables provide a range of essential nutrients and bioactive compounds, including vitamins, minerals, phytochemicals, and dietary fiber, differing widely between and within fruits and vegetables. This table reflects the contribution of selected nutrients of which deficiencies are prevalent in low- and middle income countries. See also Phase I report of this study.

[2] Total cancer refers to cancer not specified by type of cancer.

Summarized based on studies from e.g. Afshin et al., 2019; Alemu et al., 2019; Aune et al., 2017; Yip et al., 2019.

## 2.3 Leverage points

During the first phase of the study, we identified various leverage points, assumptions and associated guiding questions among food systems with prominent roles for fruits and vegetables, which fed into the design of the country case studies. To answer each question, we applied a mix of literature research, primary data analysis and interviews through focus group discussions (FGDs) and key informant interviews (KII), see Table 2.2.

***Table 2.2*** *Leverage points and related guiding questions from Phase I*

| Leverage point | Assumptions | Guiding research question Phase II |
|---|---|---|
| Production | 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? |
| Cost price | 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? |
| Fruit and vegetable supply chain efficiency | More efficient supply 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? |
| | More secure fruit and vegetable markets increase value chain efficiency, farmer | Are there examples that more secure markets (formal markets) are beneficial to smallholder farmers? How should farmers benefit from such arrangements? |

| Leverage point | Assumptions | Guiding research question Phase II |
|---|---|---|
| | income, and reduce post-harvest losses | What are the post-harvest losses in the fruit and vegetable supply chains? |
| Communication | 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?<br>Do they impose standards on producers?<br>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? |
| Diversity | More and higher diversity in fruit and vegetable crops produced and traded leads to 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?<br>What are the trends in fruit and vegetable consumption, are these dependent on season, geographical location (production/ non-production areas), and can these trends be disaggregated by different types of fruits and vegetables? |
| Consumer prices | 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? |
| Women participation | 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 fruit and vegetable value chain operations? What explains these successes and is there evidence of them being scaled up?<br>What business models work best for women's inclusion and leadership? |
| | 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? |
| Consumer participation | Public enforcement of standards will enhance food safety for consumers of fruits and vegetables | An inventory of relevant standards (public/private).<br>How are these standards enforced?<br>Do consumers trust these standards? How are they perceived and acknowledged by other stakeholders in the food system? |
| | 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?<br>How have policies enabled women to address systemic constraints that they face, and to successfully access sufficient nutrition?<br>An inventory of innovative policy and strategy examples implemented – who is implementing them? Are consumers' motives taken into account? |
| | Increased food safety, consumer awareness and responses to consumer preferences leads 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? |
| | Improved availability, affordability and acceptability leads to intake of fruits and vegetables 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? |

## 2.4 Theory of change

The leverage points presented in the previous section impact on specific components of the food system, but have systemic effects through their feedback loops. Together, they represent an emerging theory of change that can be considered when designing an intervention strategy and related investment policies. Leverage points for food system change are based on

assumptions regarding their causal pathways from the point of intervention to expected impact.

In the second phase of the study, we investigated these leverage points and their underlying assumptions to reflect on the plausibility that targeted investments will impact food systems and result in higher consumption of fruits and vegetables, as well as economic empowerment for women.

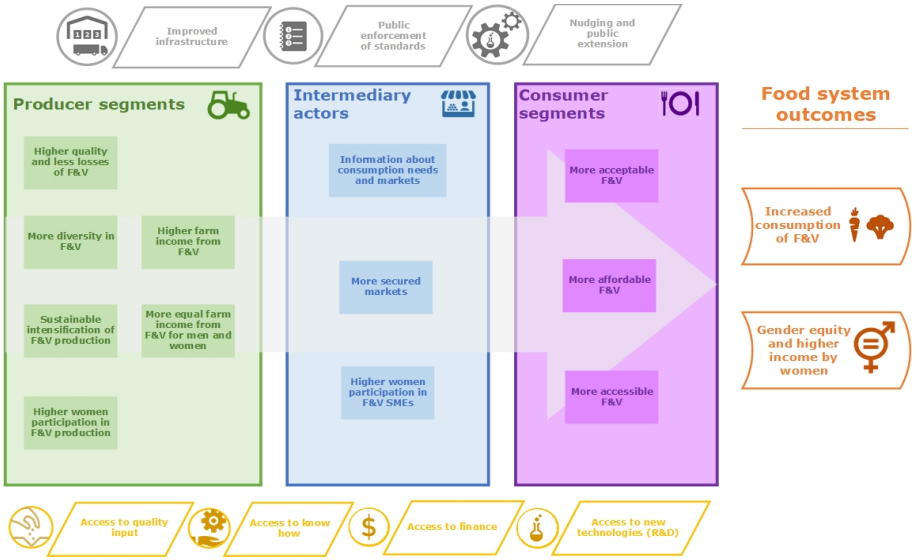


***Figure 2.1*** *Leverage points for fruits and vegetables in food systems*
*Source: Authors' own.*

## 2.5 Selection of crops

To provide scope and focus to the study, we selected the most important categories of fruits and vegetables in each of the seven countries. To do this, we applied two main sets of selection criteria:

- The most important current and potential categories of fruits and vegetables for poor and middle-class urban and rural consumers, in terms of income generation, their importance for nutrition (trying to represent a mix of the various sentinel foods that are essential for a healthy diet), and empowerment opportunities for women.
- The most important production areas serving these linkages. Also, important consumer categories and the most prominent fruit and vegetable chains, food environments and consumer linkages in the food system were considered.

Table 2.3 provides an overview of the different groups of fruits and vegetables, including the sentinel foods that are typically consumed by a large share of the population in each country.

***Table 2.3*** *Crops selected by country*

| | Tanzania | Burkina Faso | Nigeria | Ethiopia | India | Nepal | Bangladesh |
|---|---|---|---|---|---|---|---|
| Fruit crops selected | Mango | Mango | Mango | Avocado | Orange | Mango | Mango |
| | Orange | Papaya | Pawpaw | Mango | Litchi | Lapsi | Pineapple |
| | | Nere fruit | Citrus | Orange | Mango | Kiwi | Jackfruit |
| | | Baobab fruit | | | | | |
| Vegetable crops selected | Amaranth (leaves) | Amaranth (leaves) | Tomato | Cabbage | Fresh Peas | Mustard (leaf) | Pumpkin |
| | Eggplant | Baobab (leaves) | Onion | Tomato | Brinjal (eggplant) | Bitter gourd | Tomato |
| | Spinach | | Amaranth | Carrot | Onion | Pumpkin | Okra |
| | Cabbage | | | | Tomato | | |

## 2.6 Approach

To answer the guiding questions, we combined different approaches, allowing for in-depth information gathering as well as cross referencing and triangulation:

- Desk research: This was focused on academic publications describing the situation in the horticultural sector of each country, with special attention focused on the selected crops. We complemented this with additional secondary data sources, such as Food and Agriculture Organization (FAO)

statistics on production figures, farm gate prices and wholesale prices. However, data was not available for all of the selected crops.

- FGDs: To collect views on ongoing developments in the fruit and vegetable sector, and to harvest expert and actor opinions on the horticultural sector, we organized 57 FGDs (online and physical), with five to 15 participants per FGD. Representatives originated from private businesses, non-governmental organizations (NGOs), government, etc.
- KIIs: These were conducted with various actors, including experts in the field of fruit and vegetable production, the development sector, public sector, and private sector. In total, we conducted 99 KIIs.

***Table 2.4*** *Number of FGDs and KIIs per country*

| | Tanzania | Burkina Faso | Nigeria | Ethiopia | India | Nepal | Bangladesh | Total |
|---|---|---|---|---|---|---|---|---|
| FGDs | 4 | 5 | 8 | 10 | 20 | 5 | 5 | 57 |
| FGD participants | 41 | 75 | 63 | 93 | 186 | 50 | 52 | 560 |
| KIIs | 6 | 21 | 6 | 30 | 12 | 15 | 9 | 99 |

In addition, we produced crop budget calculations for the selected crops. This was based on typical farm costs like seeds, fertilizers, crop protection, labor (including family labor valued at a day wage of a typical laborer), and potential revenues from the foreseen harvest. All calculations were made for 1 ha of production, excluding fixed costs like land rent. As input for these calculations, we used various sources, including relevant literature, but also expert information from the KIIs.

# 3

# Results

# 3 Results

## 3.1 Introduction

In every country studied, fruits and vegetables are important for people's nutrition. Fruits and vegetables come from many sources to consumers; sometimes collected from the wild, or produced in intensive production systems. Fruits can be of an annual nature or grow on perennial trees, while a great variety of vegetables are found. But how fruits and vegetables find their way to consumers is also highly diverse (see Section 3.2). In order to bring diverse fruits and vegetables to consumers, ingenious and elaborate networks of traders, processors and other middlemen have evolved (section 3.2). To feed into these supply chains, producers of all sizes and backgrounds also grow these crops in highly diverse environments, being challenged by different agro-ecological and climatic conditions, yet succeed in feeding both rural and urban communities.

Contributions of fruits and vegetables to GDP ranges between 1% (Ethiopia) and 16.7% (Nepal) among the seven countries. India is by far the greatest exporter of fruits from the selected countries. Table 3.1 also highlights that countries such as Nigeria, Nepal and Bangladesh are net importers of fruits and vegetables. Some countries import specific fruits and vegetables or related products – Nigeria and Burkina Faso, for example, import high volumes of tomato paste from China.

***Table 3.1*** *Total production, export and import volumes (in 1,000 metric tons), 2018*

| | | Fruits | Vegetables |
|---|---|---|---|
| Bangladesh | Production | 4,635 | 5,694 |
| | Export quantity | 100 | 30 |
| | Import quantity | 424 | 380 |
| Burkina Faso | Production | 114 | 324 |
| | Export quantity | 35 | 50 |
| | Import quantity | 25 | 42 |
| Ethiopia | Production | 935 | 1,708 |
| | Export quantity | 13 | 107 |
| | Import quantity | 16 | 53 |
| India | Production | 94,979 | 131,997 |
| | Export quantity | 895 | 2,798 |
| | Import quantity | 1,106 | 51 |
| Nepal | Production | 1,341 | 3,972 |
| | Export quantity | 33 | 7 |
| | Import quantity | 160 | 178 |
| Nigeria | Production | 11,986 | 16,436 |
| | Export quantity | 1 | 18 |
| | Import quantity | 69 | 352 |
| United Republic of Tanzania | Production | 5,516 | 2,635 |
| | Export quantity | 48 | 40 |
| | Import quantity | 12 | 4 |

Source: FAOSTAT.

## 3.2 Fruit and vegetable consumption

### 3.2.1 Trends in intake of fruits and vegetables

No recent nationally representative data on the daily consumption of fruits and vegetables in grams was available for any of the seven countries studied. This confirmed the general lack of representative data on what people actually

consume. We used the most recent data (2017) from the *Lancet's* Global Burden of Disease (GBD) study to describe the fruit and vegetable intake for each country.[1] Figure 3.1 shows that, in all selected countries, the intake of fruits and vegetables is below the recommendations of the World Health Organization (WHO) (400 g/day for fruits and vegetables combined), the GBD (250 g/day of fruits; 360 g/day of vegetables) and the EAT-Lancet reference diet (200 g/day of fruits and 300 g/day of vegetables). Gaps in fruit intake are generally larger than those in vegetable intake (Figure 3.1). The extent of the fruit and vegetable intake gaps, and the difference in gaps between fruit and vegetable intake, however, show much variation between countries. Nepal and India have the lowest gap (<30%) in vegetable intake, while Bangladesh, Ethiopia and Nigeria have the highest gap in vegetable intake (>75%). Tanzania and Nigeria have a gap in fruit intake of below 50%, whereas Bangladesh, Ethiopia and Burkina Faso have a fruit intake gap of 80% or more. Although GBD data should be cautiously interpreted especially for Africa,[2] these figures indicate that low fruit intake might be a larger problem than low vegetable intake. This is also confirmed in a study using household expenditure data in selected countries in Africa, showing larger gaps in fruit intake (expressed as contribution to calorie intake) compared to vegetable intake for both urban and rural areas in Ethiopia and Tanzania (Headey et al., 2021). Although fruits and vegetables are in general referred to as one food group, most attention is often given to vegetables. The larger fruit intake gap, combined with stronger evidence of the health risks of low fruit intake, emphasizes the need to ensure that work to increase fruit intake receives appropriate attention in public and private investments.

