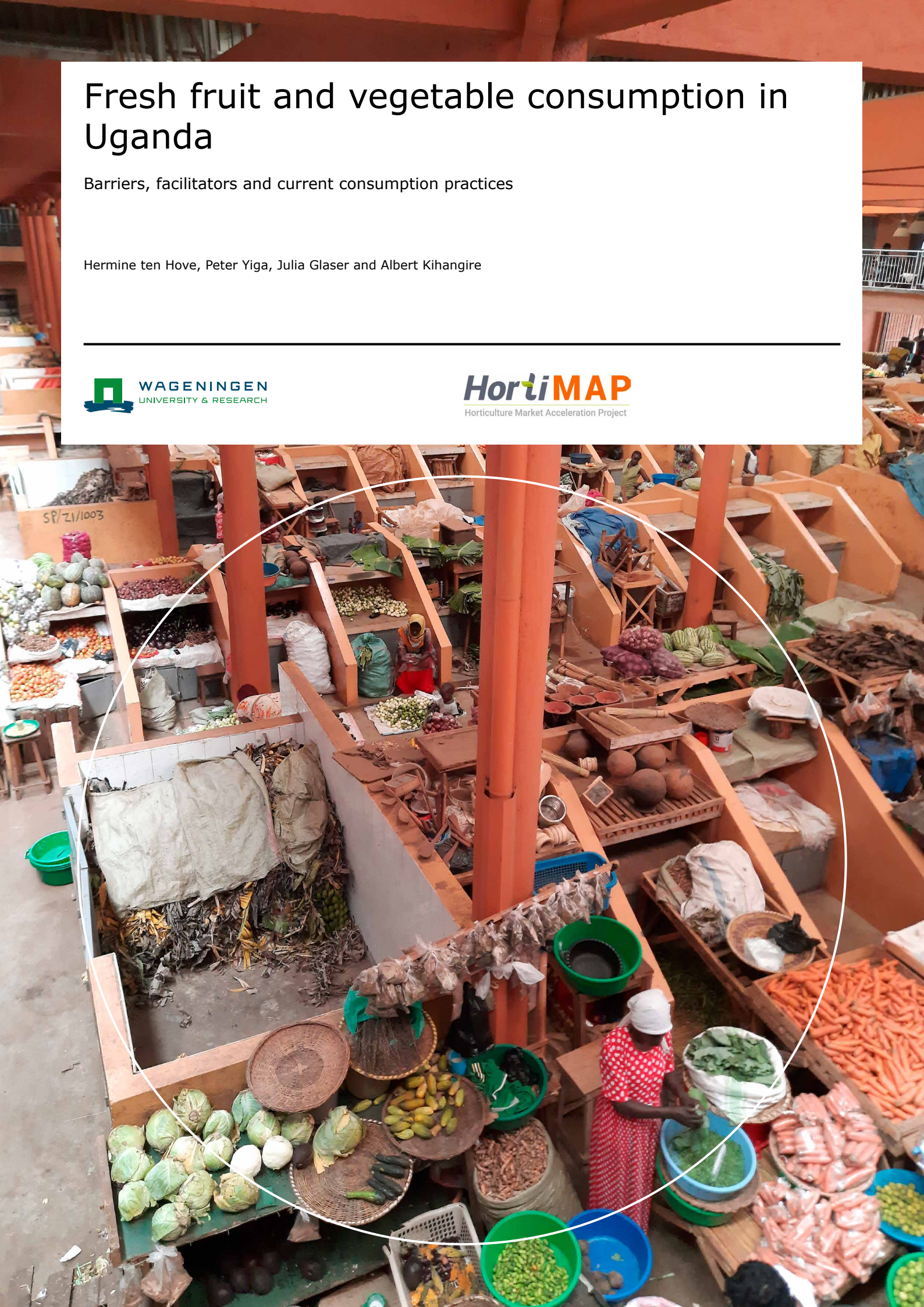
# Fresh fruit and vegetable consumption in Uganda

Barriers, facilitators and current consumption practices

Hermine ten Hove, Peter Yiga, Julia Glaser and Albert Kihangire

WAGENINGEN
UNIVERSITY & RESEARCH

HortiMAP
Horticulture Market Acceleration Project



# Fresh fruit and vegetable consumption in Uganda

## Barriers, facilitators and current consumption practices

Hermine ten Hove[1], Peter Yiga[2], Julia Glaser[1] and Albert Kihangire[3]

1 Wageningen Centre for Development Innovation, Wageningen University & Research
2 Independent consultant
3 TechnoServe Uganda

This research was commissioned by the Horticulture Market Acceleration Project (HortiMAP), which is funded by the Embassy of the Kingdom of the Netherlands in Uganda.

Wageningen Centre for Development Innovation
Wageningen, May 2023

Report WCDI-23-250

WAGENINGEN UNIVERSITY & RESEARCH

HortiMAP
Horticulture Market Acceleration Project

ten Hove, Hermine, Peter Yiga, Julia Glaser, Albert Kihangire, 2023. *Fresh fruit and vegetable consumption in Uganda; Barriers, facilitators and current consumption practices.* Wageningen Centre for Development Innovation, Wageningen University & Research. Report WCDI-23-250. Wageningen.

To inform intervention strategies to improve fruit and vegetable consumption in rural and urban Uganda, this study aimed to better understand the current consumption practices for fresh fruits and vegetables (FFV). It combined a quantitative consumer survey (n=407) with 5 key informant interviews with experts on the subject of consumption of nutritious, safe and diverse FFV. The study describes consumers' facilitators and barriers towards FFV consumption, safety perceptions of FFV, the way they handle FFV after purchase and their demand for processed FFV. It also provides suggestions for strategies that show potential to drive FFV consumption in Uganda.

Keywords: Fruit, vegetables, consumer study, nutrition, food safety, Uganda

This report can be downloaded for free at https://doi.org/10.18174/630024 or at www.wur.eu/wcdi (under knowledge products).



Report WCDI-23-250

Photo cover: Peter Yiga

# Contents

# Acknowledgements

The authors of the report would like to thank and acknowledge the following people for their valuable contribution to this research:

- The TechnoServe Uganda team, with special thanks to Annette Kawooya and Daniel Mineno.
- The study field team: Archie Denilson Ebotu, Betty Achan, Faith Anyango, Geno Miriam Joy, Kalyemenya Steven, Katherine Nakatudde, Kunihiira Rosira, Moreen Nantambala, Muhawenimana Rosemary, Nabisubi Zamu, Niwagaba Grace, Resty Kagoya and Winnie Nabbanja.
- Patrick Oyee and Phina Kamanyire of the ISSD Uganda team.
- Wageningen University & Research colleagues Esther Ronner and Edwin van der Maden.

# List of abbreviations and acronyms

| | |
|---|---|
| HortiMAP | Horticulture Market Acceleration Project |
| FFV | Fresh Fruits and Vegetables |
| LMIC | Low and Middle Income Countries |
| M&E | Monitoring and Evaluation |
| MSME | Micro, small and medium enterprises |
| NCD | Non-Communicable Disease |
| ToC | Theory of Change |
| WCDI | Wageningen Centre for Development Innovation, Wageningen University & Research |
| WHO | World Health Organization |
| WUR | Wageningen University & Research |

# Summary

Consuming fruit and vegetables according the World Health Organization's recommendations can lead to better health, yet fresh fruit and vegetable (FFV) consumption remain low in Uganda. To inform intervention strategies to improve fruit and vegetable consumption in rural and urban Uganda, this study aimed to better understand the current consumption practices for fruits and vegetables. It combined a quantitative consumer survey (n=407) with 5 key informant interviews with experts on the subject of consumption of nutritious, safe and diverse FFV. The consumers were sampled at markets in the Kigezi, Mbale / Mt. Eigon and Victoria Crescent regions.

*Barriers and facilitators to FFV consumption.* The study identified cost, distance to market, hygiene at the market, seasonality, underestimation of recommendations, (perceived) unsafety of fruits and vegetables and unwillingness to try new types of fruits and vegetables as barriers to fruit and vegetable consumption in general. General facilitators to FFV consumption were (perceived) health effects, preparation time, skill needed for preparation, taste, and willingness to try new types of fruits and vegetables. Influence of household members was mostly a facilitator, except when it comes to bitter tomatoes, where it is a barrier to consumption.

*Safety perceptions of FFV.* A large majority of consumers is at least somewhat worried about food safety – mainly about contamination with dirt or bacteria, and/or with chemical residues. The most popular action that consumers take to avoid unsafe fruits and vegetables is cleaning, peeling or treating them before consumption to make them safer. The habit of avoiding specific fruits and vegetables altogether is prevalent too, as well as only buying from a source they trust. A large majority of market visitors reported their willingness to pay a premium for certified safe fruits and vegetables – i.e., 200 shillings above the price of non-certified produce, or higher.

*Consumer handling of FFV.* After returning home with their produce, about a quarter of consumers stores their purchases in a fridge. Baskets and shelves are the most popular storage options. About a fifth of consumers stores their produce on the floor. Washing produce is common practice, especially before preparation, but also before storage for nearly half of the studied consumers. Three-quarters of consumers use the fruits they purchase to produce fruit juice at least some of the time. As Uganda does not currently have its own national guidelines on food handling practices, there are no context-specific reference points to compare the observed practices.

*Processing of FFV in relation to consumer needs.* A majority of the respondents are not interested in buying fruits and vegetables that are (partly) processed. The main reasons for this are that respondents see processed fruits and vegetables as unclean, and that they do not experience a need to buy pre-processed produce. Expensiveness and reduction of shelf life are also considered drawbacks of processed FFV products. A third of respondents is, to some extent, interested in pre-processed produce. A key informant also did see opportunity in the sale of processed fruits and vegetables for the increased convenience it provides – especially to youth – a perception that is backed up by earlier research.

*Strategies that show potential to drive FFV consumption.* Sustainable but slow interventions like fruit trees, which only start producing results after the project period has ended, should be considered more, according to the key informants. The (perceived) lack of hygiene in the value chain, should also be addressed. Food safety investments should not just focus on separate vendors, but also the market as a whole, like addressing the availability of clean water at the market. To drive consumption of healthy FFV among consumers, the key informants recommend including an intervention that involves community gatekeepers and other (government) education structures. A focus on youth and schools is seen as a major opportunity, which would in turn the behaviour of the parents. Zooming out to the value chain as a whole, the key informants highlighted the need for a system where all actors can keep one another accountable and consumer rights and complains are taken seriously.

# 1 Introduction

## 1.1 Background

Non-Communicable Disease (NCDs) currently account for almost half of all deaths and disabilities in Low-and Middle-Income Countries (LMICs) and are projected to overtake infectious diseases by 2030 (Global Nutrition Report, 2021; WHO, 2013). Sub-Saharan Africa is the only region with a projected increase in Type 2 Diabetes prevalence by more than 100% (134%) by 2045 (International Diabetes Federation, 2021). Over the last two decades, Type 2 Diabetes prevalence in Uganda has risen from 3% to 5.6% (Global Nutrition report, 2021). The increasing burden of NCDs in LMIC settings like Uganda reflects an urgent need for efficient preventive strategies.

Clinically relevant improvements in metabolic health can be achieved by the routine intake of fruit and vegetables consistent with the WHO recommendations (Graham, Madigan, & Daley, 2022; Hill, 2009; Jayedi, Gohari, & Shab-Bidar, 2021; Robert Ross, 2020; Wallace et al., 2020). Sufficient intake of fruit and vegetables may alleviate 14 percent of deaths from gastrointestinal cancer worldwide, about 11 percent of those due to ischemic heart disease, and about 9 percent of those caused by stroke (Afshin et al., 2019; Wallace et al., 2020). In Uganda, fruit and vegetable consumption is still low, with only 12.2% of the population meeting the recommended intake of 5 servings or more (Kabwama et al., 2019). There is a need for intervention strategies to improve fruit and vegetable consumption in Uganda.

The HortiMAP project is an ongoing intervention which, among other things, aims at increasing fruit and vegetable intake in Uganda. The project is implemented by TechnoServe, in partnership with Wageningen University and Research (WUR), BiD Capital Partners, and PUM Netherlands. Interventions tailored to existing beliefs are effective in improving behavior (Eldredge et al., 2016). Hence, to further optimize the HortiMAP project, there is a need to understand the determinants and current consumption practices for fruits and vegetables. However, data on the determinants of fruit and vegetable intake in Uganda is still scanty. Accordingly, the determinants of fruit and vegetable consumption behaviours are not well understood in Uganda's context. A recent qualitative study in urban Uganda reported that low fruit and vegetable consumption is due to socio-cultural misconceptions (prestige linked to consumption of animal protein, and low social status accorded to vegetables and fruits) and knowledge/skills gaps amidst the fast-changing environment (Yiga et al., 2021). Scientific evidence from other parts of Uganda, including rural areas, to the best of our knowledge is lacking. There is thus a need for studies to validate available information in urban areas but also to find provide insights for the regions where information is lacking. On this basis, this study aimed to understand the current consumption practices for fruits and vegetables across urban and rural Uganda.

## 1.2 Objectives

**General objective:**
To understand the facilitators, barriers and current consumption practices for fruits and vegetables in Uganda.

**Specific objectives:**
1. To understand consumer facilitators and barriers to / not to consume (specific) fruits and vegetables
2. To know the proportion of target market consumers who demonstrate a preference to deliberately avoid unsafe sprayed FFV products in favour of safe FFV
3. To know what consumers do with the FFV they purchase and whether it affects their nutritional value and food safety
4. To know how processing of FFV products responds to consumer needs
5. To get insights on strategies that show potential to drive the consumption of FFV in Uganda

# 2 Methodology

## 2.1 Study design

A consumer survey was used to answer objectives 1 to 4. To design the consumer survey, a qualitative prior to quantitative survey approach was used. First, 17 explorative consumer interviews (i.e., until data saturation) were conducted to inform the quantitative consumer survey design. The interviewees were recruited from markets across the Victoria Crescent region, one of the HortiMAP implementation centers (Figure 1) using opportunistic sampling; a purposive non-probability approach. Markets sampled included Kasangati, Magigye, Jinja Central, Bugembe and Namulesa. The objective was to gain an insight into the breadth of enablers, barriers, storage techniques, preparation techniques and safety concerns these consumers perceived, and the reasons why. The explorative consumer interviews were then followed up with a larger scale quantitative consumer survey to find out which ones were most important.