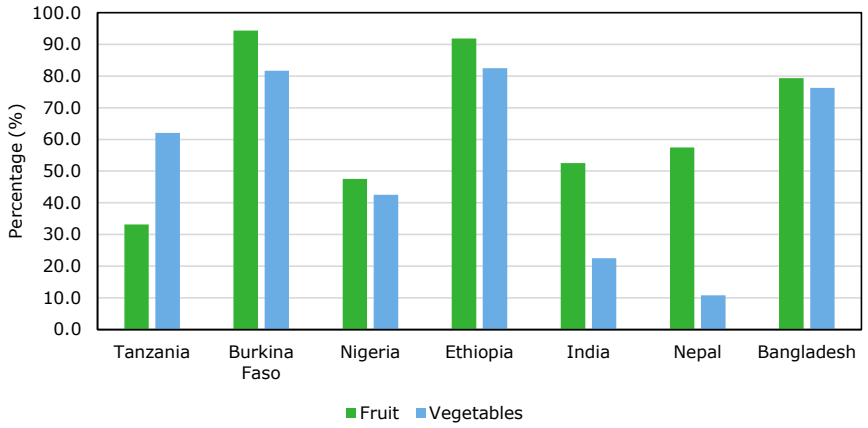


***Figure 3.1*** *Gap in fruit and vegetable intake as percentage of the recommended intake, 2017*

The lack of recent national representative intake data also limits our ability to further analyze drivers of fruit and vegetable intake, the differences in fruit versus vegetable intake, and differences between varieties of fruits and of vegetables. We have very little information on the differences in fruit and vegetable consumption between rural and urban populations, between different sub-national regions, high- and low-income households, and high- and low-production areas; nor could we identify differences in intake and intake gaps between age or gender groups in the selected countries. This supports an international plea for better dietary intake data collected using simple tools. The recently developed and launched INDEXX24 intake data collection tools, the Global Dietary Quality Score tools, and the Global Dietary Quality project questionnaires are a step forward to the collection of these data for global and regional monitoring, policy planning and research. However, validation of these methods and tools specifically to assess fruit and vegetable intake is needed.

[1] https://foodsystemsdashboard.org/countrydashboard

[2] The dietary data presented here is from GBD (http://www.healthdata.org/gbd). It is important to note that the data is not actual dietary intake data, but instead modeled estimates based on data from multiple sources, including national and sub-national nutrition and household budget surveys, and food availability from FAO food balance sheets. The amount of data that these estimates are based on varies greatly nationally and sub-nationally, and thus these estimates may under- or over-estimate dietary intake. Especially in Africa, actual intake data are missing and therefore estimated intake is based on a limited set of data and should be interpreted with care.

### 3.2.2 Costs of healthy diets

As recently revealed by the 2021 *State of Food Security and Nutrition in the World* (SOFI2020) report, three billion people worldwide cannot afford a healthy diet, defined according to the national food-based dietary guidelines, and if guidelines were not available, according to the guidelines of a neighboring country (Herforth et al., 2020). In our selected countries, more than 75% of the population cannot afford a healthy diet, with Burkina Faso and Nigeria showing the highest proportion (90% or above). Further analysis of the SOFI2020 data showed that the average costs (US$) per person, per day, for a healthy diet ranged from US$2.62 in Tanzania to US$4.13 in Nepal (Table 3.2).[3] Costs of the least expensive fruits and vegetables varied from US$0.86 in Tanzania to US$1.72 in Nepal, and between 30% and 42% of the cost of a healthy diet is accounted for by fruits and vegetables in the seven countries. In Ethiopia, for example, the affordability of fruits and vegetables was the major barrier to consumption, with the recommended intakes costing 11% of household income for the average Ethiopian, and 27% for the poorest households. This confirms that fruits and vegetables are more expensive compared to other food groups such as cereals, oils and fats, and drive a large part of the costs of a healthy diet. Unfortunately, no further cost disaggregation by fruits and vegetables separately, nor by specific fruits and vegetables, can be made, as data is not available. In addition, the costs of the least expensive fruits and vegetables were used to calculate the costs of fruits and vegetables, but it is unknown which fruits and vegetables were least expensive. For vegetables, these might be tomatoes and onions, which are known to be less nutrient-rich than dark-green leafy vegetables or cruciferous vegetables. Also striking is that there is little known in each country about the costs of fruits and vegetables in healthy diets. However, it is observed that, especially amongst low-income population groups, diets are dominated by cereals as these are cheaper (and other foods, including fruits and vegetables, are more expensive) and suppress the hunger feeling. However, cereals lack essential nutrients such as vitamin A and C, and do not exert protective properties against non-communicable diseases (NCDs) as fruits and vegetables do.

***Table 3.2*** *Current situation regarding intake and costs of fruits and vegetables*

| | Tanzania | Burkina Faso | Nigeria | Ethiopia | India | Nepal | Bangladesh |
|---|---|---|---|---|---|---|---|
| Average daily per capita consumption of fruits and vegetables (g/day/person) a) | 198 | 53 | 138 | 55 | 262 | 271 | 99 |
| Average daily per capita consumption of fruits (g/day/person) a) | 107 | 9 | 80 | 13 | 76 | 68 | 33 |
| Average daily per capita consumption of vegetables (g/day/person) | 91 | 44 | 138 | 42 | 186 | 214 | 57 |
| Cost of a healthy diet (US$/person/day) | 2.62 | 3.66 | 3.57 | 3.74 | 3.27 | 4.13 | 3.66 |
| % of the cost of a healthy diet accounted for by fruits and vegetables | 33 | 30 | 34 | 39 | 39 | 42 | 34 |
| % of the population that cannot afford a healthy diet | 85 | 90 | 91 | 84 | 78 | 76 | 75 |

Sources: a) Lancet's Global Burden of Disease (2017) and Anna Herforth and Aishwarya Venkat, personal communication. Based on an analysis in Herforth et al. (2020).

To meet the recommendations for fruit and vegetable intake, both the overall amount and the diversity of fruit and vegetables consumed needs to be taken into account. Promotion of consumption of traditional (indigenous or underutilized) fruits and vegetables is often suggested as a relatively cheap strategy to increase intake, yet very little information on traditional fruits and vegetables is available; which was also the case for the country studies where not much was known by those interviewed about these fruits and vegetables. We put much effort in the selection of sentinel fruits and vegetables that deviated from the usual consumed, such as tomatoes and onions, but we faced

[3] Source: Anna Herforth and Aishwarya Venkat, personal communication. Based on analysis in Herforth et al. (2020)

difficulties concerning the availability of information on these foods. In Nigeria, Burkina Faso, Tanzania, and Nepal, local vegetables such as amaranth leaves, baobab leaves, and nettle were selected. In India, the study indicated that wild green leafy vegetables grow abundantly locally and are freely available; however, during FGDs, it was said that these vegetables were considered 'dirty' or 'poor people's food'. A different attitude was observed in Nepal towards the traditional fruit Lapsi: Because of its sweet taste, this and other indigenous fruits are consumed, mostly in the form of pickles and candies. This is often anecdotal information, and more rigorous information on actual intake, nutritional value, and (potential) contribution to a healthy diet is unknown, and should receive more attention by national policymakers.

Box 1: Prices of fruit and vegetables compared to cereal production

In the Ethiopia study, the costs and net returns of irrigated vegetable and rain-fed cereal production have been compared. The cost price of cereals, i.e., the production costs expressed per unit of harvested produce was higher than of tomato and onion, mainly driven by the much higher yields of vegetables compared to cereals. The production costs of vegetables per hectare were four to five times higher than of cereals, but the vegetable yields were eight to 10 times higher compared to cereals. While farm gate prices of cereals (per kg) were a bit higher than tomato and onion, the higher yields of vegetables resulted in much higher profits per hectare. These results suggest that the margin (price received) of vegetable farmers was relatively high, which seems to be confirmed by the margins that other actors in the supply chain received, not only in Ethiopia but also in the other countries studied (Figure 3.2). However, producer prices of fruits and vegetables fluctuate much more than of cereals, and this not only applies in low- and middle-income countries. If there is an oversupply of fruits and vegetables, market prices respond much quicker than for cereals that can be stored or substituted more easily. This means that farmers will also have periods of lower profits and even experience financial losses. In addition, production risks, due to pests, diseases and unfavorable weather conditions, and the relatively high farmer margins, have to compensate for these.

The role of fruits and vegetables in dietary patterns is also important to highlight. In most countries, fruits are considered as a snack, a special food, a (luxurious) addition to daily meals, and are eaten fresh. Vegetables are generally part of main dishes and meals. In Africa, vegetables are mainly part of lunch and dinner and are often processed (cooked or simmered) for a relatively long time in combination with other ingredients, such as other vegetable oil, legumes, and sometimes meat (in mixed dishes such as sauces and stews). In Asia, vegetables can be part of all meals (breakfast, lunch and dinner) with varied processing (whether alone or in combination with other ingredients) times, or are consumed fresh as salad. The different role of fruit compared to vegetables may explain the larger fruit intake gap. The place of fruits and vegetables in the diet may also determine the room for maneuver for increasing fruit and vegetable intake. However, there was very little information in the country cases about these roles, and this deserves further attention.

### 3.2.3 Consumer motives and barriers to fruit and vegetable consumption

In the Phase I literature review, we found that the main constraints to higher intake emerging from a consumer point of view were suggested to be affordability (price), availability (across the year), acceptability (cultural habits, convenience), food safety, and fruit and vegetable diversity. We used the country case studies to verify these drivers and provide a deeper understanding of the nuances of the effect of such drivers on intake.

In all countries, the cost of fruits and vegetables is mentioned as one of the main drivers of consumption, though cost is by no means the sole driver. Cost seems closely linked to seasonality, as produce is cheaper during the harvest season and gets more expensive off-season. In off-season, fruits and vegetables may also be imported and this can contribute to increased prices. In a rural context, the prospect of a better selling price may also negatively influence the consumption of vegetables by farmers, as was the case in Bangladesh. If (poor) producers receive a better price from selling pumpkin at market, they reduce home consumption and so prefer selling produce to generate income. This implies that increased availability in urban markets might be at the expense of rural people's fruit and vegetable consumption, especially when there is a supply gap in urban markets. In the box below, we discuss the interactions between the prices of fruit and vegetables and income.

Box 2: The costs of fruit and vegetables and income developments

Low-income consumers will reduce intake of fruits and vegetables during off-season. But, as observed in all countries, an increase in income and purchasing power does not necessarily lead to an increase in consumption of fruits and vegetables, and certainly does not result in people achieving the recommended intake of fruits and vegetables. Consumer segmentation is therefore very important in understanding the drivers and possible impact of cost-reducing interventions. However, various studies indicate the demand for fresh vegetables is generally inelastic with respect to changes in prices. This implies that price subsidies are not effective to support demand, as, for example, indicated by Dong and Lin (2009). On the other hand, the income elasticity of demand for fruits is relatively high with 1.79 and 1.68 respectively in 2009-10 for rural and urban areas in India, indicating income elastic demand in both areas. The income elasticity for fresh vegetables is lower (0.62 in rural and 0.68 in urban areas), indicating that demand for fresh vegetables is less affected by income changes (Meena and Sharma, 2015). Comparable results of income elasticity analyses are reported elsewhere, showing a lower demand for vegetables compared to fruits based on household expenditure data in selected East African countries (Headey et al., 2021). Therefore, improving income is a necessary condition, but this alone is not sufficient for increasing intake. Modifications in other attributes – such as convenience, attractiveness and improved shelf-life – are more important drivers of fruit and vegetable choice.

Seasonal availability of fruits and vegetables is also mentioned as one of the main drivers of consumption depending on the crop and geography (e.g., topography in Nepal). During off-seasons, when availability of fruits and vegetables is limited, consumption will be reduced because they are generally more expensive and (poor) consumers refrain from buying them. Irrigation could reduce the influence of seasonality, and thus increase the availability of produce, but it is unknown whether that would translate to an increased intake. However, abundant fruit and vegetable availability during the harvest season does not necessarily translate into higher intakes. Poor handling and preservation strategies, and weak transport networks, are reasons for large losses of fruits and vegetables from the farm to the consumer in times of abundance, which especially affects urban consumers. Seasonality might affect fruits differently than vegetables, as suggested in Nigeria, where fruits are produced and are available year-round, while vegetables are seasonally available, especially in rural areas. In Tanzania, the opposite phenomenon is observed, as fruits are only available in specific seasons. It is often suggested that traditional or indigenous fruits and vegetables could fill the seasonal availability gap, but information beyond anecdotal evidence does not exist.

The country studies do indicate that gender influences the consumption of fruits and vegetables. It is suggested that women eat more healthy foods, including fruits and vegetables, but studies show conflicting evidence in different regions. A few indications of gender differences are observed in Tanzania, where norms around the consumption of fruits and vegetables play a role: fruits and vegetables are considered foods for women and children, whereas men should eat meat and cereals (for energy). This would suggest a higher fruit and vegetable intake by women, but could not be confirmed. In practice, findings suggest that, with a paucity of fruit and vegetables available (and affordable), women will prioritize ensuring the men, and then the children, are properly fed before they themselves eat. Nepal, being a predominantly female-headed farming society (men often migrate abroad to earn money), has the smallest intake gap between actual consumption and recommendations, hinting on a speculative association between gender and fruits and vegetable intake, but this could also not be verified. While, in general, it is reported that women tend to re-invest income under their control into the household, including into more nutritious foods for children, the country reports could not prove this link.

All of the country studies noted that greater knowledge and awareness on the health benefits of fruits and vegetables might increase intake. Increasing the knowledge of women was highlighted in particular as an important driver to increasing intake of fruits and vegetables, as they are often the person preparing the food for the household (though not necessarily always purchasing it). This requires improving education by health extension workers or education programs through schools. However, an increased knowledge on the health benefits of fruits and vegetables does not directly translate into meeting the recommendations of intake, as it also concerns an element of attitude change. It has also proven difficult for people to estimate portion sizes and thus judge whether their intake is sufficient. Traditional vegetables may be avoided because of perceptions of them being poor man's food, or being dirty or unhealthy (India), but gain popularity in other countries (Nepal), especially among higher-income consumers (Ethiopia), due to increasing nutritional awareness. In Tanzania, amaranth leaves, for example, remain popular irrespective of consumer income.

Taste was also indicated as one of the drivers of fruit and vegetable consumption. Fruits naturally have a sweet taste and are therefore easily accepted. In Ethiopia, it was explicitly mentioned during the FGDs that the taste of vegetables was a barrier to increasing their consumption.

Convenience has been shown to play a role in fruit and vegetable consumption – especially for lunch where people at work tend to consume meals not prepared at home, most of which contain few (if any) vegetables. In Nigeria, it was observed that an increasing number of people practice out of home consumption due to time constraints, which restricts the time available for home preparation, and therefore leads to less vegetable consumption.

In all of the countries, with the exception of Ethiopia, food safety issues were mentioned as major concerns amongst consumers. Poor control and inspection of safety aspects of fruits and vegetables, including the use of pesticides and other chemicals, were highlighted in particular. In our sample, the awareness and concern about food safety seems to be more prominent in Asian countries compared to African countries. Higher income consumers in particular show an increasing preference for organic and ecologically-friendly produce, but do not necessarily always trust organic produce; especially when mixing of organic and non-certified products at markets is suspected, and because inspection is also lacking. Reports mention that consumers often network with each other to gain product information (e.g., on food safety) and to identify reliable retailers and producers. Some reports indicate that consumers buy directly from producers, eliminating intermediaries and increasing trust. If pest management and disease control could be improved (and inspection and control stepped up), more safe fruit and vegetables will reach consumers and trust could be enhanced. Furthermore, concerns about food safety problems related to biological hazards may be less of a problem for vegetables compared to fruits, because vegetables are predominantly cook before being consumed, whereas fruits are largely consumed raw.

Although long-term effects of the COVID-19 pandemic and related restrictions are not yet known and rigorous research on dietary impacts is yet to be published, early assessments indicate mixed effects on the intake of fruits and vegetables. In Nepal, a negative effect was observed, where the demand for fruits and vegetables had been reduced due to the limited mobility of consumers to reach the market. In addition, a surplus availability of fruits and vegetables was observed in urban markets because of the migration of urban population to rural areas. In Bangladesh, a decrease in fruit consumption during COVID-19 was also observed. The decrease in consumption was higher among poor households in Dhaka compared to middle- and high-income consumers; nevertheless, the negative effect of COVID-19 on vegetable consumption was similar between poor, middle- and high-income consumers. In Tanzania and Ethiopia, for example, an increase in the consumption of vegetables (vitamins and minerals) and fruits was observed, most likely because fruits and vegetables were believed to lead to better health and boost people's immune systems. However, there remains much uncertainty about the extent of the impact of the pandemic, and the consequences depend on how the pandemic further evolves and the ability of governments to mitigate its impact.

### 3.2.4 Policies and food environment interventions

All of the country reports revealed that the governments had launched a nutrition action plan, and although these often promoted healthy diets, most did not provide detailed descriptions of policies and strategies specifically aimed at creating an enabling environment for consumers to adhere to the recommendations for fruit and vegetable intake. An exception was Bangladesh, which has strategies targeting meal planning to promote dietary diversity, and India, which has a mix of consumer-targeted strategies (including school meal programs) and nutri-garden programs to encourage consumers to grow and consume diverse vegetables. Another example of such policies are country-specific food-based dietary guidelines, which set recommendations for an overall healthy diet for the general population, taking into account the context of the country. Such recommendations include information on fruit and vegetable intake and provide material for schools or health extension workers to educate people and set standards and targets for public and private investments. In Ethiopia, the development of such context-specific, food-based dietary guidelines is ongoing and the official launch is planned to take place at the end of 2021. In Nigeria, general food-based dietary guidelines were developed in 2001, but Tanzania and Burkina Faso do not yet have guidelines. Bangladesh revised its guidelines in 2013 and India revised its in 2011. While most guidelines need to be updated and expanded, they have been underutilized as tools for informing investment strategies in terms of agricultural production (e.g., reorienting focus from cereals to fruit and vegetable production) and to facilitating access to diets that meet dietary guidelines.

The country reports describe several specific interventions/innovations that aim to increase the intake of fruits and vegetables. One example from Lagos, Nigeria, explored the potential to increase street food (SF) customers' vegetable intake by offering additional vegetables to SF meals by working jointly with 12 SF vendors (SFVs). During the intervention, the trained SFVs actively promoted the healthiness of vegetables and the option to buy an additional vegetable portion as a side dish. The study showed that almost half of the customers of the 12 SFVs bought additional vegetables with their meal (Raaijmakers et al., *forthcoming*). Another example, from Nepal, revealed the success of Haat Bazaars, a physical space for selling fruits and vegetables and other commodities where consumers and sellers meet. Haat Bazaars provide avenues for farmers who lack access to more traditional markets due to transportation constraints. About 20% of vegetables from farmers are sold in local Haat Bazaars, and such markets also sell pesticide-free fruits and vegetables. Haat Bazaars were also found to promote traditional fruits and vegetables to the consumers and provide easy access at a fair price.

In the country reports, prioritization was given to options to increase fruits and vegetables (Table 3.3). Across all seven countries, reducing consumer price and enhancing the availability of fruits and vegetables were ranked highest. Increasing consumer awareness of the benefits of fruits and vegetables was also considered a feasible option to increasing consumption.

***Table 3.3*** *Prioritization of options to increase fruit and vegetable consumption*

| ++: preferred options --: least preferred option | Tanzania | Burkina Faso | Nigeria | Ethiopia | India | Nepal | Bangladesh |
|---|---|---|---|---|---|---|---|
| Lower consumer prices | ++ | ++ | ++ | ++ | ++ | ++ | ++ |
| More, year-round supply | ++ | +/- | + | ++ | ++ | ++ | + |
| Better quality | +/- | + | +/- | - | | | +/- |
| More diverse fruits and vegetables available | +/- | +/- | + | -- | | + | - |
| Enforcing of food safety standards | + | ++ | -- | - | +/- | +/- | + |
| Nudging and campaigning | + | ++ | ++ | +/- | | + | ++ |

### 3.2.5 Conclusions on fruit and vegetable consumption

There is an urgent need to increase fruit and vegetable intake for achieving healthier diets for better nutrition and health, and potentially more so for fruit intake than for vegetable intake. The urgency to do so is not yet felt strongly by governments and consumers in most of the seven countries studied. Increasing the consumption of fruits and vegetables to meet recommendations is complex, as a myriad of interconnected drivers influence fruit and vegetable consumption. Consumers manage their intake in a dynamic way depending on who they are, where they are, what they prefer to eat, what they can afford, what is available, and how they eat. Although most drivers of consumption are mentioned in the case countries, the relative importance of, and emphasis given to, these drivers differs. The high variability in intake, intake gaps, and drivers of intake also indicates the importance of contextualization of analysis to understand such differences and of the need to tailor investments to increase fruit and vegetable intake. Support for the development or update of food-based dietary guidelines, including recommendations for fruits and vegetables, could be an important step in setting targets for investments.

There are examples of successful interventions tailored to increasing fruit and vegetable intake, but most are pilots and often lack evidence of impact through absence of rigorous evaluations; so little information as to whether they could work in other contexts is available. Achieving impact at scale is more complex and difficult than often anticipated. Scaling of consumption-oriented interventions require a simultaneous upscaling of other complementary activities in other components of the food system. Local level processes may influence and be influenced by high level dynamics, and may compete for resources and established interests in different solutions. Documentation of successful pilots, identification of the interventions needed to make such pilots successful, and evaluation of concepts in other consumer segments in other contexts, is needed.

One question that remained unanswered in all seven country reports is whether consumers will increase the fruit and vegetable intake high enough to meet recommended levels when availability, accessibility, and affordability are in place. It is worthwhile carrying out choice experiment interventions to find the answers to this query.

## 3.3 Fruit and vegetable supply chains

### 3.3.1 Different configurations

Formal markets are provisioned by formal supply systems with standards, registered businesses, and often contracted arrangements (e.g., supplying supermarkets). Informal markets involve informal businesses, mainly non-regulated standards, and a mix of formal and highly informal agreements, often based on network and kinship relations. Fruit and vegetable farmers mostly trade on informal markets. Produce is sold via different steps along the fruit and vegetable supply chain to informal wholesale and retail markets. Our study shows that these informal supply chains represent about 95-99% of the fruit and vegetable volumes traded in the countries studied. Formal markets for fruit and vegetables are emerging in most countries studied. An example is the rise of supermarkets, driven by increasing urbanization and the number of middle- and high-end consumers. We see this happening in all studied countries, but they are all at different stages of development (Table 3.4). In many countries, we observed a number of innovative short supply systems that bypass existing informal market actors and target urban consumers directly.

***Table 3.4*** *Estimated market shares (%)*

| | Tanzania | Burkina Faso | Nigeria | Ethiopia | India | Nepal | Bangladesh |
|---|---|---|---|---|---|---|---|
| Informal markets | 90 | 95 | 95 | 96 | 78 | 90 | 90> |
| Formal markets | <8 | 4 | 4 | 3 | 20 | <8 | 3-4 |
| Contract farming | <1 | <1 | 1 | <1 | <1 | <1 | <5 |
| Direct supplies to consumers | <1 | <1 | <1 | 0 | <1 | <1 | 4 |

### 3.3.2 Challenges in informal fruit and vegetable supply chains

Informal fruit and vegetable supply chains face a number of challenges, which have been observed across the seven country studies. Specificity is key for the studied fruit and vegetable supply systems, and refers to transactions for which the location of production is important. Most fruits and vegetables only grow well in certain locations at certain times, often far away from consumer locations. This means that there is an important role for traders, such as collectors and transporters. Information and coordination costs increase with distance. Buyers, therefore, often choose to establish personal relationships with sellers and producers in these areas so that they are guaranteed produce, which can be seen as a fixed investment. In all countries studied, fruit and vegetable traders and collectors invest much time in obtaining market information and traveling to farmers to check quantity and quality of the potential supply. These type-specific investments are transaction costs contributing to high consumer prices. If the seller has already sold to someone else, the buyer cannot recuperate their investment. This problem increases when there are many buyers and few sellers during the low season. However, the reverse may also be true. A producer located in a remote location may only be able to sell produce for a relatively low price during peak season.

Perishability is an important factor in the market for fruits and vegetables. Most products are highly perishable and, once picked, need to be traded and transported within a short time period. To avoid potential delays, farmers often sell to the first collector who offers a reasonable price. There is a trade-off between minimizing the risk by selling produce quickly, and obtaining a good price with the wait-and-see strategy. For traders, it is a challenge to bring produce to the market as soon as possible to minimize product losses. However, they are often not sure what price they can get at the market, so have to set the highest possible sales price and the lowest sourcing price to cover any risk of spoilage and to cover price fluctuations. Product price devaluations as high as 70%, due to loss of quality, are reported from time to time. This type of market uncertainty is an important contributor to high consumer prices for fruits and vegetables, because traders in the fruit and vegetable chain set a compensational mark-up for possible losses after buying the produce.