Key informant interviews answered objective 5. Five key informants on the subject of consumption of nutritious, safe and diverse FFV were selected in collaboration with the HortiMAP team in Uganda. Their expertise included fruit and vegetable value chains; nutrition, human health and behaviour change; consumer awareness and advocacy; food and nutrition policies; food safety; and business and Micro, Small and Medium Enterprises (MSMEs).

## 2.2 Study population and sampling strategy for the consumer survey

The study sample was drawn from the three HortiMAP regions of implementation: Kigezi, Mbale / Mt. Eigon and Victoria Crescent, as illustrated in Figure 1. The target population consisted of consumers (men and women) who visited the HortiMAP partner markets to buy groceries. The study aimed to cover both urban and rural areas and a variety of market types to adequately reflect the regions' population. Sampling was done through convenience sampling at the markets in the regions. The recruitment strategy, targeting consumers purchasing fruits and vegetables at the market stalls, could not enable creating a sampling frame. Hence, a convenience sampling strategy was used. The sampled markets were Rusiiza, New Market, Old Market, Kabale Central and Owino Market in Kigezi, Arubaine, Busia Central, Kikindu, Kona and Mbale Central Market in Mbale / Mt. Elgon, and Bugembe, Jinja Central, Kalerwe, Kasaganti, Magigye and Nabitalo in Victoria Crescent.

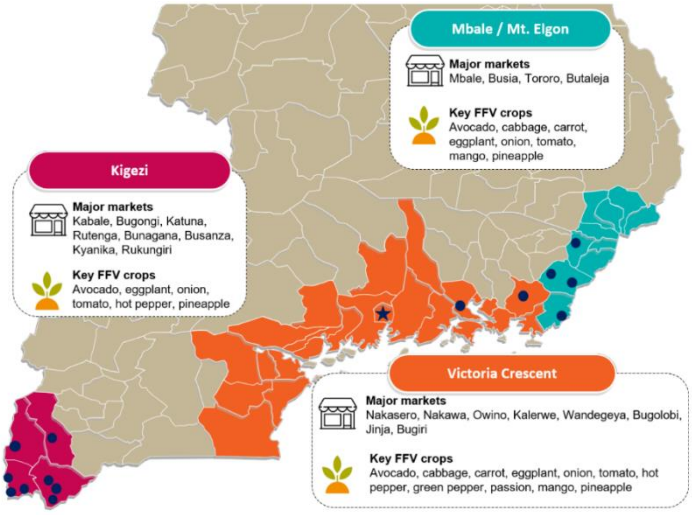



***Figure 1*** *Geographic focus of HortiMAP and the current study*

### 2.2.1 Eligibility

The following were the inclusion criteria to the study sample:

i. Respondent is (one of the) key decision makers on purchasing groceries for the household
ii. Respondent is (one of the) persons who buys groceries for the household
iii. Willingness to participate in the study and to sign the informed consent

### 2.2.2 Sample size calculation for the consumer survey

The sample size calculation is based on the following formula for an infinite population:

$$n = p(1-p)\left(\frac{Z_C}{E}\right)^2$$

p = proportion = 0.5
$Z_c$ = Z-value for confidence interval = 1.96
E = margin of error = 0.05

$$385 = 0.5(1-0.5)\left(\frac{1.96}{0.05}\right)^2$$

This means that the sample size is 385. The sample was further increased by 5% to account for contingencies such as non-complete response or recording error n (385) + (5/100*385) = 405. This number was divided by the number of regions that are being studied (i.e. 3) to determine the sample size per region: 135. This sample size means that the margin of error for each of the individual regions is roughly 9%.

Appendix 1 contains an overview of the socio-demographic characteristics of the study sample.

## 2.3 Data collection

For the consumer survey, a mobile survey tool was administered, hosted by the KoBoToolbox platform and using the ODK Collect mobile app. The survey was translated into the relevant language(s) for the three regions (Luganda and Rukiga). The survey consisted of the modules listed in Table 1. The full survey tool can be found in Appendix 2. The survey tool was pre-tested with its intended audience as part of the enumerator training, and where necessary, adapted before data collection started. Enumerators were recruited locally and trained before going to the field. Enumerators worked in teams per region.

For the key informant interviews, a semi-structured interview guide (Appendix 2) consisting of the following questions was used:

- Do you know of initiatives within Uganda that aim to increase FFV consumption?
- What are, in your opinion, the most promising interventions aiming to increase the consumption of FFV? (Restrict to a top 3 if there are many).
- Why are these so promising?
- What are the main pitfalls or challenges of these interventions?
- What do you think are key factors for success for FFV interventions aiming to increase consumption to be successful?
- What do you think are key pitfalls for FFV interventions aiming to increase consumption?

## 2.4 Data analysis

Descriptive statistics (percentages, means and standard deviations) were used to present the quantitative findings and to prioritize barriers and facilitators. Data presentation and description is made using tables, frequency distributions and graphs. Quantitative data was analysed using SPPS software, version 28. The qualitative data was analyzed by summarizing the responses that were given. The resulting text was subsequently checked and approved by the respondents.

## 2.5 Ethical considerations

Research approval and permit was sought prior to the start of the study and granted by the research ethics committee of Mildmay Uganda Research Center (REC REF 0310-2022) and Uganda National Council for Science and Technology (UNCST) (Approval number -HS2552ES). See Appendix 3 for the documentation of the received ethical approval.

# 3 Barriers and facilitators to consuming fruits and vegetables

## 3.1 Barriers and facilitators to consuming fruits and vegetables in general

The exploratory consumer interviews that were conducted identified 3 general parameters that were mentioned to have an effect on both fruit and vegetable consumption: hygiene at the market, distance to the market and health effects. The survey was used to assess the perceived size of their impact on fruit and vegetable consumption. Table 1 summarizes the results. A negative score means that the parameter has a perceived negative impact on fruit and vegetable consumption (less consumption); a positive score refers to a positive impact (more consumption). The possible scoring range is -2.00 up to +2.00. Scores between -0.10 and 0.10 are considered to signify no impact on consumption. The parameters are ranked according to their impact on the study area overall.

***Table 1*** *Barriers and facilitators for fruit and vegetables consumption by region (mean score±SD)*

| Parameter | Overall study area | | Scores per region surveyed | | |
|---|---|---|---|---|---|
| | # | Uganda (n=406) | Mt Elgon (n=134) | Victoria Crescent (n=136) | Kigezi (n=136) |
| **Barriers to consumption** | | | | | |
| Hygiene at the market | 1 | -0.72±1.17 | -0.59±1.15 | -0.45±1.22 | -1.12±1.02 |
| Distance to market | 2 | -0.17±1.06 | -0.05±1.04 | -0.20±1.05 | -0.26±1.08 |
| **Facilitators to consumption** | | | | | |
| Health effects | 1 | 1.28±1.05 | 1.55±0.60 | 1.23±1.08 | 1.06±1.29 |

The most important general barrier that applies to both fruit and vegetable consumption is a lack of hygiene at the market. Distance to market also has a negative impact, though smaller. The most important facilitator of consumption are their health effects and the availability of different types of fruits at a market.

## 3.2 Barriers and facilitators to consuming fruits

The exploratory consumer interviews identified 6 parameters that were mentioned to have an effect on fruit consumption: cost, community expectations, availability at each market visit, variety of different types at the market, taste and the influence of fellow household members. The survey was used to assess the perceived size of their impact on fruit consumption, using the same scoring system as described in Chapter 3.1. Table 2 summarizes the results. The parameters are ranked according to their impact on the study area overall. Their order and classification may be different among the different regions.

***Table 2*** *Barriers and facilitators for fruit consumption by region (mean score±SD)*

| Parameter | # | Overall study area Uganda (n=406) | Scores per region surveyed Mt Elgon (n=134) | Victoria Crescent (n=136) | Kigezi (n=136) |
|---|---|---|---|---|---|
| **Barriers to consumption** | | | | | |
| Cost of fruits | 1 | -0.75±0.96 | -0.57±1.07 | -0.84±0.89 | -0.82±0.90 |
| **No impact on consumption** | | | | | |
| Community expectations | - | -0.02±0.77 | 0.07±0.91 | 0.05±0.62 | -0.19±0.73 |
| Availability at every market visit | - | -0.02±1.22 | 0.14±1.19 | 0.11±1.09 | -0.30±1.33 |
| **Facilitators to consumption** | | | | | |
| Variety of different fruits at a market | 1 | 0.98±1.05 | 1.01±0.98 | 0.80±1.16 | 1.12±0.97 |
| Taste perception | 2 | 0.67±1.25 | 0.98±1.09 | 0.67±1.22 | 0.37±1.35 |
| Influence of household members | 3 | 0.53±1.23 | 0.86±1.12 | 0.58±1.09 | 0.16±1.34 |

The most important barrier to fruit consumption is their cost. The current study did not find an overall effect for community expectations or availability of fruits at every market visit – though there does seem to be a slight negative impact in Kigezi. The most important facilitators of consumption are the availability of different types of fruits at a market and their taste. The influence of fellow household members also has a positive impact on the consumption of fruits.

## 3.3 Barriers and facilitators to consuming vegetables

The exploratory consumer interviews that were conducted identified 8 main parameters that were mentioned to have an effect on vegetable consumption. Some of these parameters applied to vegetables in general, whereas others were expected to be different for specific types of vegetables. Different groups of vegetables were created to accommodate this diversity in the survey questions: leafy vegetables, vitamin A-rich vegetables, bitter tomatoes and other vegetables. The survey was used to assess the perceived size of the effect of the different parameters on consumption of different groups of vegetables, using the same scoring system as described in Chapter 3.1. Table 3 summarizes the results. The parameters are ranked according to their groups and then based on impact on the study area overall. Their order may be different among the different regions.

***Table 3*** *Barriers and facilitators for vegetables consumption by region (mean score±SD)*

| Parameter | # | Overall study area Uganda (n=406) | Scores per region surveyed Mt Elgon (n=134) | Victoria Crescent (n=136) | Kigezi (n=136) |
|---|---|---|---|---|---|
| ***Vegetables in general*** | | | | | |
| **Barriers to consumption** | | | | | |
| Cost of vegetables | 1 | -0.48±1.14 | -0.30±1.21 | -0.54±1.09 | -0.59±1.10 |
| **No impact on consumption** | | | | | |
| Expectation of being labelled poor | - | -0.10±0.84 | 0.14±1.07 | -0.17±0.68 | -0.26±0.67 |
| Availability at every market visit | - | 0.00±1.18 | 0.22±1.12 | 0.00±1.03 | -0.21±1.33 |
| **Facilitators to consumption** | | | | | |
| Different types of vegetables at a market | 1 | 0.83±1.06 | 0.93±1.01 | 0.57±1.16 | 0.98±0.96 |
| | | | | | |
| ***Leafy vegetables*** | | | | | |
| **Facilitators to consumption** | | | | | |
| Taste perception | 1 | 0.72±1.18 | 1.17±0.98 | 0.67±1.11 | 0.32±1.29 |
| Preparation time | 2 | 0.45±1.21 | 0.74±1.17 | 0.42±1.16 | 0.17±1.23 |
| Influence of household members | 3 | 0.27±1.26 | 0.65±1.22 | 0.31±1.12 | -0.16±1.30 |
| Skill to prepare | 4 | 0.15±1.19 | 0.59±1.03 | 0.02±1.18 | -0.14±1.21 |

| Parameter | # | Overall study area Uganda (n=406) | Scores per region surveyed Mt Elgon (n=134) | Victoria Crescent (n=136) | Kigezi (n=136) |
|---|---|---|---|---|---|
| ***Vitamin A rich vegetables*** | | | | | |
| **Facilitators to consumption** | | | | | |
| Taste perception | 1 | 0.90±0.99 | 1.23±0.83 | 0.78±0.98 | 0.68±1.07 |
| Influence of household members | 2 | 0.67±1.07 | 1.03±0.89 | 0.58±0.98 | 0.39±1.23 |
| Preparation time | 3 | 0.62±1.12 | 0.90±0.97 | 0.50±1.06 | 0.46±0.96 |
| Skill to prepare | 4 | 0.31±1.11 | 0.71±0.90 | 0.09±1.15 | 0.13±1.15 |
| ***Bitter tomatoes*** | | | | | |
| **Facilitators to consumption** | | | | | |
| Preparation time | 1 | 0.37±1.20 | 0.64±1.15 | 0.34±1.13 | 0.11±1.26 |
| Taste perception | 2 | 0.14±1.39 | 0.50±1.23 | 0.04±1.40 | -0.12±1.46 |
| **No impact on consumption** | | | | | |
| Skill to prepare | - | -0.05±1.25 | 0.47±1.05 | -0.32±1.28 | -0.31±1.26 |
| **Barriers to consumption** | | | | | |
| Influence of household members | 1 | -0.57±1.14 | -0.38±1.16 | -0.64±1.01 | -0.67±1.22 |
| ***Other vegetables*** | | | | | |
| **Facilitators to consumption** | | | | | |
| Taste perception | 1 | 0.69±1.16 | 1.03±0.961 | 0.57±1.13 | 0.45±1.30 |
| Preparation time | 2 | 0.48±1.11 | 0.75±1.09 | 0.43±1.07 | 0.26±1.12 |
| Influence of household members | 3 | 0.24±1.21 | 0.60±1.07 | 0.21±1.17 | -0.12±1.28 |
| Skill to prepare | 4 | 0.16±1.13 | 0.61±0.98 | -0.01±1.13 | -0.11±1.14 |

Out of the general parameters that apply to all vegetables, only the cost of vegetables was perceived as a barrier by the targeted consumers. The availability of different types of vegetables at the market was a perceived facilitator of vegetable consumption. The expectation of being labelled poor when consuming vegetables, or the availability of vegetables at the market, were not found to be of much influence overall – but a slight barrier in Kigezi. For the leafy vegetables (e.g. nakati, sukuma wiki, amaranth, yam leaves or ensuga) and the other vegetables (e.g. courgette, eggplant and mushrooms), the four studied parameters were all considered facilitators to varying extents. Taste perception had the largest positive influence, followed by their preparation time, the influence of household members, and the skill needed to prepare them. However, in Kigezi, the influence of household members and the skill needed to prepare were actually considered barriers. For the vitamin A rich vegetables (e.g. carrots and pumpkin), again all parameters were considered to be facilitators to consumption, though in a slightly different order of impact: 1) taste perception, 2) influence of household members, 3) preparation time and 4) skill to prepare. Among the bitter tomatoes category (e.g. ntula, katunkuma), the picture is more varied. Overall, preparation time and taste perception were facilitators, though their effect size is relatively small, and this finding does not apply to Victoria Crescent and Kigezi. The skill needed to prepare them does not have an impact on consumption overall, but slightly negative in Victoria Crescent and Kigezi. Fellow household members are not too keen on consuming bitter tomatoes and have a negative influence on consumption. Finally, the "Other vegetables" category yielded only facilitators: 1) taste perception, 2) preparation time, 3) influence of household members and 4) skill to prepare. In Kigezi, the latter two are actually (slight) barriers.