Opportunistic behavior of market participants has been observed in all countries studied, especially in the form of incomplete or distorted disclosure of relevant market information, like market prices. Many farmers fail to have up-to-date information about prices, which puts them in a disadvantaged bargaining position. Mobile phones are often used by traders and wholesalers to collect price information, who do not have an incentive to alter this imbalance in information dissemination because they are the ones who profit most from it. The seven countries studied revealed that collectors have established close-knit networks by forming associations (which are divided

according to market segment). Many farmers complained that collectors conspire on price agreements. Collecting wholesalers do sometimes compete with other traders from other markets, although even amongst traders from different locations and associations price agreements seem to be in place.

Packing materials used in informal fruit and vegetable markets are standardized (e.g., baskets, buckets or raffia baskets), but this is often not regulated. As such, produce of an inferior quality is often hidden at the bottom. In Tanzania, buyers complain that the bottom of the buckets is filled with paper, instead of fruits or vegetables. It is known that in the Nigerian food supply chain unripe tomatoes are packed at the bottom of the raffia baskets, while the best quality tomatoes are packed on top. Traders often anticipate these practices by farmers and compensate accordingly. Quality is generally assessed by appearance, and there are often no agreed and standardized quality grades, leaving much room for negotiation between farmers and traders, and between traders (e.g. collectors and wholesalers). Also, weighing of the traded produce is rarely done, and rather use units of packing materials. The lack of standardized packing, grading and weighing therefore results in disputes and adds risk to the transaction risk in the fruit and vegetable sector, resulting in higher consumer prices.

We observed a lack of government support to both formal and informal fruit and vegetable chains in all countries. However, both formally and informally traded fruits and vegetables are taxed heavily on the roads and at arrival at the markets. For example, in Nigeria, it was found that unofficial, non-regulated taxes on the road can be as high as 50% of the buying price for a 100kg bag of citrus fruit. This adds a significant cost to the final selling price.

There are also reports of exploitative behavior, and even the formation of cartels governing the fruit and vegetable trade. This exploitative behavior and high level of informality contributes to a lack of transparency in the supply chain and prevents other actors from stepping into commercial activities. We have observed many examples of shorter supply chains, often initiated by female entrepreneurs, that have overcome this challenge and are now sourcing and trading directly between farmers and consumers in the city to avoid wholesale markets. However, these are often novel market niches that have little room for large-scale application.

A well-organized fruit and vegetable supply chain contributes to a better allocation of resources, with the (economic) benefits equally shared among all stakeholders along the supply chain. The efficiency relates to smooth operating fruit and vegetables supply chains resulting in low post-harvest losses, with actors being well-aligned, and contributing to low transaction risks and associated costs. The dependency of farmers on traders, and high levels of uncertainty on sales and prices, are the biggest contributors to the inefficiency of fruit and vegetable supply chains.

***Table 3.5*** *Ranking of causes of supply chain inefficiency, with 1 as the most important cause*

| | Tanzania | Burkina Faso | Nigeria | Ethiopia | India | Nepal | Bangladesh |
|---|---|---|---|---|---|---|---|
| Asset specificity (dependency and investments costs) | 1 | | 2 | 2 | 3 | 3 | |
| Uncertainty (prices) | 2 | | 1 | 1 | 1 | 1 | 1 |
| Lack of performance measurement (e.g., sorting, grading, weighing) | | 2 | 3 | | | | 3 |
| Lack of coordination | 3 | 1 | | 3 | 2 | 2 | 2 |

High shares of post-harvest losses are observed in both fruit and vegetable supply chains. It appears that losses in Africa are higher than in Asia (Table 3.6). There is a large variation in the ranges mentioned in the country reports, and overall supporting evidence is limited. In general, it is difficult to trace and monitor produce loss throughout the supply chain, and therefore indirect methods are often applied (e.g., interviews with actors or expert estimation) that contribute to the reported variation.

***Table 3.6*** *Losses in fruit and vegetable supply chains*

| | Tanzania | Burkina Faso | Nigeria | Ethiopia | India | Nepal | Bangladesh |
|---|---|---|---|---|---|---|---|
| Post-harvest loss in fruit value chains (%) | 30-50 | 40 | 50-80 | 25 | 15-37 | 15-25 | 23-43 |
| Post-harvest loss in vegetable value chains (%) | 30-50 | 30 | 7-50 | 30 | 11-34 | 25-50 | 27-34 |

Handling practices are often poor in the informal market, contributing to post-harvest losses and decreasing the economic value of the produce. But poor handling practices also expose fruits and vegetables to possible food safety threats, thus jeopardizing public health.

***Table 3.7*** *Ranking of the causes of losses in fruit and vegetable supply chains, with 1 as the most important cause*

| | Tanzania | Burkina Faso | Nigeria | Ethiopia | India | Nepal | Bangladesh |
|---|---|---|---|---|---|---|---|
| Poor product quality | | 3 | 3 | 1 | 2 | | 3 |
| Poor handling after leaving farm gate | 1 | 3 | 1 | 2 | 1 | 1 | 2 |
| Road conditions | 2 | 1 | 2 | | | 2 | 3 |
| Packing and storage | 3 | 1 | | 3 | 3 | 3 | 1 |

The role of women has also been shown to be limited in the trade of fruits and vegetables, often as a result of their lower mobility and lack of capital required to buy large volumes of produce from farmers and to pay for transportation. Therefore, women are mainly concentrated at the retail end, where it is affordable to buy just one basket of produce and sell that during the following days to consumers at urban retail markets. Safety at wholesale markets can also be a serious issue. In Nigeria, most trading activities happen during the night when the trucks carrying the produce come in, but this is often not a safe time for women to be at the markets. Therefore, they enter the market as soon as the sun rises and are excluded from many nightly trading activities.

### 3.3.3 Emerging formal fruit and vegetable supply chains

More formalized food supply systems are emerging in almost all of the countries studied. In South Asia, supermarkets have a slightly higher market share compared to West and East Africa. They have developed to such an extent that supermarkets are no longer only for rich consumers in major cities, but are increasingly accessible for the higher end of the middle class. Formal supply chains offer opportunities for transforming the food system of developing countries by providing incentives for suppliers to invest in enhancing safety and quality, since supermarkets often set sourcing requirements. Secured markets are conducive for increasing investments in farms, and may stimulate the growth of commercially-orientated farmers that can invest in better varieties, improved production practices, and increase their farm output of (safe) fruits and vegetables over extended periods. There is sufficient evidence of farmers who supply supermarkets being better off, and therefore having access themselves to more nutrient-rich food (e.g., Chege et al., 2014). The downside of this development is that resource-poor farmers who are not able to produce high quality and safe fruits and vegetables, according to the sourcing requirements of supermarkets, will be 'pushed out' of the market. Alternative employment opportunities and safety nets need to be developed for these farmers. This problem should not be underestimated, as only a limited number of farmers will be able to 'step up', while the majority of smallholders will 'hang on' or 'step out' (Dorward, 2009).

Formal processors in the seven studied countries face serious problems in competing with imported processed fruit and vegetable products. Products are often imported at a lower cost than they can be produced domestically. This even remains the case when governmental bans on raw materials (such as concentrates) and processed products in Nigeria, are actually implemented. Lack of competitiveness makes it challenging for processors to establish a successful business model. In addition, processors struggle to source a continuous supply of sufficient raw materials. For most of the year, farmers are able to achieve higher prices at fresh markets, so are only eager to sell to processors when markets are saturated and the price for fresh produce falls. While small-scale processing does provide some opportunities for local entrepreneurs, these are often not scalable. The country studies have also

revealed that consumers prefer fresh fruits and vegetables over processed produce, which was especially the case in Nigeria and Tanzania.

### 3.3.4 Margins in fruit and vegetable supply chains

All actors achieve a healthy margin on the fruits and vegetables that are produced and traded. It appears that farmers gain a higher margin compared to traders. The traders often deal in larger volumes of fruits and vegetables, implying that the overall profit of their business is high. However, the data that could be collected only relates to actual market prices, and current indications are often based on price estimations only. For some countries, we could not retrieve any information on the margins for midstream actors.

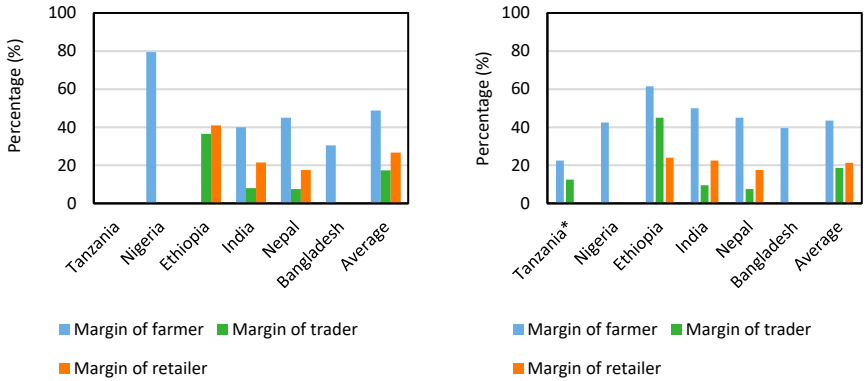


***Figure 3.2*** *Margins in fruit (left) and vegetable (right) supply chains*
**estimation for eggplant only.*

### 3.3.5 Conclusions on fruit and vegetable supply chains

Informal fruit and vegetable supply chains are dominant and will remain so for the foreseeable future. These prove themselves capable of delivering large volumes of fruits and vegetables to urban consumer markets over long distances, despite challenging infrastructure and disabling environments. Transaction risks in informal fruit and vegetable supply chains are high, due to the perishability of the produce, uncertain supplies, unregulated trade relations, lack of quality standards, lack of market information, and logistical problems associated with poor infrastructure and a lack of supply chain coordination. Given these risks and supply chain inefficiencies, which cause high rates of losses and quality depletion, the profit margins of midstream actors are not exceptional. Yet, these transaction costs are an important cause of high fruit and vegetable consumer prices.

## 3.4 Fruit and vegetable production

### 3.4.1 Key features of farming systems with fruits and vegetables

**Fruits and vegetables in farming systems**

In Phase I of this study, we identified a range of farming systems in which fruits and vegetables have a prominent position. These vary from smallholder mixed farming systems, with or without access to irrigation, to specialized, export-oriented farming systems. Fruits and vegetables in mixed farming systems are often produced in home gardens. In the seven country studies, we focused on two production systems that represent the majority of farming households, producing most of the fruits and vegetables supplied to urban consumers. With India as an exception, the smallholder mixed farming system without access to irrigation is dominant. In India, some 40% of fruits and vegetables are produced by farmers with access to irrigation. Most fruit and vegetable farming systems studied are located in remote, rural areas without access to irrigation, especially in Sub-Saharan Africa. Yet, peri-urban production by farmers producing multiple vegetables, who have access to very small plots and irrigation water, are frequently of local importance and, in several African countries, an emerging trend.

***Table 3.8*** *Estimated share (%) of different farming systems for fruits and vegetables in seven countries*

| | Tanzania | Burkina Faso | Nigeria | Ethiopia | India | Nepal | Bangladesh b) |
|---|---|---|---|---|---|---|---|
| Smallholder mixed farming with irrigation | No data | 14 | 10 | 3 | 44 | 15 | 20 |
| Smallholder mixed farming without irrigation | 70 a) | 86 | 85 | 97 | 42 | 70 | 33 |
| Smallholder specialized fruit and vegetable farming | No data | <1 | 5 | <1 | <4 | 5 | No data |
| Medium-large specialized fruit and vegetable farming | No data | <1 | <1 | <1 | 10-11 | 3 | 47 |
| Export fruit and vegetable farming | <1 | <1 | 0 | <1 | <1 | 7 | No data |

a) 70% of the fruits and vegetables are produced by smallholders, of which the majority have no access to irrigation. The contribution of other farming systems to domestic production is unknown; b) The numbers for Bangladesh are roughly predicted using available data sources, so one should be cautious while interpreting the numbers and using the results. We find that 53% of the area cultivated for fruits and vegetables are produced by smallholders with less than 1 hectare in Bangladesh. To calculate smallholder mixed farming with irrigation, we use the fraction of area cultivated vegetables under irrigation as of 2008 in the country, which equals 37% of total vegetable cultivation in Bangladesh. Multiplying that with the fraction of smallholder fruits and vegetables farming (53%), we reach 20% smallholder mixed farming with irrigation. Export fruit and vegetable farming system data is lacking.

Larger, export-oriented fruit and vegetable farms have been established, often with foreign capital and management, in countries such as Ethiopia and Tanzania. Yet, few smaller farms have followed the example and become successful in export-orientation production. Although piloted on a large scale during the past decade, the successes of small-scale commercial fruit and vegetable farming engaged in contract-farming set up by a 'mother company' have remained scarce (Holtland, 2017). A trend toward dismantling such outgrower schemes is generally observed.

Mixed farming implies that male and female farmers are involved in multiple on- and off-farm activities, often combining the production of various fruits and vegetables with that of grains, tubers and legumes for home consumption and local market sales; livestock keeping, including poultry, small ruminants and cattle; and occasional or structural wage labor, petty trade and other forms of income-generating activities. Fruits and vegetables being part of such mixed farming implies a lack of specialization by farmers that is required to develop these crops into commercial enterprises. Farmers have to pay attention to multiple farm operations, are sometimes engaged in off-farm activities, have limited labor and capital available for fruit and vegetable production, and lack specialized know-how about fruit and vegetable production.

An exception is the emerging category of peri-urban farmers, who only own very small plots of land which are often fully dedicated to fruit and vegetable production. In literature, reference is made to the term 'peri-urbanization', defined as:

> 'a process of dynamic change in land-use and livelihoods affecting the perimeter of growing or stable urban areas. Unlike the static and simplistic urban–rural dichotomy, a peri-urban interface constitutes a zone of transition between rural and urban status. The breadth, composition, and physical location of a peri-urban interface around any given urban area usually vary in different directions at a particular moment and temporally, as the leading edge of the interface may move outwards at a different rate from that of the inner edge, where areas become effectively urban or suburban' (Simon, 2021).

Reliable assessments of the importance of peri-urban farming in terms of volumes produced and supplies, as well as numbers of households included, are not yet available, although dedicated research is being undertaken.[4] An in-depth study on the importance of peri-urban farming for Ouagadougou, Burkina Faso, concluded that more than 30% of all food is produced within 50 km from the center. In the case of Tamale, Ghana, this amount was produced within only 30 km of the town center (Karg et al., 2016).

[4] Personal communication by Rene van Veenhuizen, RUAF.

Although peri-urban farming may have a long history, such as in Asia, it is observed notably in Africa that these fruit and vegetable growers often have no agrarian background, as they engage in production as an employment and cash-generating opportunity. This may constrain their start-up phase, during which they have to gain adequate know-how and skills. Moreover, these farmers are also often starting from an impoverished background, limiting their access to capital and suitable land. Yet, because of their interest in specialization of fruit and vegetable cropping, and support from informal networks, this category of farmers is developing rapidly despite the lack of formal support or conducive environment.

**Fruit and vegetable production**

As most fruits and vegetables are produced in mixed smallholder farming systems, estimates of their annual production are, by nature, difficult to determine. The seven country reports produce 'best guesses' based on FAOSTAT data and anecdotal samples. What is remarkable is that all of the countries studied record medium to high increases in both fruit and vegetable production over the past decade.

The increased production in Africa has been mainly achieved by the expansion of cultivated rain-fed areas, and not by intensification of production (i.e., higher land productivity). As recorded by FAOSTAT, the area of irrigated, arable land in Africa remained stable at 6.5% between 2000 and 2018. In Bangladesh, India and Nepal, yields have increased due to access to, and use of, irrigation, pesticides, fertilizers, and better seeds. Government subsidies have contributed to the affordability of these inputs. This is clearly visible in Table 3.9 and Table 3.10, which reveal that yields of fruits and vegetables are almost twice as high in India and Nepal, compared to the countries in Africa.

***Table 3.9*** *Total production, and trends in area, production and average yields of fruits (excluding bananas and plantain) in the seven study countries, 2019*

| | Tanzania | Burkina Faso | Nigeria | Ethiopia | India | Nepal | Bangladesh |
|---|---|---|---|---|---|---|---|
| Area (1,000 ha) | 172 | 18 | 1431 | 86 | 6200 | 121 | 409 |
| Area trend (2010-2019) in % | 24.6 | 14.1 | 4.5 | 99.4 | 9.8 | -2.9 | 0.8 |
| Production (1,000 t) | 1,808 | 115 | 8,779 | 489 | 73,706 | 1,184 | 3,903 |
| Production trend (2010-2019) in % | 23.9 | 18.2 | 10.0 | 18.6 | 36.7 | -4.4 | 23.7 |
| Yield (t/ha) | 5.0 | 6.3 | 6.2 | 5.7 | 11.9 | 9.8 | 9.7 |
| Yield trend (2010-2019) in % | 17.2 | 7.2 | 4.5 | -38.4 | 44.0 | -1.4 | 24.9 |

Source: FAOSTAT.

***Table 3.10*** *Total production, and trends in area, production and average yields of vegetables (excluding potatoes) in the seven study countries, 2019*

| | Tanzania | Burkina Faso | Nigeria a) | Ethiopia b) | India | Nepal | Bangladesh |
|---|---|---|---|---|---|---|---|
| Area (1,000 ha) | 534 | 33 | 2,548 | 116 | 8484 | 299 | 651 |
| Area trend (2010-2019) in % | 46.4 | 7.6 | 70.5 | 40.3 | 18.0 | 20.7 | 37.0 |
| Production (1,000 t) | 3,543 | 318 | 14,851 | 1,029 | 132,027 | 4,291 | 6,301 |
| Production trend (2010-2019) in % | 42.9 | 15.1 | 35.0 | 31.6 | 24.8 | 28.3 | 44.9 |
| Yield (t/ha) | 6.6 | 9.8 | 5.83 | 8.6 | 15.6 | 14.4 | 9.7 |
| Yield trend (2010-2019) in % | 19.6 | 9.4 | -20.9 | -6.1 | 12.6 | 15.5 | 32.4 |

Source: FAOSTAT

a) Excluding okra due to deviations observed in the data; b) Excluding chilies due to deviations observed in the data.

**Fruit and vegetable yield gaps**

The difference between fruit and vegetable yields obtained under experimental conditions and current mixed smallholder farming systems is defined as the

'yield gap'. Across all seven countries studied, the yield gaps are generally very high. However, there are important variations in yield gaps between the different crops, particularly related to less marketed and studied crops, such as most leafy vegetables. Reasons for large yield gaps are mainly low input use, low quality of inputs, and lack of know-how, resulting in suboptimal crop management.

***Table 3.11*** *Current yield gaps and on farm losses*

| | Tanzania | Burkina Faso | Nigeria | Ethiopia | India | Nepal | Bangladesh |
|---|---|---|---|---|---|---|---|
| Yield gap in fruits (%) | 68-85 | 3 | 85 | 82 | 40-47 | 15-60 | No data |
| On-farm losses of fruits (%) | | 50 | No data | 10 | 2-7 | 5-10 | No data |
| Yield gap in vegetables (%) | 73-92 | 17 | 50 | 88 | 40-45 | 25-35 | 22-62 |
| On-farm losses of vegetables (%) | | 75 | No data | 15 | 2-7 | 5-10 | 15-20 |

Besides yield gaps, high on-farm losses are recorded. While these are associated with extreme weather events and pests and diseases, poor harvesting, handling and storage practices also contribute to physically damaged or unripe and overripe harvested produce, which significantly reduces shelf-life and product value. In several countries, it was mentioned that, during periods of abundant supply, prices are so low that farmers lack any economic incentive to harvest their crop, resulting in the loss of harvest.

**Profitability of fruit and vegetable production**

Data on costs of production and contribution of fruit and vegetable production to household income are very scarce and are often absent. FGDs and KII in the seven countries indicate that, in general, the profitability of fruit and vegetable production is very good. Yet, farmgate prices fluctuate significantly and are the first determinant of fruit and vegetable profitability for producers.

To compare countries studied, we selected tomato production as a proxy crop, as it was produced in most of them. Though the costs and revenues are expressed per hectare, it must be noted that average plot sizes differ greatly and are generally very small, resulting in aggregation biases. Production costs and crop returns can also differ greatly due to differences in management and input use, and associated crop yields. Even more so, gross and net income are very much defined by the farm-gate prices, which are extremely volatile.

With these restrictions in mind, it appears that tomato production in many of the studied countries is potentially profitable, but requires significant upfront investment in fertilizers, pesticides and seeds.

***Table 3.12*** *Estimated costs and income of one tomato production cycle a)*

| | Tanzania | Burkina Faso | Nigeria | Ethiopia | India | Nepal | Bangladesh |
|---|---|---|---|---|---|---|---|
| Cost of production in US$/ha | No data | No data | 360 | 2,660 | 1,680 | No data | 4,053 |
| Total gross crop income (price x yield) in US$/ha | No data | No data | 610 | 5,740 | 6,650 | No data | 4,742 |
| Total net crop income in US$/ha | No data | No data | 240 | 3,080 | 4,970 | No data | 689 |

a) No data available for Burkina Faso, Tanzania and Nepal as these country studies did not include tomatoes.

**Use of agro-inputs**

The seven country studies confirm that the use of agro-inputs is generally low in all African countries, while in Asia input availability is better and more affordable. It is plausible that higher input use has resulted in the higher crop yields reported in Asia.

Descriptions of the seed systems in the seven countries show a large variation. They vary from informal seed systems in which farmers use farm-saved seed, or source seed through informal networks or markets, through to commercial private seed systems where farmers use seed produced by global seed companies. What is critical to understand is that one farming household could be using more than one of these sources to attain seed. The source of the seed depends on a variety of factors, such as. the production system, farmers' willingness to invest in quality seed, the crop itself, its reproduction system, and the presence of a commercial sector. For most commercial fruit and

vegetable crops, a commercial seed and breeding sector does exist, but farmers growing other vegetables, like leafy vegetables and traditional non-global vegetables, and most fruits, are primarily served through the informal sector, which rarely carries out any breeding activities. One exception that was observed was amaranth, in Tanzania, for which improved varieties have been developed and are distributed by private seed companies.

The country reports indicate that the seed industry for vegetables is more advanced in India as compared to the other countries in South Asia and Africa. In India, the private sector actively invests in the development of varieties, their release, seed production, promotion, and marketing. Hybrid varieties are also being increasingly produced.

The seed industry in East Africa provides quality seed of vegetable varieties derived from global breeding companies and also from public sources (such as the World Vegetable Center). For some vegetables, informal and intermediary seed systems may take up seed production, but for most, the seed is sourced by private commercial seed companies from global companies. As hybrid seeds become increasingly popular and demand rises, regional seed companies are also becoming more dependent on sourcing seed from abroad. While vegetable seed is an important source of income for East African seed companies, in West Africa, seed companies treat vegetables as a by-product. Their core business is cereals, and they add open-pollinated varieties (OPVs) of well-known vegetable varieties (for which breeders' rights are often no longer applicable) to their portfolio. The seed is also sourced from other African regions. Consequently, in West Africa, intermediary and informal systems (also with OPVs) remain dominant, while in East Africa, an intermediary situation is developing, where a more private commercial seed system is beginning to evolve.

### 3.4.2 Challenges to fruit and vegetable production

Results from the seven country studies indicate that the most important challenges to fruit and vegetable production are ranked differently by male and female farmers. Men largely refer to access to farm inputs and finance, followed by access to water and know-how. Women, however, rank the lack of access to land as the most important challenge. This is likely because, while policy in all seven countries allows both daughters and sons to inherit land, in practice, the majority or all of the land is passed onto sons. Nepal is an exception due to high levels of male migration, which forces the women to manage the available land and look for inputs. In the case of Bangladesh, respondents indicated that land and finance were related – without land as a collateral, finance wasn't possible.