# 4 Food safety perceptions and actions

Respondents were asked to what extent they are worried about the safety of the fruits and vegetables they consume and what actions they take to avoid fruits and vegetables they perceive as unsafe. The respondents that chose the action "I only buy from a source I trust" were subsequently asked about the type of sources that they do trust. All respondents were asked about the causes of food safety concerns, and their willingness to pay a premium for "certified safe fruits and vegetables". Those who indicated to be (maybe) willing to do so, were subsequently asked to choose an amount they would be willing to pay for 4 safe tomatoes if 4 "normal" tomatoes cost 1000 shillings. Table 4 shows the frequency of each of the different answering options.

***Table 4*** *Food safety perceptions of fruits and vegetable handling practices across the regions*

| | Overall study area | Region surveyed | | |
|---|---|---|---|---|
| **Parameter** | **Uganda** | **Mt Elgon** | **Victoria crescent** | **Kigezi** |
| **Food safety perception** | **(n=403)** | **(n=132)** | **(n=136)** | **(n=135)** |
| Not worried | 28.5% | 32.1% | 30.1% | 23.4% |
| Slightly worried | 39.1% | 35.8% | 44.1% | 37.2% |
| Highly worried | 32.4% | 32.1% | 25.7% | 39.4% |
| **Actions taken to avoid perceived unsafe fruits and vegetables** | **(n=403)** | **(n=132)** | **(n=136)** | **(n=135)** |
| Yes, I clean/peel/treat them to make them safe for consumption | 63.6% | 62.4% | 60.0% | 68.4% |
| Yes, I avoid specific types of fruits and vegetables altogether | 34.9% | 33.8% | 34.8% | 36.0% |
| Yes, I only buy them from a source I trust | 28.5% | 28.6% | 34.8% | 22.1% |
| No, not really | 3.5% | 3.8% | 3.0% | 3.7% |
| **Trusted source of safe fruits and vegetables** | **(n=114)** | **(n=38)** | **(n=47)** | **(n=29)** |
| Market vendor | 87.7% | 89.5% | 89.4% | 82.8% |
| Farmer | 24.6% | 18.4% | 31.9% | 20.7% |
| Supermarket | 18.4% | 15.8% | 17.0% | 24.1% |
| Other | 1.8% | 0.0% | 2.1% | 3.4% |
| **Food safety concerns** | **(n=403)** | **(n=132)** | **(n=136)** | **(n=135)** |
| Contamination with dirt or bacteria | 60.8% | 56.8% | 67.6% | 57.8% |
| Chemical residues | 54.8% | 56.1% | 50.0% | 58.5% |
| Other | 7.2% | 10.6% | 5.1% | 5.9% |
| I don't know | 4.7% | 3.8% | 5.1% | 5.2% |
| Adulteration | 3.7% | 3.0% | 2.9% | 5.2% |
| **Willingness to pay a premium** | **(n=403)** | **(n=132)** | **(n=136)** | **(n=135)** |
| Yes | 72.1% | 77.3% | 73.5% | 65.7% |
| No | 17.4% | 12.9% | 22.1% | 17.2% |
| Maybe | 10.4% | 9.8% | 4.4% | 17.2% |
| **Amount of acceptable premium price** | **(n=332)** | **(n=115)** | **(n=106)** | **(n=111)** |
| 1200 shillings for 4 tomatoes | 46.1% | 49.6% | 42.5% | 45.9% |
| 1500 shillings for 4 tomatoes | 25.9% | 20.0% | 29.2% | 28.8% |
| 2000 shillings (or more) for 4 tomatoes | 22.3% | 28.7% | 19.8% | 18.0% |
| I don't know | 5.7% | 1.7% | 8.5% | 7.2% |

The results show that a majority of consumers are worried about food safety to some extent: 71.5% (i.e., 34.4% is highly worried, 39.1% is slightly worried). The most popular action that consumers take to avoid unsafe fruits and vegetables is cleaning, peeling or treating them before consumption to make them safer. The habit of avoiding specific fruits and vegetables altogether is prevalent too: 34.9% of consumers indicate that they do so. 28.5% of consumers navigate their food safety concerns by only buying from a source they trust – mainly market vendors, and to a lesser extent farmers and supermarkets. Few consumers (3.5%) do not take any action at all to avoid consumption of unsafe fruits and vegetables – meaning that 96.5% of consumers do take deliberate action. Consumers perceive "contamination with dirt or bacteria" (60.8%) and "chemical residues" (54.8%) as the major causes of food safety issues.

72.1% of consumers are willing to pay a premium for certified safe fruits and vegetables. The lowest surplus amount (200 shillings above the price of non-certified produce) is the most popular choice, though 22.3% of consumers indicates to be willing to pay double the standard market price for the promise of safety.

# 5 Use of purchased fruits and vegetables

## 5.1 Purchase

Consumers were asked about their habits when it comes to shopping for fruits and vegetables. Table 5 provides insight into their likelihood to try out new fruits and vegetables, the frequency of household market visits to purchase fruits and vegetables, and the reasons behind that frequency.

***Table 5*** *Shopping habits for fruits and vegetables across the regions*

| Parameter | Overall study area | Region surveyed | | |
|---|---|---|---|---|
| | Uganda | Mt Elgon | Victoria crescent | Kigezi |
| **Likelihood to try out new fruits and vegetables** | **(n=404)** | **(n=133)** | **(n=136)** | **(n=135)** |
| Not likely | 30.2% | 21.1% | 36.8% | 32.6% |
| Somewhat likely | 34.2% | 34.6% | 36.8% | 31.1% |
| Very likely | 35.6% | 44.4% | 26.5% | 36.3% |
| **Average no. of market visits to buy fruits and vegetables per week** | 4.29±2.32 | 4.68±2.31 | 4.60±2.19 | 3.57±2.32 |
| **Reasons for visiting the market at the current frequency** | **(n=400)** | **(n=133)** | **(n=135)** | **(n=132)** |
| No time to go more frequently | 19.8% | 27.1% | 9.6% | 22.7% |
| No resources to pay for transport to go more frequently | 23.3% | 24.1% | 23.7% | 22.0% |
| No storage to go less frequently | 14.5% | 15.8% | 17.0% | 10.6% |
| Because we plan our meals ahead of time | 27.0% | 27.8% | 28.9% | 24.2% |
| Because we do not plan our meals ahead of time | 19.3% | 20.3% | 25.9% | 11.4% |
| We pass by the market /need to be there for other reasons | 33.0% | 38.3% | 32.6% | 28.0% |
| We forget products and have to return | 7.8% | 12.0% | 5.2% | 6.1% |
| I like to go (number of market visit) times | 16.3% | 14.3% | 19.3% | 15.2% |

Consumers' likelihood to try out new fruits and vegetables if they find them on the market is spread more or less equally across the three options: about a third of the consumers are not likely to do so, a third are somewhat likely, and another third are very likely to try out new options.

In a week, a household visits the market an average of 4.29 times in order to purchase fruits and vegetables. Around 20% of consumers would go more often if they had more time, and a similar proportion would go more often if they had more resources to pay for transport. 33% of consumers say that their market visiting frequency is (partly) determined by the fact that they pass by the market on their way (back from) elsewhere. At the same time, 14.5% indicates that they cannot go less frequently because they would not be able to store the produce they buy. Meal planning (or a lack thereof) also determines the frequency of market visits.

## 5.2 Storage and home processing

The exploratory consumer interviews that were conducted identified key practices when it comes to storage and home processing of the produce purchased. Table 6 is an overview of the frequency at which these practices occur.

***Table 6*** *Fruits and vegetable handling practices across the regions*

| | Overall study area | Region surveyed | | |
|---|---|---|---|---|
| **Parameter** | **Uganda** | **Mt Elgon** | **Victoria Crescent** | **Kigezi** |
| **Storage practices** | **(n=396)** | **(n=131)** | **(n=134)** | **(n=131)** |
| Fridge | 25.3% | 26.7% | 33.6% | 15.3% |
| Basket | 62.6% | 73.3% | 56.0% | 58.8% |
| Shelves | 36.1% | 27.5% | 38.1% | 42.7% |
| Floor | 19.2% | 19.1% | 15.7% | 22.9% |
| Other | 9.3% | 9.2% | 6.7% | 12.2% |
| **Wash before consumption** | **(n=394)** | **(n=134)** | **(n = 132)** | **(n=128)** |
| Yes, always | 88.8% | 92.4% | 91.8% | 82.0% |
| Yes, sometimes | 11.2% | 7.6% | 8.2% | 18.0% |
| No | 0.0% | 0.0% | 0.0% | 0.0% |
| **Moment when fruits are washed** | **(n=394)** | **(n=134)** | **(n = 132)** | **(n=128)** |
| Before storage | 42.1% | 44.6% | 50.7% | 30.5% |
| Before preparation | 89.0% | 93.8% | 87.3% | 85.9% |
| Other | 0.8% | 0.0% | 2.2% | 0.0% |
| **Make juice out of fruits** | **(n= 394)** | **(n=132)** | **(n=133)** | **(n=129)** |
| No | 25.6% | 22.0% | 22.6% | 32.6% |
| Yes, out of all | 2.5% | 0.8% | 3.8% | 3.1% |
| Yes, out of most | 6.6% | 8.3% | 8.3% | 3.1% |
| Yes, out of some | 65.2% | 68.9% | 65.4% | 61.2% |

About 25% of consumers uses a fridge to store the fruits and vegetables they have purchased (more in Victoria Crescent, less in Kigezi). A basket is the most popular option for food storage, followed by shelves. Nearly 20% of consumers reports storing their produce on the floor.

Consumers report to be diligent in washing their produce before consumption – a large majority (88.8%) does it always. All of the remaining respondents wash their produce sometimes. The main moment of washing is right before preparation – 89.0% of respondents washes their produce at that time. 42.1% washes before storage.

Juicing fruits is a popular way of processing food at home, with 65.2% of respondents indicating that process some of their fruit that way.

## 5.3 Perception of fruit and vegetable consumption levels

The survey collected consumer perceptions of whether or not they consume a sufficient amount of fruits and vegetables. The consumer was not told beforehand what the recommendation was (though the recommendation was shared afterwards). Figure 2 summarizes the results of this question.

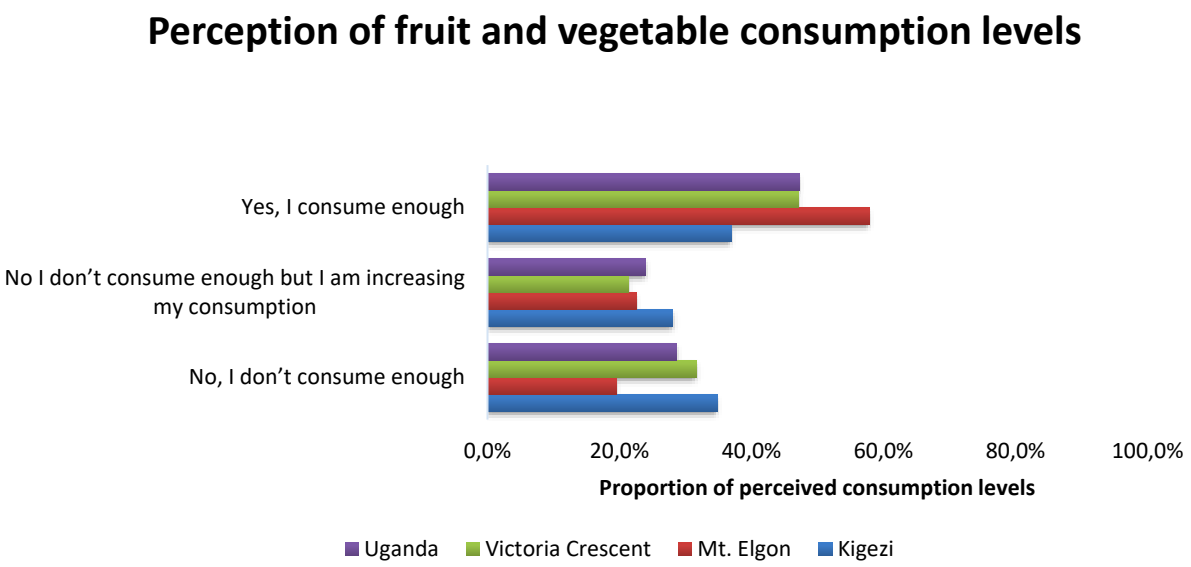



***Figure 2*** *Perception of consumption levels by region*

About 47.3% of the study population believes that they consume enough fruits and vegetables. 24.0% of the total group of respondents indicates that they do not consume enough, but that they are trying to increase their consumption. 28.7% of respondents does not consume enough and is not actively trying to increase their fruit and vegetable consumption.