***Table 3.13*** *Ranking top three most important production limiting factors for male and female producers (1 most important, 3 least important)*

| | Tanzania | | Burkina Faso | | Nigeria | | Ethiopia | | India | | Nepal | | Bangladesh | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M = male, F = female | M | F | M | F | M | F | M | F | M | F | M | F | M | F |
| Access to water | | | 1 | | | | 3 | | 2 | | 2 | | | |
| Access to land | | 1 | | 1 | | 1 | | 1 | | 1 | | 2 | | 2 |
| Access to finance | 2 | 2 | 3 | 2 | 1 | | 2 | 2 | 3 | 3 | 3 | 3 | | 1 |
| Access to inputs | 1 | 3 | 2 | 3 | | | 1 | 3 | 1 | 2 | 1 | 1 | 1 | |
| Access to labor | | | | | | 2 | | | | | | | | |
| Access to know-how/ extension | 3 | | | | 3 | | | | | | | | 2 | |
| Access to technology | | | | | | | | | | | | | | |
| Access to markets | | | | | 2 | | | | | | | | | |
| Other (social norms) | | | | | | | | | | | | | | 3 |

Access to farm inputs is mainly defined by the availability and affordability of quality seeds, water, fertilizers, and pesticides. In all seven countries, production during the rainy season is heavily constrained by inaccessibility of the land, pests and diseases, and variable rainfall conditions resulting in dry spells as well as flooding. Locally, rainy seasons are becoming less reliable as a result of climate change. Many vegetables and fruits are prone to being damaged by pests and diseases under unfavorable climate conditions, while crop protection management is sub-optimal. Therefore, production during the dry season is attractive for farmers. Over the past decades, public and private research and development (R&D) – notably breeding of vegetable varieties –

have prioritized building in pest and disease resistance, for example into tomatoes and onions. Breeding of more nutrient-rich fruits and vegetables, including indigenous crops, has received much less attention, however.

Farmer responses to overcoming constraints imposed by pests and diseases include using chemical crop protection inputs (pesticides) and producing during the dry season, when the pressure of pests and diseases is generally lower and easier to control. In Asia, such farmer responses often result in overdosage of chemical inputs, as these are readily available and affordable due to government subsidies. As many farmers have no adequate equipment, or knowledge on and experience with applying pesticides, their improper use results in occupational health problems and emissions into the environment. In addition, the overuse and misuse of pesticides is an unnecessary cost factor for farmers, and pesticide residues on the produce create health risks for consumers.

The country studies from Asia illustrate examples of farmers reducing their use of agro-chemicals, such as through integrated pest management (IPM) practices. It is not yet evident whether these examples are anecdotal efforts supported by NGOs and other development agencies, or a serious trend towards the use of safer fruit and vegetable production practices.

In Africa, chemical pest and disease control is increasing, but the availability of these inputs is less assured and product prices are higher as no government subsidies are applied. Yet, we have identified emerging consumer concerns about food safety and environmental risks associated with the improper use of agro-chemicals, particularly in cotton-based cropping systems and irrigated vegetable farming systems.

Across all seven countries, farmers with access to irrigation opt for off-season vegetable production to avoid high disease and pest pressure, but also to increase the frequency of vegetable production. The availability of irrigation facilities varies across the countries studied, but the proportion of irrigated areas for fruit and vegetable production is highest in India.

Confirming findings from Phase I, the country studies conclude that limited access to irrigation water is an important constraint to increasing vegetable production. Access to irrigation water in perennial fruit tree cropping is not considered a constraint by farmers in the seven countries, but could contribute to significant production gains, especially in dryer agro-climatological zones. Access to irrigation is associated with higher costs of production, which is one reason why farmers opt for higher value crops that have more secured markets, such as onions and tomatoes. As most irrigated areas are located remotely, produce must be transported over longer distances, which also defines farmers' choices of crops and excludes more perishable leafy vegetables and fruits. These crops are produced in greater volumes in peri-urban areas, which are in the vicinity of larger consumer markets. Though production in these areas resolves some of the obstacles imposed by long distance transportation, there are other constraints, such as water quality – which is often contaminated by human and animal secretions – and uncertain land entitlements.

Results from the seven country studies are also consistent in their conclusion that women are more time-constrained than men because of their greater household responsibilities, so would struggle to significantly expand fruit and vegetable production. Women that can engage in more commercial levels of fruit and vegetable production, such as harvesting baobab leaves in Burkina Faso, have managed to do this alongside their domestic chores. The same goes for women that are wage-employed in fruit or vegetable processing in India. It was also consistently reported that employed women are paid less than their male counterparts, with the explanation that men do heavier labor. In Nepal, access to on-farm labor is constrained because of the relatively better paid alternatives off-farm. Whether this leads to more women being employed on-farm was not evaluated.

### 3.4.3 Increasing farm income from fruits and vegetable production

Periodic oversupply of fruits and vegetables, associated with strong drops in farm gate prices, is frequently mentioned as a key constraint to raising farm income from production and sales of these crops. Oversupply is strongly associated with seasonality in production, observed in crops such as tomatoes, onions and mangoes. Seasonality is caused by conditions generally favorable for a particular crop or natural factors (such as the mango trees flowering after the dry season). Farmers may respond by using crop varieties that allow for early harvesting or production under less favorable situations, for example producing tomatoes during the rainy season. This requires novel varieties with

specific properties, such as resistance to diseases, shorter growing seasons, or a longer shelf life.

Oversupply of fruits and vegetables could also be better absorbed by markets if greater numbers and more diverse processing industries would develop in the midstream operations of value chains. The low prices of processed products, due to cheap imports (for example, tomato paste) and limited consumer interest, are two constraints to this. Consumers may be keen to purchase dried fruits and vegetables if these already feature in their dishes (such as dried okra and baobab leaves), although examples of the successful introduction of new processed produce are rare and scalability is limited due to low market demand. Fruit juices, for example, seem to target niche markets for emerging middle-class consumers in urban areas.

Options for reducing the costs of production, thereby increasing farm income, are reported to be very limited. An option more likely to have an impact on increasing farm income in all seven countries is instead to reduce the cost price, i.e., the price per unit of produce. When intensifying production, costs per unit of land will always increase through the use of more and/or better inputs, and this requires access to capital. Yet, if farmers have the know-how to use such inputs effectively and efficiently, such investments will pay off because crop yields increase, resulting in a lower price per unit of produce (Table 3.14).

***Table 3.14*** *Ranking of options for raising farm income from fruits and vegetables (ranking 1 = highest)*

| | Tanzania | Burkina Faso | Nigeria | Ethiopia | India | Nepal | Bangladesh |
|---|---|---|---|---|---|---|---|
| Increasing productivity | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Expansion of area | | | | | | 3 | |
| Reducing costs | 2 | 2 | 2 | 2 | 2 | | |
| Contract farming | 3 | | | | | | 3 |
| Producer organization | | 3 | 3 | 3 | 3 | 2 | 2 |

### 3.4.4 Key challenges to deliver more diverse fruits and vegetables to meet consumer needs

The first phase of this study concluded that consumer access to fruits and vegetables is limited by the quantity and variety of supplies. Lower supplies often result in higher retail prices, which make fruits and vegetables less affordable for households with limited purchasing power. In contrast, fruits and vegetables are sometimes available in abundance in situations of seasonal oversupply, but often lack variety to provide consumers with a diverse diet. In the seven country studies, we explored the options for farmers to produce more diverse fruits and vegetables. We conclude that there are three pertinent constraints that are preventing farmers from diversifying their fruits and vegetables production:

**Information asymmetries**: In all seven countries, farmers do not have adequate insights into consumer needs. Reference is made to traders and their collectors keeping information on market demands away from farmers. This implies that the latter operate 'in the dark', relying on buyers and local markets when planning new cropping seasons. This information asymmetry reduces the bargaining power of farmers and impedes them from making well-informed decisions, hampering their innovation capacity and investments beyond mainstream crops. Information asymmetries also impact more on female producers than on male producers. We conclude that farmers – especially women – require greater and better access to market intelligence to adjust their fruits and vegetables production to (emerging) consumers preferences.

**Risks of unsecured markets**: Across the seven countries, we observe a distinct contrast between farmers producing through formalized and longer-term contracts, and those supplying informal markets. The former are supported by market information, farm inputs, and credits which, together with secured markets, significantly enhance production conditions and reduce risks. This results in a farmer's ability to invest, innovate and adjust production to market demands. Farmers producing for informal markets generally struggle with access to credit, quality farm inputs and market intelligence. They experience high risks of offsetting their produce after harvest and are dependent on few local markets and buyers. Generally speaking, these risks affect female farmers more than men. We conclude that, in general, informal markets are associated with high risks, which affect a farmer's appetite and

abilities to invest in new crops and crop varieties. Formalizing supply arrangements between smallholders and midstream operators, including wholesalers as well as processors, is a feasible option to overcome these constraints and may result in more diverse supplies of fruits and vegetables.

**Access to seeds of new varieties and crops**: Even when farmers have access to information regarding consumer preferences and market demands, they generally have poor access to high quality seed and planting materials to meet these demands. There are examples of farmers using novel seed from export value chains for producing for domestic markets, but these are not always suitable for smallholder conditions, are not adapted to Sub-Saharan African agro-ecologies, and do not necessarily meet local consumer demands. Much of the current R&D is focused on selected mainstream crops for domestic production, such as onions and tomatoes. These efforts are mainly to improve economic gains for farmers and midstream actors, and are focused to a lesser extent on the impact on improving the diets of consumers. Moreover, crops that have higher traded volumes and commercial value are often dominated by men, thus excluding women producers, traders and processors from benefiting. Dissemination of novel crop types and new varieties is often hampered by inefficient public extension, and exclusion of midstream actors during R&D processes. Yet, there are examples of successful introductions, such as new watermelon and mango varieties in Ethiopia. We conclude that more R&D is needed on fruit and vegetable crops, and crop varieties demanded by domestic consumers. Promoting the adoption and use of novel crops and new varieties can be achieved through public extension, but even more through the involvement of mid-stream and private actors (both men and women) that are involved in all processes of breeding and quality seed development.

### 3.4.5 Key challenges and strategies for women's inclusion in fruit and vegetable production

Women face multiple barriers to more commercial engagements in agricultural production, which includes fruits and vegetables. The challenges faced were identified in Phase I have been confirmed by the Phase II country studies. These barriers can be summed up as follows:

A shortage of time, due to the **double burden** of 'work' and 'care' activities, prohibits women from allocating more time to production, value addition or marketing. Women in India explicitly noted their hesitance to increase productivity because of their already long working days (around 10 hours) and, on average, women in rural areas in Burkina Faso work a combined 8.5 hours. Men also control this time in the sense that they determine what women do on the land.

**Mobility** is also a constraint, caused either by being 'tied' to the household because of work responsibilities, or it being socially unacceptable for women to travel longer distances by themselves. This social norm generally derives from concerns about harassment and violence towards women. However, this is notably different in African compared to Asian countries. In Burkina Faso, Nigeria and Tanzania, there are examples of women engaged in marketing of produce and spending hours far away from home. While some examples of this exist in India, they were the exception to the norm.

**Lack of assets (including land) and access to credit** are another factor and, while these are separate, they are related through the fact that a lack of collateral prohibits women from gaining larger-scale loans. While in all three Asian countries, self-help groups (SHGs) can help women establish small-scale saving and loan schemes, which in turn can be reinvested in their micro-businesses, the option to scale-up requires either physical collateral or backing through a registered group, such as a cooperative. Therein lie examples of women being able to scale-up their businesses.

In the seven case studies, there are examples of women who have been able to increase both production and marketing of fruits and vegetables, and control the income generated. In other words, investing in production alone will likely not yield meaningful change in economic benefits by women, though it could nevertheless improve nutritional uptake of household members and overall income. Where there are examples of 'win-win' (women's empowerment, income increase and improved nutritional uptake), three 'tiers' can be distinguished wherein a 'business model' can be described that would potentially benefit women:

- At the most informal and most widespread level, SHGs support income generation through training, without the structure itself having to become viable. Collection points at community levels are sometimes set up and, in Bangladesh, a 'women's corner' is reserved in some local markets for women to sell their produce. The produce sold here typically comes from women's kitchen gardens and may be the uneaten surplus.

- As a step up from this, producer groups – both informal or formal (e.g., becoming registered) – provide more services, though have more operating costs and so need to be connected to (informal) markets to remain sustainable. Producer groups function as aggregation points and service providers, though the more developed ones also support farmers with packaging and branding, and value-addition.
- At the next level are women who are business leaders in their own right, having started an agribusiness. In practice, this is a diverse category, including women with higher education levels, an urban background and disposable income, as well as women from rural backgrounds and little formal education but incredible drive and business acumen. What they have in common is that they become recognized by their community and society more generally as leaders in their own right, and function as examples to other women (and men) that they can become leaders in agribusiness. In Burkina Faso, India, Nigeria, and Tanzania, there are multiple examples of these types of women, although there was little evidence from Bangladesh, Ethiopia and Nepal.

There are two important caveats to these tiers, particularly for the first two. First, the time required for women to commit to these activities requires the endorsement and support of family members, especially their husbands, and so a household-wide approach rather than 'just' focusing on women is needed to ensure their time can be made available. Second, the first and second tiers require significant support for an extended period of time to enable women and women's groups to become sufficiently established so that they could become viable – and, even then, just like any other start-up, they face risks. The third tier is closer to what may be interpreted as a more traditional business viability strategy, e.g., supporting an existing start-up to grow. The two lower tiers require more substantial underwriting and a recognition that, for many women, their focus is on short-term coping strategies and less on medium- to long-term business model strategies. The evidence from multiple countries shows that support from locally implemented government and/or NGO programs that have a longer term horizon (e.g., a minimum of four to five years) has a greater chance of positively impacting women. There is no evidence that supporting women in fruit or vegetable sectors is inherently better than other sectors. Moreover, a more holistic, multi-sector approach is more likely to benefit them.

### 3.4.6 Conclusions on fruit and vegetable production

Across the seven countries, there is a general trend towards increasing fruit and vegetable production. In Africa, such increases have been mainly achieved by the expansion of areas under production, while in Asia, they are explained by crop intensification through increased use of inputs. Access to irrigation is critical to not only increasing production, but also increasing the frequency of production, reducing dependency on erratic rainfall, and avoiding seasonality of production associated with lower farmgate prices. Profitability of fruit and vegetable production is generally good for producers, but depends on farmgate prices, which fluctuate significantly and are not controlled by farmers.

Peri-urban farming systems offer better opportunities for sustainably increasing the production of highly perishable fruits and vegetables compared to remote, mixed farming systems. In the latter, farmers disperse their attention over many crops and livestock, which limits their ability to specialize in fruit and vegetable production. Moreover, farmers in these remote farming systems often have fewer market outlets and may therefore receive lower prices, affecting the profitability of production.

Yet, if the goal is increasing rural consumption of fruits and vegetables, then attention must be given to enhancing the variety of fruits and vegetables rather than increasing production. Diversifying fruit and vegetable crops and crop varieties in home gardens offers opportunities to improve intake levels among all segments of rural consumers, without increasing labor demand (see below).

To date, private R&D, notably in India, has focused on variety breeding of commercial crops, such as tomatoes and onions, but these have very limited nutritional value and exclude women from trading larger volumes. In Africa, there are hardly any private breeding programs and commercial seed companies mainly use varieties developed in Asia. In most countries, there is very limited public R&D and almost no breeding of fruits and vegetable varieties. Supplying consumers with a greater diversity of fruit and vegetable varieties will require major changes in public and private R&D, and a refocusing of knowledge development and resource allocation on nutrition-rich crops. As these are generally not well studied, this will require considerable investment.

There are multiple constraints to enhancing the benefits of women in fruit and vegetable production, but the most prominent ones include labor requirements for more intensive vegetable production, and access to inputs (including irrigation and land), which limit options for women's engagement in perennial fruit tree production.

Unequal gender relations and social norms often mean that women are more constrained in engaging commercially in fruit and vegetable production and marketing compared to men. However, the country studies have identified many examples whereby women have overcome gender-related barriers to expand fruit and vegetable production, market their produce, and benefit economically. Many of these exceptions are associated with the leadership skills of individual women or well-embedded community development initiatives. Scaling-up such success requires more attention for women's education and empowerment, as well as efforts to change social norms through national policies, addressing systemic gender inequalities (such unequal land entitlements/legislation), and campaigns promoting female role models.

# 4

# Conclusions and recommendations

# 4 Conclusions and recommendations

## 4.1 Conclusions

Based on the global scoping study and seven country studies, we present the following conclusions on fruits and vegetables:

### 4.1.1 Consumption of fruits and vegetables

1. Consumption of fruits and vegetables is below recommended intake levels in all regions of the world, representing a key driver for malnutrition in all its forms and diet-related NCDs. The gap in fruit intake is higher than in vegetable intake, while overall fruit and vegetable intake in Africa is generally lower than in Asia. This was confirmed by our case studies, which revealed the lowest intake in Ethiopia and Bangladesh, and the highest (but still below the recommendations) in India and Nepal.

2. Healthy diets are not affordable for a large part of the population in many countries. The high costs are predominantly driven by fruits and vegetables, and animal-sourced foods. Our case studies show the cost of a healthy diet ranges from US$2.6-4.1 per person, per day, and 30-42% of these costs are accounted for by fruits and vegetables. The highest cost of a healthy diet, and fruit and vegetable contribution towards this, was in Nepal (US$4.1 and 42%), while the lowest cost was in Tanzania (US$2.6), and the lowest contribution was in Burkina Faso (30%). In addition, research on income elasticity ranges for fruit show that an increase in income will lead to greater intake, but this is less effective for vegetables.

3. Fruits and vegetables have distinct roles in dietary patterns. Fruits are considered snacks, especially for children, are eaten raw, and are not part of main dishes and meals – instead, they are consumed in between meals. Vegetables are mainly cooked before consumption, are essential parts of meals (especially lunch and dinner), and women mainly determine if and what vegetables are prepared.

4. Consumer choice for fruits and vegetables is defined by price, taste, diet norms, convenience, and safety concerns. The priority of these drivers is not universal and changes over time, indicating the need to segment consumers, for example, by income class. It also indicates that consumer behavior can be influenced by targeted interventions. Price is a strong driver but not for all consumer groups: When income increases, for example, the importance of other drivers, such as convenience, increases too. Income is necessary, but insufficient to increase consumption to recommended levels. Our studies have shown that most poor people consume increasing amounts of fruits and vegetables when their income increases, but only up to a point. Despite further increases in incomes, consumption does not reach recommended intakes, indicating that drivers other than price are of importance.

5. Our studies highlight that processed fruits and vegetables mainly serve elite consumers, except for dried vegetables when they are already part of the dietary pattern in fresh form, but are not available in fresh form due to low supply.

6. Although it is known that women tend to spend their additional income on food, healthcare, and children's education, our review and country studies did not provide further data whether a higher women's income would increase fruit and vegetable intake specifically, and whether this increase would benefit her children, herself, and/or other household members.

7. In general, in Africa, consumers have very limited access to information about food safety issues. There is an emerging concern among middle-class consumers in Africa, but this is more developed in Asia. These concerns are mainly related to the fear of food contamination by pesticides rather than any concern about biological hazards. There are hardly any public or private standards for food safety and quality in any of the seven countries, and if they are present, then they are not enforced.

8. Seasonality affects the availability, accessibility and affordability of fruits and vegetables. In lean seasons in all seven countries, when the supply of fruits and vegetables to food environments is low, intake is also low. However, even during the harvest season, when there is an abundance of fruits and vegetables, some of the produce does not reach consumers due to the low profitability for traders and retailers.

9. Tomatoes and onions dominate vegetable intake, but their nutritional and health value is much lower compared to dark green leafy vegetables, red, orange or yellow (vitamin A-rich) vegetables, and cruciferous vegetables. Very little knowledge is available on the consumption of indigenous fruits and vegetables, their role in dietary patterns, and their contribution to nutritional and health values. None of the seven case studies were able to provide evidence that a more diverse supply of fruits and vegetables resulted in higher consumption levels.

10. The seven case studies did not provide further information on whether an increase of fruit and vegetable intake to recommended level fits in the present diets. An increase in fruits and vegetables may require a major adaptation of the existing dietary pattern in terms of changing meal frequency, meal composition, recipes of mixed dishes, and processing methods. Vegetables are part of a dish or meal, and increasing the amount of vegetables may also necessitate an increase or substitution of other ingredients. These may be healthy (such as whole grains, legumes, nuts, and seeds) or may have a health risk (for example saturated fat and salt).

### 4.1.2 Food environments for fruits and vegetables

11. In most of the seven countries, formal retail markets (i.e., supermarkets) are increasing their market share in urban centers, driven by a growing middle class. This implies that formal markets have a limited reach towards high-end consumers and the upper-middle class. The formal retail markets often pay premium prices but also set specific conditions (safety requirements, quality norms, volumes) for fruits and vegetables in their contracts with local farmers. This provides an incentive for suppliers to increase produce quality to benefit from premium market prices and secured markets. Sourced volumes, however, are small, and scalable opportunities are limited.

12. Informal retail outlets remain important for poorer consumers. These retailers have information about their clientele and can offer small, affordable volumes of fruits and vegetables. Poorer consumers benefit from more variation in retail as this increases their choice in fruits and vegetables.

### 4.1.3 Fruit and vegetable supply chains

13. Informal fruit and vegetable supply chains are effective but not efficient. These chains prove to be capable of delivering large volumes of fruits and vegetables to urban consumer markets over long distances, despite challenging infrastructure and disabling environments.

14. Transaction risks in informal fruit and vegetable supply chains are high due to perishability, uncertain supplies, unregulated trade relations, lack of quality standards, lack of market information, and logistical problems associated with poor infrastructure, and a lack of supply chain coordination. These transaction risks are the main cause of high fruit and vegetable consumer prices. Transaction risks must therefore be reduced if consumer prices are to be lowered.

15. Informal fruit and vegetable supply chains are dominant and will remain so for the near future. Informal fruit and vegetable midstream actors have received little support from governments and other investors and enablers. Interventions to support these actors are needed to achieve higher fruit and vegetable consumption and empower women economically. Informal economy requires other types of interventions, such as access to finance and various government services, as compared to those targeted at the formal economy.

16. Many interventions by both public and private actors have attempted to formalize fruit and vegetable supply chains, but we have found very few sustainable successes. This study also revealed that, for export supply chains, contract farming arrangements are being dismantled.

17. Midstream fruit and vegetable actors, notably wholesale traders, have no information about consumer needs and preferences. Informal retailers often have direct contact with consumers, but there is little backward linkage between retailers and actors down the chain. This is one of the

prominent reasons why the majority of fruit and vegetable chains are supply driven, and do not respond to consumer needs and preferences.

18. Mobility constraints by social norms and household responsibilities prohibit women from playing a larger role further up the supply chain. Exceptions are more prevalent in African countries, where different social norms have enabled some women to market products and control their income. Despite these exceptions, systemic gender inequalities must be overcome before women in general can benefit from commercial fruit and vegetable activities. Examples of successful women entrepreneurship, however, act as role models for other women and contribute to changing social perceptions of women's roles.

19. Successful innovations by women are often located in peri-urban settings. Informal supply chains provide more opportunities for women than formal supply chains, as women generally have less access to collateral due to unequal asset ownership. Informal, high volume supply chains are often dominated by men, but short value chains are more feasible for women to participate in, due to mobility constraints (see Conclusion 18), smaller volumes, and the ability to develop direct supply relations to consumers.

20. In the seven countries studied, fruit and vegetable losses are high due to poor harvesting techniques, packaging, handling, transport, storage, and market facilities. Risks of high losses result in high pricing to consumers and inefficient resource use across the entire supply chain.

### 4.1.4 Fruit and vegetable production

21. Across the seven countries studied, significant yield gaps have been observed for all fruit and vegetable crops. The most prominent obstacles to increasing fruit and vegetable production are access to, and the availability of, inputs (pesticides, seed, water, fertilizers) and lack of know-how. Country studies in Asia illustrate that improved access to inputs results in higher yields. Better access to inputs in Asia has occurred due to government subsidy programs and private sector involvement in input supply. Limits to entrepreneurial skills and ambitions among fruit and vegetable producers are also obstacles that need to be addressed.

22. In mixed smallholder farming systems, tomatoes and onions are the most important vegetables produced. Tomatoes and onions have lower nutritional value and reduced associated health risks compared to other vegetables, and receive major R&D attention as a result of economic considerations. More nutrition-rich fruit and vegetable crops have generally been neglected by public and private R&D organizations. Investing in R&D on nutrient-rich fruits and vegetables will benefit consumer health and female producers and other actors along the supply chains.

23. Little knowledge and information is available on the production of fruits and vegetables in home gardens, their role in dietary patterns, their contribution to nutritional and health values, and contribution to household income, and that of women who commonly sell surpluses at local markets. None of the seven case studies were able to provide quantitative insights into the share of home garden production of fruits and vegetables in total national production and consumption.

24. Peri-urban farming systems offer more opportunities for enhancing the supply of notably highly perishable fruits and vegetables to urban consumers in terms of volumes, diversity and quality, compared to remote, mixed farming systems. An exception is made by non-perishable, perennial fruits, which can be transported over long distances and need secure land ownership. Remote mixed farming systems can serve to enhance the consumption of fruits and vegetables of rural consumers, including poorer segments.

25. Many public extension services lack staff, resources and know-how to promote sustainable intensification of fruits and vegetables. There are private extension services emerging and they illustrate that increasing producer know-how is feasible, but often struggle to scale their operations.