## 5.4 Commonly consumed fruits and vegetables

Consumers were asked to report which fruits and vegetables they normally consume at any point in the year. Figure 3 and Figure **4** show the proportion of participants that habitually consume a fruit and vegetable, respectively.

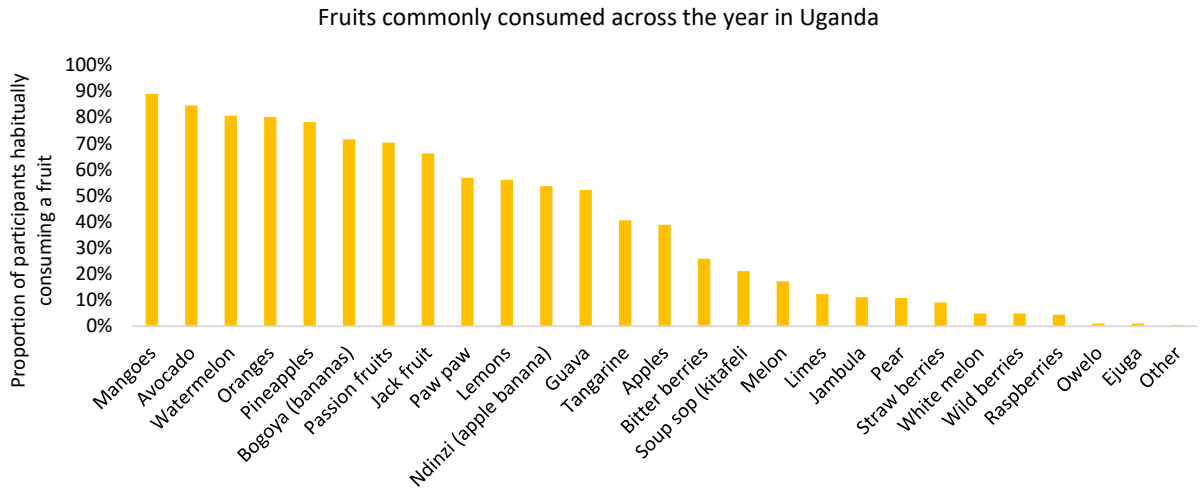



***Figure 3*** *Fruits commonly consumed across the year in Uganda*

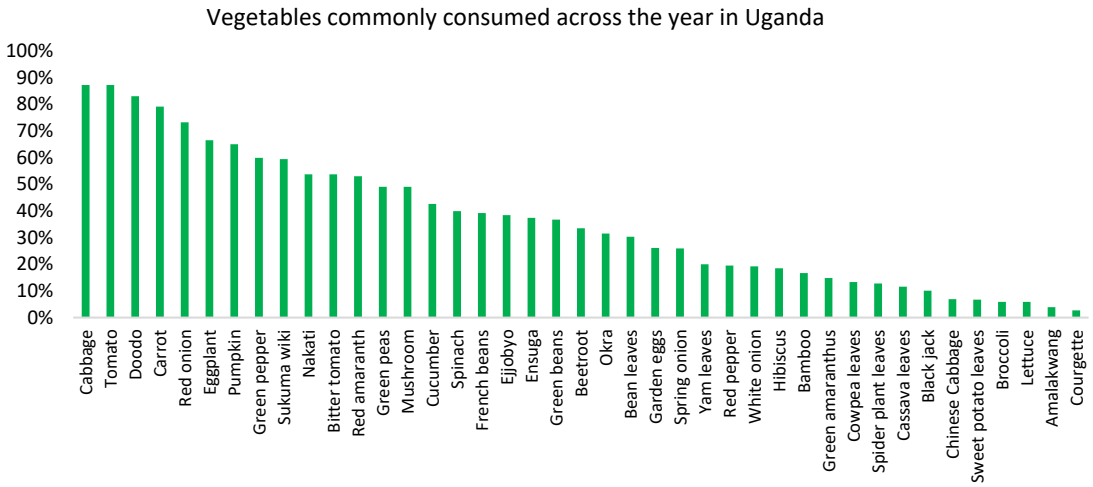



***Figure 4*** *Vegetables commonly consumed across the year in Uganda*

Mangoes, avocado, watermelon, oranges, pineapples, bananas, passion fruit, jack fruit, paw, lemons, apple banana and guava are the most commonly consumed fruits – each consumed by over 50% of the respondents. Cabbage, tomato, dodo, carrot, red onion, eggplant, pumpkin, green pepper, sukuma wiki, nakati, bitter tomato and red amaranth are the most popular vegetables – also consumed by over 50% of the respondents.

More details about fruit and vegetable consumption including regional differences can be found in Appendix 4.

## 5.5 Role of the market

Consumers were asked which of the fruits and vegetables that they consume they commonly purchase at the market. Table 8 and Table 9 capture the results of this question, ordered from "most commonly purchased at the market" to "least commonly purchased at the market".

***Table 7*** *Percentage of fruit consumers who commonly purchase that fruit at the market*

| | Overall study area | Region surveyed | | |
|---|---|---|---|---|
| **Parameter** | **Uganda** | **Mt Elgon** | **Victoria Crescent** | **Kigezi** |
| **Fruits commonly purchased from the market (proportion of those commonly consumed – total number for each fruit is based on the pattern of consumption)** | | | | |
| Watermelon | 94.2% | 89.7% | 96.3% | 97.1% |
| Pineapples | 91.2% | 91.4% | 95.6% | 87.4% |
| Oranges | 91.1% | 85.8% | 93.9% | 94.8% |
| Pear | 90.9% | 94.4% | 100% | 84.2% |
| Bogoya (cavendish banana) | 87.3% | 91.2% | 82.3% | 86.7% |
| Apples | 86.7% | 87.2% | 90.2% | 83.3% |
| Tangerines | 86.7% | 81.5% | 92.7% | 89.7% |
| Mangoes | 85.9% | 73.8% | 88.8% | 96.5% |
| Lemons | 85% | 79.3% | 86.3% | 90.5% |
| Ndinzi (apple banana) | 83.5% | 87.8% | 81.1% | 80.6% |
| Grapes | 82.6% | 100% | 77.8% | 78.6% |
| Passion fruit | 82.5% | 86.9% | 91.7% | 72.8% |
| Sour sop | 73.3% | 69% | 81.3% | 66.7% |
| Pawpaw | 73% | 75.3% | 82.3% | 62.7% |
| Avocado | 71.4% | 79.7% | 77.6% | 58.2% |
| Jackfruit | 70.6% | 65.8% | 69.6% | 80.3% |

| | Overall study area | Region surveyed | | |
|---|---|---|---|---|
| **Parameter** | **Uganda** | **Mt Elgon** | **Victoria Crescent** | **Kigezi** |
| Straw berries | 70.3% | 75% | 100% | 65.2% |
| Limes | 70% | 63.6% | 78.6% | 71.4% |
| Jambula | 64.4% | 71.4% | 50.0% | 60.0% |
| Guava | 59.4% | 68.7% | 56.9% | 50.7% |
| Bitter berries | 59% | 74.1% | 56.1% | 51.4% |
| Wild berries | 40% | 40% | 33.3% | 44.4% |
| Other | 25% | 0% | 0% | 50.0% |
| Melon | 19.1% | 9.4% | 23.2% | 26.7% |

***Table 8*** *Percentage of vegetable consumers who commonly purchase that vegetable at the market*

| | Overall study area | Region surveyed | | |
|---|---|---|---|---|
| **Parameter** | **Uganda** | **Mt Elgon** | **Victoria crescent** | **Kigezi** |
| **Vegetables commonly purchased from the market (proportion of those commonly consumed – total number for each vegetable is based on the pattern of consumption)** | | | | |
| Hibiscus | 94.7% | 94.3% | 100% | 81.8% |
| Broccoli | 91.4% | 100% | 100% | 84.6% |
| Carrot | 91.3% | 92.4% | 96.6% | 86.0% |
| Courgette | 90.9% | 100% | 100% | 80.0% |
| Okra | 90.6% | 88.7% | 88.6% | 94.9% |
| Red onions | 90.2% | 87.4% | 93.7% | 89.6% |
| Green pepper | 90.1% | 92.9% | 92.6% | 85.6% |
| Tomatoes | 89.2% | 87.6% | 92.3% | 87.8% |
| Beet root | 89% | 94.9% | 86.8% | 86.4% |
| Lettuce | 87% | 100% | 85.7% | 81.8% |
| French beans | 86.7% | 92.7% | 89.5% | 80.0% |
| Yellow pepper | 85.7% | 75% | 100% | 72.7% |
| Cabbage | 84.4% | 88.9% | 94.1% | 72.2% |
| Bamboo | 83.8% | 83.9% | 75.0% | 100.0% |
| Cucumber | 83.6% | 89.7% | 92.7% | 69% |
| Ntula | 83.3% | 86.3% | 83.9% | 79% |
| Mushroom | 83.3% | 86.3% | 83.9% | 79% |
| Nakati | 83.% | 81.2% | 89% | 69.6% |
| Green peas | 82.9% | 90.5% | 91.1% | 68.1% |
| White onions | 79.2% | 88.5% | 78.9% | 71.9% |
| Bugga | 78.5% | 85.2% | 87.0% | 36.4% |
| Eggplant | 78.4% | 84.6% | 80.8% | 69.6% |
| Red pepper | 78.4% | 91.7% | 91.3% | 59.4% |
| Sukuma wiki | 77.1% | 78.1% | 82.2% | 67.9% |
| Spinach | 75.9% | 90.0% | 90.0% | 58.3% |
| Pumpkin | 71.5% | 77.5% | 81.9% | 56.2% |
| Spider plant leaves | 71.2% | 80.6% | 68.8% | 20.0% |
| Garden eggs | 68.9% | 66.7% | 81.5% | 60.7% |
| Cowpea leaves | 68.5% | 69.2% | 100% | 58.3% |
| Jjobyo | 67.9% | 68.8% | 76.9% | 0.0% |
| Green beans | 66.9% | 90.7% | 80.0% | 40.6% |
| Spring onion | 64.8% | 91.2% | 65.7% | 38.9% |
| Amalakwanga | 62.5% | 58.3% | 100% | 0.0% |
| Green Amaranths | 60.0% | 100% | 66.7% | 30.4% |
| Doodo | 59.6% | 68.3% | 73.5% | 41.5% |
| Ensuga | 56.7% | 64.6% | 58.8% | 50.0% |
| Cassava leaves | 46.8% | 50.1% | 55.6% | 43.3% |
| Blackjack | 46.3% | 83.3% | 0.0% | 50.0% |
| Pumpkin leaves | 42.9% | 59% | 42.4% | 23.5% |
| Yam leaves | 35.8% | 53.3% | 20.8% | 29.6% |
| Sweet potato leaves | 33.3% | 0.0% | 50% | 34.8% |
| Bean leaves | 25.4% | 50.0% | 18.8% | 14.3% |

The table shows that some fruits and vegetables are more likely to be sourced from the market than others. For fruits, wild berries and melons are commonly sourced elsewhere. For vegetables, it seems that generally, leafy vegetables are less likely to be purchased than other types of vegetables.

## 5.6 Variation in and out of season

Respondents were asked which fruits and vegetables they habitually consume at any point in the year. For each product mentioned, they were asked to indicate how many days a week they consume it when it is in season, and how many days when it is not in season. Figure 4 and Figure 5 show the consumption frequencies in and out of season for fruit and vegetable consumption, respectively.

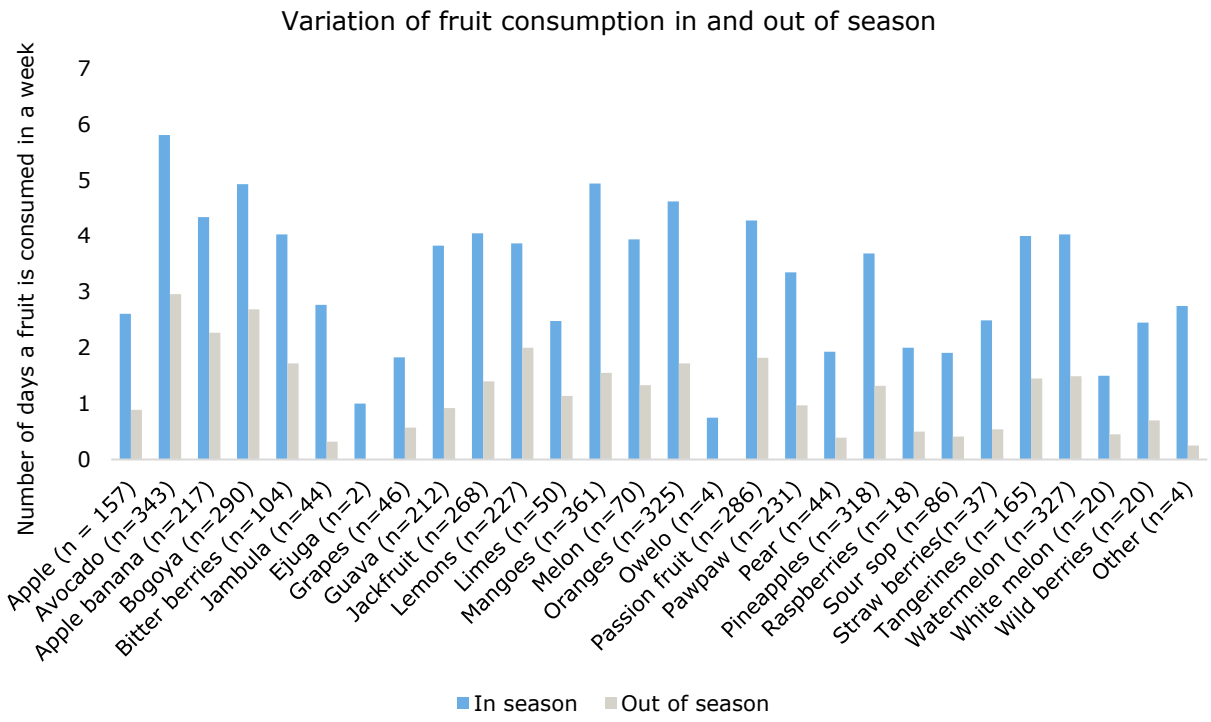



***Figure 5*** *Variation of fruit consumption in and out of season*

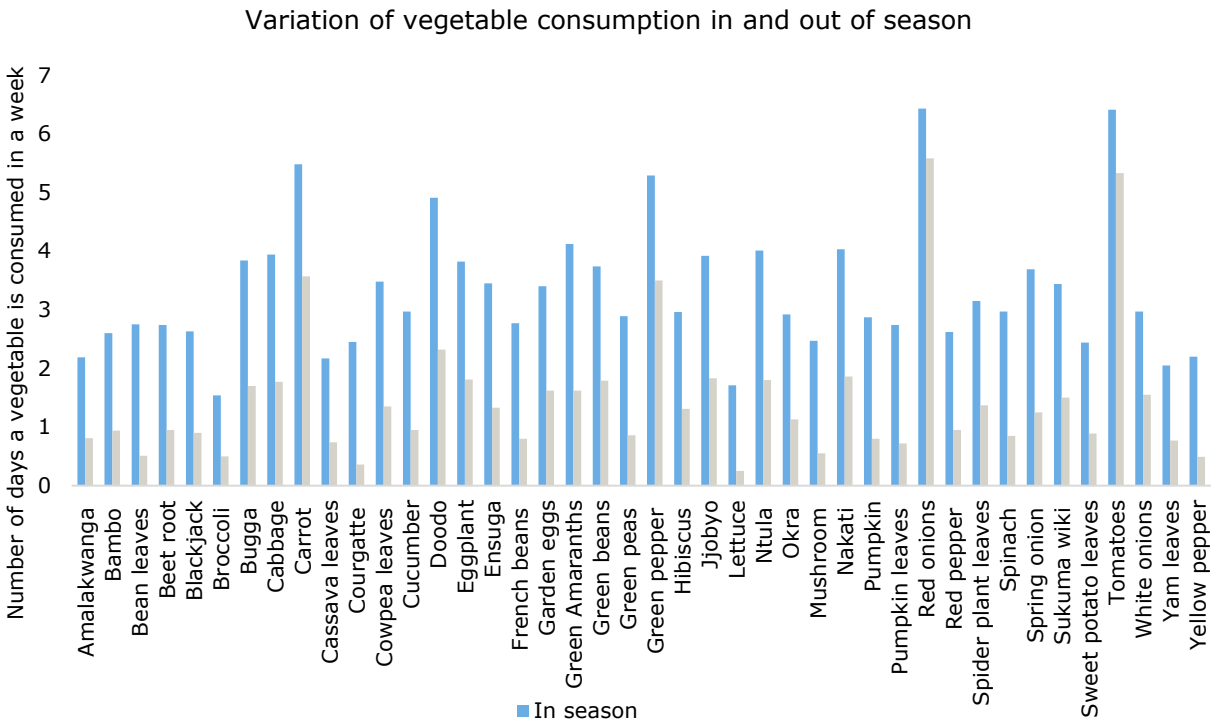



***Figure 6*** *Variation of vegetable consumption in and out of season*

The graphs show that seasonality plays a role for all fruits and for all vegetables, though to varying extents. Interestingly, it seems as if none of the crops become completely unavailable outside of their season.

# 6 Demand for processed fruits and vegetables

Consumers were asked about their habits when it comes to buying produce at the market that is already (partly) processed. This could refer to all kinds of processing (e.g., peeling, cutting, removing seeds, boiling, etc.), though cutting seems to be the most common current processing practice. Those who indicated that they do not, and are not interested, in buying processed produce were subsequently asked their reasons (more than one answer could be given). The consumers that were potentially interested in purchasing processed produce were asked about the fruits and vegetables they would specifically like to buy. The demand for (partly) processed fruits and vegetables is summarized in Table 9 below.

***Table 9*** *Demand for purchase of (partly) processed fruits and vegetables*

| | Overall study area | Region surveyed | | |
|---|---|---|---|---|
| **Parameter** | **Uganda** | **Mt Elgon** | **Victoria Crescent** | **Kigezi** |
| **Buying (partly) processed** | **(n=396)** | **(n=132)** | **(n=134)** | **(n=130)** |
| No, but I would if it was made easier | 6.3% | 0.8% | 3.0% | 15.4% |
| No, I am not interested | 66.7% | 65.2% | 67.9% | 66.9% |
| Yes, often | 5.6% | 6.8% | 9.0% | 0.8% |
| Yes, sometimes | 21.5% | 27.3% | 20.1% | 16.9% |
| **Reason for not buying processed vegetables or fruits** | **(n = 257)** | **(n=85)** | **(n=87)** | **(n=85)** |
| Not clean | 51.8% | 61.2% | 52.9% | 41.2% |
| No need | 43.6% | 32.9% | 44.8% | 52.9% |
| Too expensive | 21.4% | 20.0% | 20.7% | 23.5% |
| Other | 17.5% | 24.7% | 19.5% | 8.2% |
| Perishes too quickly | 13.2% | 8.2% | 14.9% | 16.5% |
| **Which fruits and vegetables do you like to buy partly prepared** | **(n=125)** | **(n=45)** | **(n=40)** | **(n=40)** |
| Cabbage | 70.4% | 68.9% | 70.0% | 72.5% |
| Sukuma wiki | 27.2% | 60.0% | 17.5% | 0.0% |
| Nakati | 19.2% | 8.9% | 50.0% | 0.0% |
| Mangoes | 15.2% | 24.4% | 7.5% | 12.5% |
| Jackfruit | 9.6% | 8.9% | 2.5% | 17.5% |
| Carrot | 6.4% | 4.4% | 7.5% | 7.5% |
| Doodo | 6.4% | 2.2% | 15.0% | 2.5% |
| Pineapples | 6.4% | 13.3% | 2.5% | 2.5% |
| Melon | 4.0% | 8.9% | 0.0% | 2.5% |

A majority of consumers (66.7%) are not interested in purchasing produce that is (partly) processed. The main reason for not doing so is a perception that these processed products are not clean (51.8%). The second reason is that the consumers did not perceive a need for pre-processed produce (43.6%). Price is a factor for 21.4% of the consumers who are not interested, and 13.2% of them feel that processed produce perishes too quickly.

The 33.3% of consumers that did express a (potential) interest in purchasing processed produce mainly want to purchase cabbage. In Mt Elgon, there also seems to be a market for pre-processed sukuma wiki, whereas the Victoria Crescent region would be interested in nakati.

# 7 Strategies to drive consumption of fruits and vegetables

This section contains a summary of the main opportunities and pitfalls for projects, interventions and initiative that aim to increase the consumption of fresh fruits and vegetables in Uganda, as brought up by the key informants. The opportunities and pitfalls were clustered in the following themes: Value chains (including food safety), markets and vendors, production, food processing, consumer behaviour and a category with the key opportunities and pitfalls not fitting in the previous mentioned categories.

The findings can be related to the interviewees' field of expertise using the following codes:

| Interview code | Field of expertise |
|---|---|
| A | FFV value chain, value addition, standards and food safety |
| B | Nutrition, human health and behaviour change |
| C | Consumer awareness and advocacy, food and nutrition policies |
| D | Food safety |
| E | Business and Micro, Small and Medium Enterprises (MSME) |

## 7.1 Value chain (including food safety)

| Opportunities and key factors of success | Pitfalls and challenges |
|---|---|
| There is a world to win when packaging, handling and cold storage improvement. - D | Storage of commodities at the farm level is challenging – B |
| Food safety concerns and responsibilities should be shared with all players in the food system and not only farmers – C, E<br>Transporters often miss food safety knowledge - E | Food safety is an overlooked problem in most projects - D |
| Emphasize the connectedness between players and make them aware of their role in the food system – C | Not considering the needs and drivers of all players in the value chain. - B |
| Create a mechanism where all actors, including consumers, can keep each other responsible and accountable. Make sure consumer complaints can be heard and taken serious – C | There is often a lot of mistrust between players in the food system. These should be considered and addressed before collaboration can happen – C |
| Introduce a certification system for food safety standards – A | Lots of food safety capacity building done but only for export - E |
| Involve the private sector in accountability. If you only rely on gov., implementation will be slow and enforcement will be limited – A | MSME in transport often do not have the financial means to invest in improved materials (packages, transport) - E |
| Strengthening the food safety monitoring and testing facilities is important to improve food safety – E | MSME development often focuses on producers and traders since they are easy to localize. The other players are harder to localize – E |

All interviewees addressed the value chain as a place for opportunity and a key factor for success to increase FFV consumption. Almost all interviewees stressed the importance of a systems perspective for interventions that aim to improve the value chain for FFV. It became clear that the key informants defined success as a state where all actors in the value chain are more in contact, collaborate more and keep each other accountable. A stronger role for the private sector as well as for consumers was mentioned by two interviewees. Also, a (private sector-led) certification system and an improved food safety monitoring system were seen as opportunities for projects to improve the FFV consumption in Uganda. Multiple interviewees stated that, although the government should play a role, activities should not depend on government interventions and legislation only. Since the reinforcement of food safety regulation by the government is probably low, an interviewee indicated that there are opportunities where different actors can keep each other accountable. However, the need for consistency was mentioned by one interviewee so aligning with current policy practices is important.

Some of the mentioned challenges and pitfalls of projects and initiatives aiming to improve the FFV consumption were related to the absence of a systems perspective. Some interviewees felt that food safety is often an overlooked topic in value chain development projects. Secondly, interviewees also indicated that projects sometimes fail to address the needs and drivers of different stakeholders or are not able to address the mistrust between different stakeholders. Opening up the conversation and bringing different actors in contact were suggested as possible steps to overcome these challenges.

Furthermore, challenges and opportunities with regard to more concrete steps in the value chains came up during the interviews. The absence of a cold chain, together with the absence of other improved storage methods (on the farm level) were indicated as major challenges. Furthermore, transporters often lack knowledge on food safety and information campaigns and training often do not reach them. Limited packaging or incorrect packaging on different levels (farm, transporters, storage) was mentioned as well. One key informant stated that there is a lot of capacity building focusing on different stakeholders in the value chain but often focuses only on export. Lastly, access to finance for MSMEs, but also hesitation in investments by MSMEs was seen as a challenge to improve food safety in the FFV value chain.

## 7.2 Market and vendors

| Opportunities and key factors of success | Pitfalls and challenges |
|---|---|
| Setting up road side markets with some basic facilities (roof, water, storage) - D | Market development often focuses only on bigger cities - D |
| Training vendors in the hygienic display of products was successful and also non-participants copied the approach - D | Waste disposal is often forgotten when thinking of market interventions - D |
| Ensure clean water availability at markets so FFV are not contaminated when washed but also vendors' personal hygiene improves - C | |

The key informants shared that interventions focusing on individual vendors and their way of displaying have shown positive results and were indicated as an opportunity to increase the FFV consumption in Uganda. However, the interviewees also addressed the need to look beyond individual vendors and address the market as a unit. Investment in improving the market facilities like a roof, clean water, correct waste disposal and where possible improved storage was seen as great opportunities to improve food safety and increase the consumption of FFV.

A main pitfall mentioned was that market interventions focus mainly on bigger cities and more formal markets, neglecting rural and more informal (roadside) markets.

## 7.3 Production

| Opportunities and key factors of success | Pitfalls and challenges |
|---|---|
| Providing fruit seedlings. Fitted very well with the local context - D | Providing agricultural inputs and seedlings that do not fit the local context and knowledge of people - D |
| Urban farming including fruit trees can be an opportunity - A | Fruit trees are often not included in small-scale agricultural production interventions which is a pity since they grow so well in most places -B |
| Use of bio pesticides in home gardens - B | The availability of quality seeds and agricultural inputs for home gardens is limited outside the project. - B |
| Collaborate with agricultural extension services. Increases outreach and sustainability - B | Agricultural extension services have limited attention to food safety and nutrition - D |
| Food safety should not only be addressed from an export perspective but also for farmers' health - C | Farmers are not so organized and cannot collectively invest in transport/storage/ Packaging/price. – D |
| Peer coaching structure through farmer field schools worked very well to introduce home gardens and nutrition education. Also, inviting non-participants to show what the project is doing helps to improve the outreach, positive deviance and sustainability of the project - B | Commercialization of agricultural production also leads to negative environmental effects and a decrease in wild FFV - D |
| | Not considering the dry season availability. Diets can only be improved if off-season availability is improved - B |

Some of the opportunities and pitfalls related to production activities came from projects focusing on home gardens. There were quite some reflections from key informants relating to agricultural input, including seeds and seedlings. Interviewees stated that it is important for the long-term impact of a project that introduced inputs are available also when the project ends. So, investigating and responding to the needs of these agro input providers is important. An interviewee stated that it is important that initiatives are clear about the business case for these input providers. Furthermore, one interviewee mentioned as a pitfall that projects sometimes introduce varieties that do not fit the local context. Lastly, some interviewees indicated that home garden projects often do not include fruit trees although they can fit the environmental and cultural context very well. Including fruit trees in home gardens and urban food production projects was seen as an opportunity to increase the consumption of fruit.