26. The profitability of irrigated vegetable production is superior compared to rain-fed vegetable production, due to reduced rainfall risks, higher levels of radiation, lower pest and disease pressure in the dry season, and higher effectiveness of crop management (lower nutrient losses, less pesticide rinsing from crops). This implies that interventions to enhance vegetable production must prioritize expansion of irrigation and water-harvesting

facilities. To avoid negative effects on the environment, however, water use efficiency must be improved at the same time.

27. The current profitability of perennial fruit production is high due to the low cost of production. The most prominent constraints to increasing production are establishment investment, costs of labor during harvesting, and uncertain markets. Opportunities for enhancing fruit production include improving access to finance, the introduction of short and high-yielding tree varieties, and the establishment of irrigation and storage facilities.

28. Lack of know-how and risk-averse behavior of farmers results in the overuse of inputs (pesticides, fertilizers, water), which results in a waste of resources and potentially negative effects on the environment, occupational health, and food safety.

29. High production and marketing risks are associated with a lack of specialization among fruit and vegetable producers. Specialization enhances specific crop know-how, which is needed to reduce yield gaps through sustainable intensification.

30. Women and men both play important roles in fruit and vegetable production. Women are more prohibited than men from producing and trading higher volumes of fruits and vegetables due to additional household responsibilities, and lack of access to land and finance. This is especially critical in countries such as Nepal, where women play a more important role in fruit and vegetable production and trade when men migrate for work (referred to as 'feminization of agriculture').

31. Female fruit and vegetable producers experience more obstacles to increasing production and marketing of their produce than men due to social norms, which limit their mobility and unequal access to production assets. This results in higher dependency on collectors and local wet markets. Examples of successful aggregation of fruit and vegetables produced by women illustrate the positive effects on their income and confidence.

## 4.2 Emerging areas for philanthropic investment

A starting point for addressing the lack of consumption of fruits and vegetables is 'reverse thinking' – putting the dietary outcomes we want from food systems upfront in responsive food policy-making and legislation, and investments and interventions, and working towards incentivizing systems that create these outcomes.

Philanthropic investment in fruit and vegetable sectors can impact consumption, supply and production, but different types of investment produce different results for different foods in different contexts, so we need to know more about how specific investments, such as nudging consumers, improving supply efficiency, or improving producer access to irrigation, play out in food systems for different fruits and vegetables.

Investments can stimulate the 'push' of fruits and vegetables, such as by increasing production or diversity in crops available through retail markets, or the 'pull' by stimulating the demand for fruits and vegetables, such as through school feeding programs or consumer nudging campaigns. Push and pull investments and related measures represent different impact pathways that must be carefully designed and based on validated theories of change.

Based on the conclusions presented in the report, we identify in the following sections options and considerations for philanthropic investments which have higher probability of yielding social-economic returns.

Box 3: Investing to enhance in food system outcomes

Applying reverse thinking is key to achieving food system outcomes, such as enhanced food and nutrition security. When starting from consumer needs, investments should prioritise the production, supply and promotion of more nutritious, safe fruits and vegetables, such as dark green leafy vegetables, red; orange; or yellow; vegetables and cruciferous vegetables. These priorities can be achieved by focusing on the respective drivers and leverage points of changes in the food systems. 'Examples are given in this report, such as increasing access to fruits and vegetables (including papaya, guava and melon) by reducing the seasonality in production and supplies. Examples of such opportunities of fruits are papaya, guava and melon. Another example of an opportunity to achieve systemic changes is investing in peri-urban food systems to enhance the volume, diversity and quality of supplies to urban consumers, which also positively impacts the economic opportunities of women. And, if the goal is enhancing rural food and nutrition security, then it is recommended to invest in diversifying fruit and vegetable production in home gardens that are part of remote, mixed farming systems.

### 4.2.1 Investments to enhance fruit and vegetable consumption ('Pull')

Investments to increase fruit and vegetable intake require clear consumer segmentation and targeting of the main drivers of intake for each consumer segment. This is a critical prerequisite for promoting effective interventions to achieve higher consumption of fruits and vegetables, because different consumer segments respond to different incentives. Segmentation could be done along income lines, but also along other criteria, such as age, workplace and school. Behavior change communication to adjust social norms about gender and women's empowerment should also be integral to all investments.

Income improvement, rather than a reduction of retail prices, is likely to lead to a greater increase in the consumption of fruit and, to a certain extent, vegetable intake for low-income consumers. Fruit demands seem to be more elastic compared to demand for vegetables. Investments should focus on supporting and diversifying income generating activities for the poor, and in targeted social protection policies which support healthy diets, and fruit and vegetable intake, more directly (for example, through vouchers for nutritious foods and healthy school or workplace meals).

Middle-class consumers respond more to investments that enhance convenience, such as providing fresh foods at workplaces, and fruits and vegetables that are pre-cleaned and cut. More promising is the informal market, which can increase the fruits and vegetables on offer in street foods, provide home-delivery of fresh fruits and vegetables, and increase convenience-value by chopping vegetables, for example. Investments into the industrial processing of fruit and vegetables have been found to have a limited contribution to improving healthy diets.

Investments in increasing fruit intake should receive more attention. Fruits are lumped into a generic food group with vegetables, but they possess distinct features, have a different place in dietary patterns, and need different investments to increase consumption. Increasing fruit intake will lead to a greater impact on the health of the population, as fruits have a higher propensity for reducing health risks compared to vegetables. Fruits, which are often consumed as snacks in-between meals and may require less adaptation of dietary patterns, may increase the potential impact of fruit investments on intake compared to vegetables. Such investments are likely to benefit all segments of consumers above two years of age.

Investments should prioritize nutrition-rich fruits and vegetables, such as dark green leafy vegetables, red, orange or yellow (vitamin A rich) vegetables, and cruciferous vegetables, and shy away from tomatoes and onions. However, we still know very little about the consumption of indigenous (collected) fruits and vegetables, their role in diets, and their potential to fill the intake gap. Investments should support filling this knowledge gap, to contribute to confidence and insights in the ability of these fruits and vegetables to fill (part of) the intake gap at scale.

Evidence of the extent of biological hazards and pesticide residues for fruits and vegetables in different contexts should be further explored and communicated, as these are increasing problems and concerns for consumer health. Food safety institutions generally lack capacity and resources. More analysis of effective interventions to enhance the functioning of these institutions is needed prior to making investments.

There are many examples of interventions oriented towards increasing fruit and vegetable consumption, but these are often not rigorously evaluated, fail

to identify the complementary actions needed for upscaling, and lack evidence of whether they are effective in different contexts. Repetition of promising interventions in different contexts should prevail above the testing of innovative interventions in single contexts.

A better understanding of the role fruits and vegetables play in dietary patterns is needed to understand how increased intake can be incorporated into current consumption patterns. The conception that a consumer can simply eat more fruits and vegetables ignores the need to incorporate increased amounts into often traditional dishes and meals.

Ways to strengthen consumer agency to address food safety and diet quality issues should be identified. Consumers are rarely included in discussions on food system transformations for healthier diets. There are limited numbers of institutions representing consumers, although there are examples of consumer movements emerging. Investments to strengthen these movements can result in more awareness, lobbying and agency, but this should be further tested and evaluated.

#### 4.2.2 Investments to improve the food environment ('Push')

Informal retailers are most aware of consumer preferences. Investments with the purpose of improving backward and forward information flows in fruit and vegetable supply chains must start with the relationship between retailers and wholesalers. Retailers can also be instrumental and mobilized in public campaigning and raising awareness.

Investing in informal retail, from street vendors and corner shops to ambulant vendors and convenience stores, has potential positive impacts on the accessibility and quality of fruits and vegetables. Additional impacts of investment in the retail sectors on food system outcomes include income generation and employment creation.

#### 4.2.3 Investments to improve fruit and vegetable supply chains ('Push')

Investments in informal economies require different intervention models compared to those in formal economies. As the latter are directed through formal institutions, these will not reach informal target groups. This study highlights a lack of understanding of how to mobilize and transform informal institutions, and their organization and governance, to increase supply chain efficiencies that result in lower consumer prices. Given the proportional importance of informal fruit and vegetable chains, covering often over 90% of the supply to domestic consumers, well-targeted investments have potentially high impacts on the volumes and quality of supplies, as well as other food system outcomes, such as employment, income and economic inclusion of women.

Investments to increase the affordability of fruits and vegetables to consumers must reduce transaction costs and risks in the supply chain. Opportunities to reduce transaction risks include investments in infrastructure, market information systems, and logistics such as cold storage. Opportunities to reduce supply chain losses include improved pest and disease control, harvesting techniques, and better packaging and handling. These investments can result in a reduction of supply chain losses.

Investments with the purpose of empowering women in fruit and vegetable supply chains must focus on role models that challenge social norms. These will result in necessary systemic changes. Therefore, interventions have to identify potential women as role models and adapt support facilities, including finance and business skills development.

Another investment option to empower women is the targeting of women in peri-urban fruit and vegetable supply chains, as these currently provide more conducive conditions compared to remote, long-distance supply chains.

Information asymmetries on consumer demands, prices and market developments between producers and midstream actors were observed across all seven countries studied. Investments in information facilities, including digital information systems, will improve supply chain transparency and empower actors who lack access to information. Such investments should be combined with enhancing the digital literacy of women.

#### 4.2.4 Investments to increase and diversify fruit and vegetable production ("Push")

Investments that are directed at enhancing fruit and vegetable input supply must be accompanied by investments in the know-how and capacity of producers to best use these inputs to avoid increased food safety issues and

unsustainable farm practices, such as environmental pollution and depletion of water resources. These investments will have a positive impact on the sustainability of fruit and vegetable production and reduce the risks that consumers lose trust in the safety of fruit and vegetables, with potential adverse effects on their intake.

Nutrition-rich fruit and vegetable crops need more attention from public and private R&D and extension services in anticipation of increasing consumer demands. One option could be investing in the breeding of nutrient-rich fruit and vegetable crops and crop varieties, and integrated seed system developments. This will benefit all consumer segments, as the supply of fruits and vegetables will diversify, enhancing consumer choice, and prices are likely to reduce.

Investments in irrigation and water harvesting to increase the productivity of fruits and vegetables must consider the carrying capacity of the environment and consequences for the local hydrology and other water users and services.

Investments to increase fruit and vegetable production require segmentation of producers: those that can make a step towards commercialization and those that are not. Entrepreneurial ambitions among fruit and vegetable producers are prerequisites for investing in skills and know-how development, input supply and marketing. Such investments contribute to processes of specialization, and higher and more sustainable fruit and vegetable production.

In countries with poor infrastructure, peri-urban farming systems offer more opportunities to increase the production and quality of more perishable fruits and vegetables. Peri-urban farming systems also offer better opportunities for women's involvement in production and trade, as risks of harassment when taking produce to distant markets are limited. It is currently being researched what the impact of peri-urban farming systems is in terms of employment and income generation. It is generally acknowledged that they supply considerable volumes of food to urban consumers (in the cases of Ouagadougou and Tamale, 30% of total food supplied) and include poorer segments of households. However, peri-urban farming systems are associated with poor water quality issues and insecure land ownership. Addressing these issues needs to be considered when investing in peri-urban fruit and vegetable production systems.

To reach remote, rural consumers, investments should not only focus on increasing productivity but also on diversifying the production of fruit and vegetable crops and crop varieties. In mixed farming systems, fruits and vegetables are often produced in home gardens by women, and primarily serve to feed the household, while access can be traded. These conditions are not favorable for specialization in fruits and vegetables, which is a requirement for the sustainable intensification of production. An exception is made by less perishable fruits and vegetables, such as citrus and cabbage, which are produced in dedicated, irrigated plots.

Regional and local implementation of existing public policy, that explicitly addresses gendered constraints to production, must be supported. Investments can enhance recruitment of female staff at all levels, female access to finance, land, water, and the reduction of household responsibilities for women.

Investments to enhance increasing fruit and vegetable production by women must take into account limitations in their labor availability, or run the risk of increasing their already long working days. Moreover, to benefit from increased production, women must also be active in the marketing of their produce. The latter can be achieved by investing in modes and modalities of aggregating and processing produce under women's leadership. Vehicles for this include informal producer groups, aggregators, community-based organizations, and (registered) single-sector or multifunctional cooperatives.

Interventions must be designed to engage men as well as women from a gender perspective. For example, male leaders in the community and husbands must be included so that both women and men become leaders in changing societal gender norms.

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# References and websites


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Wageningen Economic Research
P.O. Box 29703
2502 LS The Hague
The Netherlands
T +31 (0)70 335 83 30
E communications.ssg@wur.nl
www.wur.eu/economic-research

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