Secondly, also two interviewees commented on the collaboration with the agricultural extension services. One interviewee indicated that there is often limited attention to nutrition and food safety in the services provided. Another interviewee indicated that collaboration with agricultural extension services is a great opportunity to increase the outreach and sustainability of interventions. Lastly, one interviewee indicated that food safety is often addressed only from an export perspective and that more attention should be given to food safety in the relation to farmers' health.

Some opportunities and pitfalls also focused on the organization of smallholder farmers and food producers. One interviewee indicated that peer coaching using the structure of farmer field schools was a promising way to improve the sustainability of a project. Inviting other people outside the direct farmers you work with is also a way to reach these positive effects. One interviewee pointed out that the absence of farmer organization structures is an important pitfall. This leads to the limited collective investment of farmers into transport, storage, packaging or bargaining for higher prices.

Two environmental pitfalls were addressed by the key informants. The first one indicated that increased production does not necessarily lead to increased consumption of FFV if the off-season availability does not improve. Secondly, another interviewee indicated that commercialization of agricultural production has led to less availability of wild FFV and with that, a decrease in FFV consumption.

## 7.4 Food processing

| Opportunities and key factors of success | Pitfalls and challenges |
|---|---|
| Drying amaranth leaves and processing them into a powder at home. This improves the availability outside the season and fits consumer wishes - D | Production for consumption projects focus often only on basic post-harvest. There is limited attention to processing with the aim of increasing the shelf life. Considering the availability of time and money is of importance when introducing this other post-harvest processing -B |
| To increase the demand for FFV, invest more in food processing for also convenience. - A | At-home packaging of home-processed goods for sale is challenging. - D |

Some interviewees also touched upon opportunities and pitfalls for projects focusing on FFV consumption that were related to food processing. One interviewee gave an example of an easy food processing technique that increased the availability and shelf life of amaranth leaves (drying and processing them into a powder). Another interviewee indicated that projects that focus on increased production for own home consumption (such as home gardens) should also pay more attention to post-harvest handling; increasing the shelf-life of products. This could also have a positive effect on off-season availability. However, another interviewee indicated that at-home packaging of processed goods for sale is challenging. So, food processing for longer availability on household level is an opportunity to increase consumption of fruits and vegetables. Another opportunity that was brought up by an interviewee was to focus on food processing for convenience, for example cutting and mixing different vegetables. This was seen as also an important opportunity to increase demand for FFV, especially for youth.

## 7.5 Consumer behaviour

| Opportunities and key factors of success | Pitfalls and challenges |
|---|---|
| Use community gatekeepers in your behaviour change communication and use different channels (phone, mass media, talk shows). - B | Behaviour change communication: Not tailoring the messages/recipes/people involved to the local context - B |
| Nutrition education was quite successful through farmer groups because they are existing and well organized - B | People who already eat FFV also find it important and want to spend money on it. It is most challenging to get non-consumers to eat FFV – D |
| Using a peer coaching structure through farmer field schools and women's saving groups for nutrition education worked very well and improved the sustainability of the project - B | Empowering women (regarding money, production decision, and time availability) to make healthy choices for their families was challenging. Rigorous engagement with community gate keepers is of importance to change harmful gender norms that deter consumption of a healthy diet – B |
| Cooking demos with FFV: people find them very fun! - B | |
| Emphasize the importance of safe food in nutrition behaviour change communication. – C<br><br>Also to increase the demand and willingness to pay for safe food - A | |

Another cluster of pitfalls and opportunities that came up during the interviews focused on influencing consumer behaviour. One interviewee stated that engaging and working together with community gatekeepers, such as religious leaders or village representatives is of main importance for a behaviour change project to work. Furthermore, projects are likely to fail if they are not able to tailor the message to the context of the community it focuses on. Additionally, this interviewee shared that using farmer field school and peer coaching were promising methods to spread nutrition education aiming to change consumption patterns. Likewise, cooking demos were experienced as fun and effective activities to introduce new vegetables and fruits. Another informant pointed out that food safety is often missing in nutrition education and is an important step to increase the demand, and willingness to pay, for safe foods.

Another challenge that came up during the interviews was related to women's empowerment. The interviewee indicated that nutrition education or behaviour change communication is often targeting women. However, projects or interventions often fail to ensure that women are able to choose for more FFV in the diets of the household since they cannot influence the use of money within the household, make decisions in terms of production, or do not have the time available that is needed to produce, cook or fetch these FFV.

## 7.6 Others

| Opportunities and key factors of success | Pitfalls and challenges |
|---|---|
| Collaborate with schools. Youth can be change agents, and produced products could be sold to the school. – **A+B+C** | Projects often lack good quality data - B |
| Work on a common language and consistency with regard to food safety. - C | Corruption is a challenge in most projects – 2 people |
| Take a gender perspective to address the underlying structures that hold your intervention back (through community gatekeepers) - B | The policy environment for MSME is often too restrictive for these actors - E |
| When working on food safety policy, emphasize that policymakers are consumers themselves. - C | When projects focus on MSMEs, they often fail due to the absence of a holistic approach - E |

Some of the mentioned opportunities and pitfalls did not fall under specific categories. One of the mentioned opportunities by three of the interviewees was related to youth engagement. These key informants indicated that changing the consumption patterns of youth is probably a leverage point to increase FFV consumption in the wider population. This is because they are a significant part of the population, may have different needs than other consumers, they are the consumers of the future and they can influence the preference of their parents. Two key informants also saw opportunities in collaboration with schools. Parents and farmers could produce more FFV which they supply to the school, increasing the FFV consumption of the youth but also giving producers a steady income with a short supply chain.

Other opportunities and pitfalls were related to overall project management. The lack of good quality data, the lack of a consistent language between all actors and corruption were mentioned as the main challenges for overall project management. One key informant also indicated that a gender perspective is important if you want to address the underlying structures that cause the problem you aim to address.

Two other pitfalls focused specifically on challenges related to micro, small and medium enterprises in the food system (MSMEs). Policies, including food safety policies, are often not considering the specific needs of MSMEs and are often too restrictive. Secondly, if projects work with MSMEs, they often tackle one or two challenges MSMEs experience, for example, financial literacy. This decreases the chances of change.

The last-mentioned opportunity was related to food safety policies. The key informant stressed that it is important to make the food safety story personal for policymakers. Projects should address the fact that they are consumers themselves.

## 7.7 Main information sources

To supplement the information provided by the key informants, the consumer study mapped the main sources of information when it comes to advice on fruit and vegetable consumption (Table 10). Respondents could choose a maximum of three channels.

***Table 10*** *Main sources of information of advice on fruit and vegetable consumption*

| | Region Surveyed | | | |
|---|---|---|---|---|
| **Parameter** | **Kigezi** | **Mbale/Mt Elgon** | **Victoria Crescent** | **Uganda** |
| **Sources of information** | **(n=135)** | **(n=132)** | **(n=136)** | **(n=403)** |
| (Community) radio | 67.4% | 40.2% | 57.4% | 55.1% |
| Health clinic or center/growth monitoring session/ antenatal care | 25.9% | 47.0% | 45.6% | 39.5% |
| VHT/ Health volunteer/community health worker | 39.3% | 30.3% | 22.1% | 30.5% |
| Female family friends/ female friends | 17.0% | 31.1% | 19.1% | 22.3% |
| Other (mainly TV and market vendors) | 12.6% | 30.3% | 21.3% | 21.3% |
| Male family friends/male friends/male neighbors | 9.6% | 11.4% | 10.3% | 10.4% |
| Church/mosque/religious places | 14.1% | 6.8% | 3.7% | 8.2% |
| NAG-members/Nutrition champions | 0.7% | 9.8% | 5.1% | 5.2% |
| Traditional medicine | 2.2% | 1.5% | 1.5% | 1.7% |

(Community) radio is the most popular source of information (55.1%), followed by the health clinic (39.5%). Variation exists between the different regions.

# 8 Discussion and conclusions

## 8.1 Summary of results

This section provides the answers to each of the research questions.

**1. What are consumer facilitators and barriers to / not to consume (specific) fruits and vegetables?**
The study used two approaches to get an idea of the consumer facilitators and barriers to consume fruits and vegetables. The first approach was that factors that were brought up during the exploratory consumer interviews were quantified by asking directly about the impact that a factor has on the respondent's consumption. This part of the analysis showed that the barriers to fruit consumption are, from most negative perceived effect to least negative perceived effect: cost, hygiene at the market, and distance to the market. For vegetable consumption, again arranged according to perceived effect size, the barriers are: hygiene at the market, cost and distance to the market. For bitter tomatoes in particular, the influence of household members was found to be a barrier. Meanwhile, facilitators for fruit consumption are their perceived health effects, the variety of different fruits that can be found at a market, an appreciation for their taste, and the influence of household members. Vegetable consumption is promoted by perceived health effects and the available variety as well. For most categories of vegetables, taste, preparation time, influence of household members and skills to prepare were found to be facilitators (with the exception of bitter tomatoes, where skill to prepare and influence of household members did not have a positive impact).

For some factors, explorative interviews showed that quantifying the impact on consumption using a Likert scale would be difficult for consumers. Hence, an indirect method of assessment was used. These factors included seasonality, perception of already consuming enough, dependence on market, food safety considerations and likelihood to try out new fruits and vegetables. The study showed that fruits and vegetables intake, is highly influenced by seasonality; higher consumption in season, and lower out of season. The extent to which seasonality leads to gaps in availability in terms of diversity and quantity across the year was not covered by the current study, but could be mapped out based on the crops' growing seasons. Lack of awareness of recommended fruit and vegetable intake levels could also be a barrier to fruit and vegetable consumption. We found that about 47.3% of the study population believes that they consume enough fruits and vegetables. Topical study by Kabwama et al. (2019) found that only 12.2% Ugandans meet the WHO fruit and vegetable recommendations, so it is likely that a significant share of our study population is mistaken about their consumption being sufficient, or at least sufficient according to WHO guidelines. Unawareness or underestimation of the guidelines likely plays a role in this. Food safety is also a barrier, with a substantial proportion of participants reporting to avoid some vegetables and fruits due to food safety concerns. The topic of food safety will be covered in more detail in the second research question. The likelihood to try out new fruits and vegetables could be considered as both a facilitator and a barrier to a certain extent, as there was an equal distribution between groups that considered themselves "not likely" to try out new fruits and vegetables (if available), "somewhat likely" and "very likely".

**2. What is the proportion of target market consumers who demonstrate a preference to avoid unsafe sprayed FFV products in favour of safe FFV?**
This question was studied by first asking about the extent to which consumers were worried about food safety in general – not necessarily through spraying. 71.5% of consumers indicated to be at least somewhat worried about food safety. Consumers perceive "contamination with dirt or bacteria" (60.8%) and "chemical residues" (54.8%) as the major causes of food safety issues. The most popular action that consumers take to avoid unsafe fruits and vegetables is cleaning, peeling or treating them before consumption to make them safer - 63.6% of consumers does so. The habit of avoiding specific fruits and vegetables altogether is prevalent too; reported by 34.9% of consumers. 28.5% of consumers navigate their food safety concerns by only buying from a source they trust – mainly market vendors, and to a lesser extent farmers and

supermarkets. Few consumers (3.5%) do not take any action at all to avoid consumption of unsafe fruits and vegetables – meaning that 96.5% of consumers do take deliberate action.

If the preference to avoid unsafe sprayed FFV products is expressed by reported willingness to pay a premium for certified safe fruits and vegetables, then the proportion that does so is 72.1%. The lowest surplus amount (200 shillings above the price of non-certified produce) is the most popular choice, though 22.3% of consumers indicates to be willing to pay double the standard market price for the promise of safety.

**3. What do consumers do with the FFV they purchase and does this affect nutritional value and food safety?**

About 25% of the respondents stores (part of) their purchases in a fridge. This percentage likely reflects the proportion of consumers that owns a fridge. A basket is the most popular option for food storage, followed by shelves. Nearly 20% of consumers reports storing their produce on the floor. Nearly 90% of consumers always washes their produce before consumption, the remaining respondents did so sometimes. 42% of consumers wash their produce before storage, 89% before preparation. About 75% of respondents used their fruits to produce juice at least some of the time. The exploratory interviews demonstrated that vegetables are most commonly used as an ingredient of a stew, and are unlikely to be their own side dish. It is expected that this practice limits the amount of vegetables consumed per meal, but this hypothesis was not tested in the current study.

Some of the studied practices for storage and preparation are not recommended anywhere, e.g., storing produce on the floor. Others are more context-specific. Uganda does not currently have its own national guidelines on food handling practices, so there are no context-specific reference point to compare the observed practices to. Having such guidelines would provide insight into where each fruit or vegetable is best stored. Tomatoes, potatoes, eggplant, peppers and onions for example, are advised to be stored outside the fridge in the Netherlands to prevent them from drying out (Voedingscentrum, N.D.), but these guidelines may not apply in the Ugandan context. Likewise, cleaning foods before storage is not recommended in the United States of America as the increased exposure to moisture may augment microbial growth (Colorado State University, 2010), but this risk may be weighed differently in Uganda (considering unhygienic markets). Recommending juicing as a way of processing fruit is also a contested issue between different countries (Ruxton & Myers, 2021). Consuming the whole fruit may be more nutritious given the higher fibre content, but fresh fruit juice is more nutritious than soda. This makes the question of whether specific consumer practices affect nutritional value and food safety somewhat difficult to answer.

**4. How does processing of FFV products respond to consumer needs?**

A majority of the respondents are not interested in buying fruits and vegetables that are (partly) processed. The main reasons for this are that respondents see processed fruits and vegetables as unclean, and that they do not experience a need to buy pre-processed produce. Expensiveness and reduction of shelf life are also considered drawbacks of processed FFV products. 33% of respondents is, to some extent, interested in pre-processed produce. A key informant also did see opportunity in the sale of processed fruits and vegetables for the increased convenience it provides – especially to youth[1]. This perception is backed up by earlier qualitative research (Yiga, Ogwok, Achieving et al., 2021), which showed that young adults would prefer precut vegetables if they were available with assured quality in terms of safety. The most commonly sold processed crops are cabbage, sukuma wiki, nakati, mangoes, jackfruit, carrot, doodo, pineapples and melon – with notable regional differences.

**5. What are strategies that show potential to drive the consumption of healthy FFV in Uganda?**

Starting from production, a key takeaway from the key informant interviews is that sustainability beyond the implementation period is important. Inputs and seeds should also be available after the project has ended. At the same time, sustainable but slow interventions, which only start producing results after the project period has ended, should be considered more. Fruit trees are an example of this, which may explain why they remain underrepresented in interventions. Food processing was considered as a next step in the value chain, but received few inputs from the key informants. Meanwhile, the consumer survey showed that potential of

[1] The dataset of the current quantitative study did not show a statistically significant association between being aged <35 and buying preprocessed fruits and vegetables.

marketing pre-processed produce is limited by a (perceived) lack of hygiene. This lack of hygiene, which can be partly caused by a lack of clean water at the market, was also one of the reasons why the key informants recommended food safety investments to not just focus on separate vendors, but also the market as a whole. To drive consumption of healthy FFV among consumers, the key informants recommend involving community gate keepers and other (government) education structures. The key informants see a focus on youth and schools as a major opportunity, which would in turn the behaviour of the parents. The consumer survey highlights the main barriers and facilitators of fruits and vegetables. Strategies can be designed to build on the facilitators, or to reduce some of the barriers (though this can be challenging and may not be possible for all barriers). Zooming out to the value chain as a whole, the key informants highlighted the need for a system where all actors can keep another accountable and consumer rights and complains are taken seriously.

Based on the findings of the study, the authors list a number of recommendations on how to drive consumption of healthy FFV in Uganda under "Recommendations under HortiMAP".

## 8.2 Validity of the findings

This section describes the consequences of a some of the methodological choices made.

- The study used markets as the location to sample participants, which means that the findings reflect the barriers and facilitators of consumers that currently rely on those markets for some of their produce shopping. The views of consumers that procure their produce elsewhere (e.g., from their own production or from supermarkets) are not as represented in the current study, so the findings need to be interpreted with caution.
- The measures in the consumer survey were self-reported. This may have introduced reporting bias by expressing participants' ideas rather than their actual behaviour or inducing a social desirability bias. Unfortunately, these are common limitations in the field of behavioural nutrition research.
- Ordinal data (as an outcome of the Likert-type questions that were asked for the analysis of Chapter 3) is analysed by calculating a mean and a standard deviation, rather than the standard practice of taking the median or mode. This choice was made to be able to better compare the size of the impacts of the different parameters that were studied, and ultimately provide more meaningful data on the roles that the parameters play. If the median or mode is used, the only possible outcomes would be -2, -1, 0, +1 and +2. Means (e.g., +1.67 and +0.87, instead of their respective medians of 1 and 1) provide a more fine-grained insight into the responses given. However, this means that results should be interpreted with caution. If a +1 translates to "Slightly positive impact" and a +2 to a "Very positive impact", how does one put a +1.67 into words? Furthermore, one should not conclude that a 1.67 means "52% more impact" compared to 0.87 – or other interval or ratio statements. Finally, the fact that the means are based on ordinal data are also the reason why standard deviations are rather high – for each individual respondent, the lowest possible increment to their answer is 1.
- Our qualitative study slightly deviated from the scientific recommendations to conduct at least 15 in depth interviews to reach saturation. Some perspectives that are likely to be relevant, like that of government stakeholders, are missing. Nevertheless, the use of a mixed method approach comprising of quantitative and qualitative studies is a unique strength of our study. To a large extent, the findings of the consumer survey were validated by the qualitative study.

## 8.3 Recommendations for HortiMAP

Based on the outcomes of the consumer survey, the recommendations made by the key informants, the authors' own experiences, and evidence from the literature, the following recommendations are made to HortiMAP in order to drive the consumption of healthy FFV in Uganda by addressing the identified barriers and facilitators:

***Table 11*** *Barriers and facilitators and how they could be leveraged by HortiMAP*

| Barrier | Potential strategy |
|---|---|
| Cost | Emphasize the benefits of fruits and vegetables in behaviour change communication to promote informed expenditure choices.<br>Promote consumption of fruits and vegetables when they are in season as they are cheaper then.<br>Diversify by setting up front/backyard vegetable gardens (innovations like using plastic bottles) to limit overdependence on market. |
| Distance to the market | Understand which best practices for produce handling along the value chain could be promoted to improve produce shelf life (e.g., harvesting techniques, reducing bruising during transport, etc.)<br>Promote (crop-specific) best practices for storage.<br>Facilitate and invest in improved cold chain technologies across the value chain and cold storage at household level. |
| Hygiene at the market | Facilitate hygienic practices to individual vendors as well as to the market as a whole. |
| Influence of household members | Promote cooking techniques that make all vegetables, and especially bitter tomatoes, more palatable to the whole household. |
| Seasonality | Explore feasibility of the application of preservation techniques to expand the season (and retain nutritional quality), either at household level, or as part of the value chain (e.g. by market vendors). |
| Underestimation of recommendations | Promote consuming more fruits and vegetables (e.g., using media campaigns).<br>Build awareness of portion sizes (e.g., by visualizing the amounts that count as 1 portion). |
| (Perceived) unsafety of fruits and vegetables | Promote food safety, quality assurance and management practices along the value chain (e.g., certification, due diligence, government advocacy).<br>Increase awareness of what are realistic threats to food safety (and what are not) to increase demand for safe produce.<br>Develop and promote actions (e.g., through a media campaign) that consumers can take themselves to improve food safety – covering topics like storing, washing and preparing.<br>Results show that 72% of consumers are willing to pay a premium for safe FFV. Therefore develop & promote a business case for vendors (and other retailers) to source, educate and supply safe FFV to consumers. |
| Unwillingness to try new types of fruits and vegetables | Cross-share existing good practices (which are already found to be palatable in other areas) using the new types of fruits and vegetables.<br>Decrease unfamiliarity by sharing samples and organizing cooking demonstrations. |
| **Facilitator** | **Potential strategy** |
| (Perceived) health effects | Emphasize the health benefits of fruits and vegetables in behaviour change communication (e.g., in the planned retail- and industry-led campaigns)<br>See the barrier "(Perceived) unsafety of fruits and vegetables". |
| Influence of household members | Target youth and schools in behaviour change communication activities, if the project's time span is to be extended. |
| Preparation time | Ensure that promoted recipes are quick to prepare. |
| Skill | Skills are mostly perceived as sufficient for the current types of dishes prepared, but may need to be increased if new fruits and vegetables/dishes are promoted. |
| Taste | Promote new, tasty recipes that include higher quantities of fruits and vegetables (e.g., through cooking demonstrations).<br>Promote consumption of vegetables as its own dish (not just as an ingredient to a stew-like dish). |
| Willingness to try new types of fruits and vegetables | Facilitate exposure to new types of fruits and vegetables. |

When designing interventions at consumer level, the concept of "food literacy" can be helpful to develop a systematic approach. Food literacy is defined as "the scaffolding that empowers individuals, households, communities or nations to protect diet quality through change and strengthen dietary resilience over time. It is composed of a collection of inter-related knowledge, skills and behaviours required to plan, manage, select, prepare and eat food to meet needs and determine intake." These requirements are captured in Figure 7.

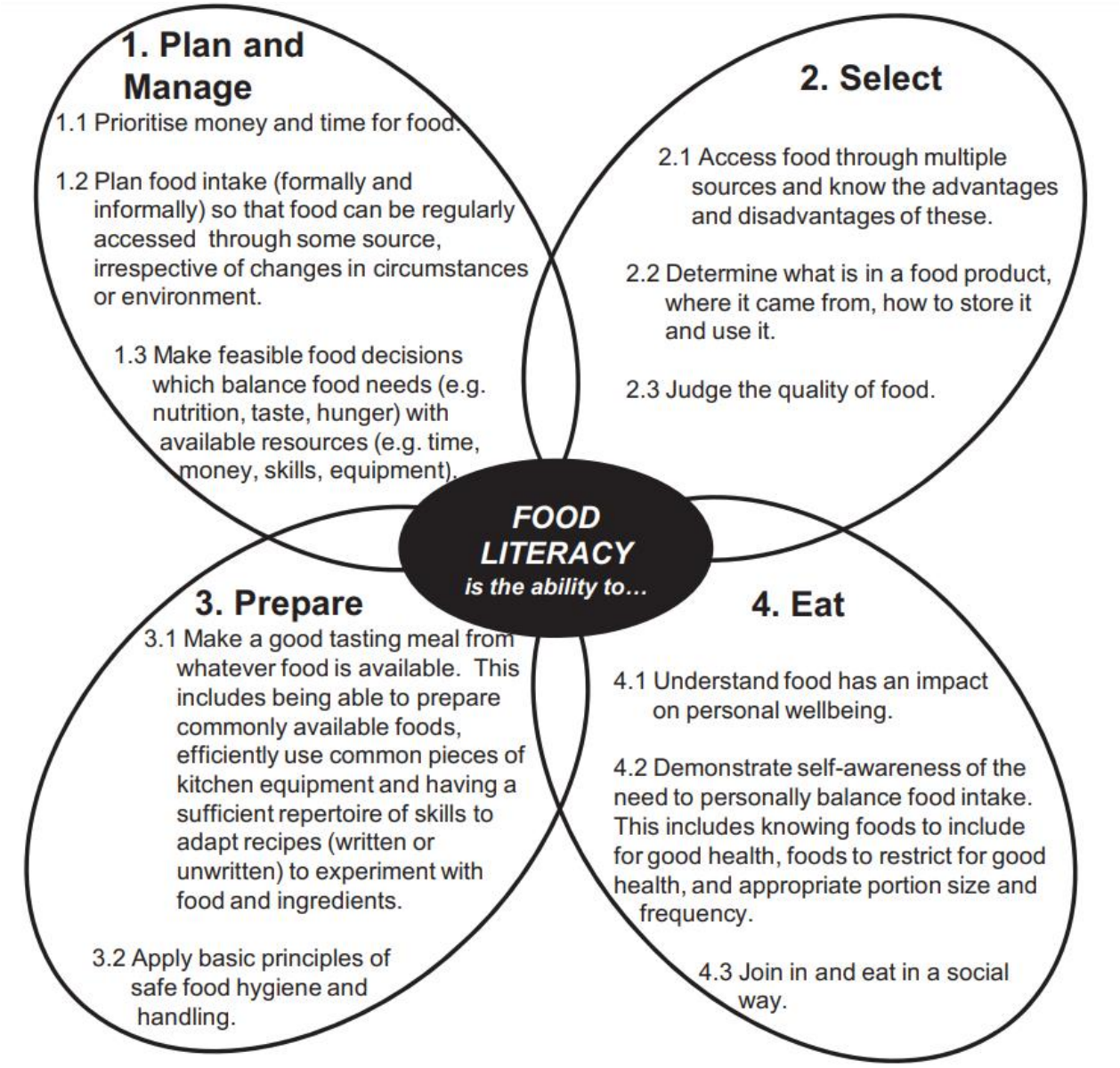



***Figure 7*** *The eleven components of food literacy (Vidgen & Gallegos, 2014)*

# References


Colorado State University, Zander, A., & Bunning, M. (2010). Guide to Washing Fresh Produce. Retrieved February 24, 2023, from https://www.nifa.usda.gov/sites/default/files/resource/Guide%20to%20Washing%20Fresh%20Produce508.pdf.

Development Initiative. (2021) 2020 Global Nutrition Report: Action on equity to end malnutrition. In: Development Initiatives, ed. Bristol, UK.

World Health Organization. (2013) Projections of mortality and causes of death, 2015 and 2030.

Afshin, A., Sur, P. J., Fay, K. A., Cornaby, L., Ferrara, G., Salama, J. S., . . . Abebe, Z. (2019). Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet, 393*(10184), 1958-1972.

Graham, H. E., Madigan, C. D., & Daley, A. J. (2022). Is a small change approach for weight management effective? A systematic review and meta-analysis of randomized controlled trials. *Obesity Reviews, 23*(2), e13357.

Hill, J. O. (2009). Can a small-changes approach help address the obesity epidemic? A report of the Joint Task Force of the American Society for Nutrition, Institute of Food Technologists, and International Food Information Council. *The American Journal of Clinical Nutrition, 89*(2), 477-484.

Jayedi, A., Gohari, A., & Shab-Bidar, S. (2021). Daily Step Count and All-Cause Mortality: A Dose–Response Meta-analysis of Prospective Cohort Studies. *Sports Medicine*, 1-11.

Kabwama, S. N., Bahendeka, S. K., Wesonga, R., Mutungi, G., & Guwatudde, D. (2019). Low consumption of fruits and vegetables among adults in Uganda: findings from a countrywide cross-sectional survey. *Archives of Public Health, 77*(1), 1-8.

Robert Ross, I. J. N., Shizuya Yamashita, Iris Shai, Jaap Seidell, Paolo Magni, Raul D. Santos, Benoit Arsenault, Ada Cuevas, Frank B. Hu, Bruce A. Griffin, Alberto Zambon, Philip Barter, Jean-Charles Fruchart, Robert H. Eckel, Yuji Matsuzawa & Jean-Pierre Després (2020). Waist circumference as a vital sign in clinical practice: a Consensus Statement from the IAS and ICCR Working Group on Visceral Obesity. *Nature Reviews Endocrinology, 16*, 177 - 189.

Ruxton, C. H. S., & Myers, M. (2021). Fruit Juices: Are They Helpful or Harmful? An Evidence Review. Nutrients, 13(6), 1815. https://doi.org/10.3390/nu13061815

Vidgen, H. A., & Gallegos, D. (2014). Defining food literacy and its components. *Appetite*, *76*, 50–59. https://doi.org/10.1016/j.appet.2014.01.010.

Voedingscentrum. (N.D.). Waar bewaar ik groente en fruit? Consulted on 24 February 2023, via https://www.voedingscentrum.nl/nl/thema/kopen-koken-bewaren/eten-bewaren/waar-bewaar-ik-groente-en-fruit.aspx.

Wallace, T. C., Bailey, R. L., Blumberg, J. B., Burton-Freeman, B., Chen, C. O., Crowe-White, K. M., . . . Lewis, R. (2020). Fruits, vegetables, and health: A comprehensive narrative, umbrella review of the science and recommendations for enhanced public policy to improve intake. *Critical reviews in food science and nutrition, 60*(13), 2174-2211.

Yiga P, Ogwok P, Achieng J et al. (2021) Determinants of dietary and physical activity behaviours among women of reproductive age in urban Uganda, a qualitative study. Public Health Nutrition 24, 3624-3636.

# Appendix 1 Respondent characteristics of study participants

***Table 12*** *Socio-demographic characteristics of study participants by region*

| Parameter | Overall study area | Region surveyed | | |
|---|---|---|---|---|
| | Uganda (n= 407) | Mt Elgon (n= 134) | Victoria crescent (n=136) | Kigezi (n=137) |
| Sex | | | | |
| Female | 295 (73.2%) | 96 (72.2%) | 95 (71.4%) | 104 (75.9%) |
| Male | 108 (26.8%) | 37 (27.8%) | 38 (28.6%) | 33 (24.1%) |
| Age | 34.25±10.55 | 34.22±9.60 | 34.49±11.83 | 34.04±10.15 |
| Household size | 5.31±2.33 | 5.86±2.62 | 4.93±2.17 | 5.51±2.01 |
| Number of children under 18 | 2.64±1.71 | 3.20±1.94 | 2.42±1.56 | 2.28±1.45 |
| **Education status** | | | | |
| No formal education | 13 (3.1%) | 6 (4.6%) | 2 (1.5) | 5 (3.7) |
| Some primary | 49 (12.1%) | 13 (9.7%) | 19 (14.0%) | 17 (12.5%) |
| Completed primary | 93 (22.9%) | 29 (21.6%) | 34 (25%) | 30 (22.1%) |
| Completed ordinary level secondary | 146 (36.0%) | 50 (37.3%) | 55 (40.4%) | 41 (30.1%) |
| Completed Advanced level secondary | 36 (8.9%) | 9 (6.7%) | 14 (10.3%) | 13 (9.6%) |
| Post-secondary and above | 69 (17%) | 27 (20.1%) | 12 (8.8%) | 30 (22.1%) |
| **Marital status** | | | | |
| Divorced/separated | 30 (7.4%) | 7 (5.3%) | 20 (14.7%) | 3 (2.2%) |
| Married monogamous | 239 (58.9%) | 80 (60.2%) | 68 (50.0%) | 91 (66.4%) |
| Married polygamous | 19 (4.7%) | 9 (6.8%) | 9 (6.6%) | 1 (0.7%) |
| Separated (temporary) | 22 (5.4%) | 6 (4.5%) | 11 (8.7%) | 5 (3.6%) |
| Single/never married | 70 (17.2%) | 22 (16.5%) | 20 (14.7%) | 28 (20.4%) |
| Spouse migrated for work temporarily | 5 (1.2%) | 4 (3.0%) | 0 (0%) | 1 (0.7%) |
| Widowed | 21 (5.2%) | 5 (3.8%) | 8 (5.9%) | 8 (5.9%) |
| **Employment status** | | | | |
| Employed at an office | 16 (4%) | 9 (6.7%) | 0 | 7 (5.1%) |
| Employed, not at an office | 127 (31.4%) | 56 (41.8%) | 55 (40.7%) | 16 (11.8%) |
| Farming | 60 (14.8%) | 6 (4.5%) | 16 (11.9%) | 38 (27.9%) |
| Housewife / stay-at-home father | 18 (4.4%) | 6 (4.5%) | 8 (5.9%) | 4 (2.9%) |
| Student | 12 (3%) | 2 (1.5%) | 4 (3.0%) | 6 (4.4%) |
| Unemployed | 17 (4.2%) | 7 (4.2%) | 2 (1.5%) | 8 (5.9%) |
| Other | 155 (38.2%) | 48 (36.8%) | 50 (37%) | 57 (41.9%) |

# Appendix 2 Survey tool

| Question type | Question | Hint |
|---|---|---|
| | **0. Interview details** | |
| Note | Welcome to the survey. Please fill out the questions below before starting the interview. | |
| Select one | Region | |
| Select one | Name of Enumerator | |
| Select one | Market | |
| | **Module 1: Inclusion criteria** | |
| Note | NOTE TO ENUMERATOR: The next questions are meant to establish whether this respondent meets the inclusion criteria to the survey. | |
| Number | What is your age (in years)? | |
| Select one | Are you one of the people that makes the decisions about the food bought at your home? | |
| | **Module 2: Consent form** | |
| Note | Please read the statement below to the respondent and provide them with the consent form. Make sure that they fully understand and give consent before continuing. | |
| Note | Hello. My name is ${enumerator}. We are asking you to take part in the research study called "Facilitators and barriers for you to consume fruits and vegetables in Uganda". The HortiMAP programme is an ongoing intervention aimed at supporting the fruit and vegetable sector in Uganda. At the moment, some HortiMAP interventions include: increasing the production and availability of high quality and safe fresh fruits and vegetables, and training of fresh fruit and vegetable vendors to educate consumers about the benefits of consuming fruits and vegetables at the sales points. To further optimize the HortiMAP interventions, there is a need to understand the factors which help or hinder Ugandans from eating enough fruits and vegetables. That is the purpose of this study. Your contribution would be very valuable, but of course you are free to decline at any time. To compensate you for the time you give to us, we will give you 10,000 UGX at the end of the interview. Please take a moment to read the consent form. Let me know if you have any questions. Then, if you agree to participate, please sign the form. | Give the respondent the possibility to ask questions. |
| Select one | Has the consent form been signed? | Check if the consent form contains the respondent's name and signature. |
| Select one | Do you, as the enumerator, certify that the nature, the purpose and the potential benefits of participating in this research have been explained to the respondent? | |
| | **Module 3: Details on the respondent and their household** | |
| Note | The next questions are about you and your household. | |
| Select one | Respondent gender | |
| Select one | What is your marital status? | |
| Number | How many people live in your household? | Every person who usually resides in this households at least four nights a week on average and has done so over the last four weeks. |
| Number | How many children under 18 years live in your household? | |
| Select one | What is the highest education level you completed? | |
| Text | What other education level did you complete? | |
| Select one | What is your employment status? | |

| Question type | Question | Hint |
|---|---|---|
| | **Module 4: Fruit and vegetable consumption** | |
| Note | We will now continue to ask you a few questions on the fruits and vegetables you habitually consume. | |
| Select one | Do you think that you consume enough fruits and vegetables? | Read out the answer options to the respondent. |
| Select multiple | What are **fruits** that you usually consume at any point in the year? | Select all that apply. Probe about different seasons to make sure that fruits are not in season are also captured. |
| Select multiple | Which ones of the fruits you mentioned do you normally purchase from the market? | Select all that apply. |
| Note | The following two questions will be repeated for all fruits that the respondent mentioned. | |
| | **Fruit consumption** | |
| Number | How many days a week do you consume ${current_fruit} when it is **in season**? | Enter a number between 0 and 7. |
| Number | How many times a week do you consume ${current_fruit} when it is **not** in season? | Check if the consent form contains the respondent's name and signature. |
| Select multiple | What are vegetables that you usually consume at any point in the year? | Select all that apply. Probe about different seasons to make sure that vegetables are not in season are also captured. |
| Select multiple | Which ones of the vegetables you mentioned do you normally purchase from the market? | Select all that apply. |
| Note | The following two questions will be repeated for all fruits that the respondent mentioned. | |
| | **Vegetable consumption** | |
| Number | How many days a week do you consume ${current_vegetable} when it is **in season**? | Enter a number between 0 and 7. |
| Number | How many times a week do you consume ${current_vegetable} when it is **not** in season? | Enter a number between 0 and 7. Enter 99 if ${current_vegetable} is always in season. |
| | **Module 5: Barriers and facilitators to FFV consumption (part I)** | |
| Note | The next questions are about what makes it difficult or easy for you to eat the recommended amount of fruits and vegetables per day. This recommended amount is 3 portions of vegetables and 2 portions of fruits a day. That means about 400 grams. For fruit, a serving means one piece of fruit - like one yellow banana. For vegetables, one serving equals one medium cucumber, or one handful of cooked nataki. | |
| Note | What influence do the following aspects have on your consumption of **fruits and vegetables**? | |
| Select one | What influence does **Distance to market** have on your consumption of **fruits and vegetables**? | Read out the answer options to the respondent. |
| Select one | What influence does **Hygiene at the market** have on your consumption of **fruits and vegetables**? | Read out the answer options to the respondent. |
| Select one | What influence do **Their health effects** have on your consumption of **fruits and vegetables**? | Read out the answer options to the respondent. |
| | **Module 5: Barriers and facilitators to FFV consumption (part II)** | |
| Note | What influence do the following aspects have on your consumption of **fruits**? | |
| Select one | What influence does **The number of different types that can be found at the market** have on your consumption of **fruits**? | Read out the answer options to the respondent. |
| Select one | What influence does **The expectation of what community members will say** have on your consumption of **fruits**? | Read out the answer options to the respondent. |
| Select one | What influence does **The cost of fruits** have on your consumption of **fruits**? | Read out the answer options to the respondent. |

| Question type | Question | Hint |
|---|---|---|
| Select one | What influence does **The availability whenever I visit the market** have on your consumption of **fruits**? | Read out the answer options to the respondent. |
| Select one | What influence does **The opinion of household members** have on your consumption of **fruits**? | Read out the answer options to the respondent. |
| Select one | What influence does **Your opinion of their taste** have on your consumption of **fruits**? | Read out the answer options to the respondent. |
| | **Module 5: Barriers and facilitators to FFV consumption (part III)** | |
| Note | What influence do the following aspects have on your consumption of **vegetables**? | |
| Select one | What influence does **The number of different types that can be found on the market** have on your consumption of **vegetables**? | Read out the answer options to the respondent. |
| Select one | What influence does **Expectation of being labeled poor** have on your consumption of **vegetables**? | Read out the answer options to the respondent. |
| Select one | What influence does **The cost of vegetables** have on your consumption of **vegetables**? | Read out the answer options to the respondent. |
| Select one | What influence does **The availability whenever I visit the market** have on your consumption of **vegetables**? | Read out the answer options to the respondent. |
| | **Module 5: Barriers and facilitators to FFV consumption (part IV)** | |
| Note | The following questions will be repeated for a few categories of vegetables. | |
| Note | ****1. Consumption of leafy green vegetables**** | |
| Note | What influence do the following aspects have on your consumption of **leafy green vegetables**? | For example: nakati, sukuma wiki, amaranth, yam leaves, ensuga. |
| Select one | What influence does **The skill needed for their preparation** have on your consumption of **leafy green vegetables**? | Read out the answer options to the respondent. |
| Select one | What influence does **The time needed for their preparation** have on your consumption of **leafy green vegetables**? | Read out the answer options to the respondent. |
| Select one | What influence does **Your opinion of their taste** have on your consumption of **leafy green vegetables**? | Read out the answer options to the respondent. |
| Select one | What influence does **The opinion of household members** have on your consumption of **leafy green vegetables**? | Read out the answer options to the respondent. |
| Note | ****2. Consumption of vitamin A-rich vegetables**** | |
| Note | What influence do the following aspects have on your consumption of **vitamin A-rich vegetables**? | For example: carrots, pumpkin. |
| Select one | What influence does **The skill needed for their preparation** have on your consumption of **vitamin A-rich vegetables**? | Read out the answer options to the respondent. |
| Select one | What influence does **The time needed for their preparation** have on your consumption of **vitamin A-rich vegetables**? | Read out the answer options to the respondent. |
| Select one | What influence does **Your opinion of their taste** have on your consumption of **vitamin A-rich vegetables**? | Read out the answer options to the respondent. |
| Select one | What influence does **The opinion of household members** have on your consumption of **vitamin A-rich vegetables**? | Read out the answer options to the respondent. |
| Note | ****3. Consumption of bitter tomatoes**** | |
| Note | What influence do the following aspects have on your consumption of **bitter tomatoes**? | For example: ntula, katunkuma. |
| Select one | What influence does **The skill needed for their preparation** have on your consumption of **bitter tomatoes**? | Read out the answer options to the respondent. |
| Select one | What influence does **The time needed for their preparation** have on your consumption of **bitter tomatoes**? | Read out the answer options to the respondent. |
| Select one | What influence does **Your opinion of their taste** have on your consumption of **bitter tomatoes**? | Read out the answer options to the respondent. |
| Select one | What influence does **The opinion of household members** have on your consumption of **bitter tomatoes**? | Read out the answer options to the respondent. |

| Question type | Question | Hint |
|---|---|---|
| Note | ****4. Consumption of other vegetables**** | |
| Note | What influence do the following aspects have on your consumption of **other vegetables**? | By these, we mean courgette, egg plant and mushrooms. |
| Select one | What influence does **The skill needed for their preparation** have on your consumption of **other vegetables**? | Read out the answer options to the respondent. |
| Select one | What influence does **The time needed for their preparation** have on your consumption of **other vegetables**? | Read out the answer options to the respondent. |
| Select one | What influence does **Your opinion of their taste** have on your consumption of **other vegetables**? | Read out the answer options to the respondent. |
| Select one | What influence does **The opinion of household members** have on your consumption of **other vegetables**? | Read out the answer options to the respondent. |
| | **Module 6: Processing and use** | |
| Note | The next questions are about what you do with the fruits and vegetables after you have brought them into your home. | |
| Number | How many times a week does someone from your household visit the market? | Consider all household members and staff that may be sent on behalf of the household, not just the respondent. |
| Select multiple | What are the reasons that your household visits the market ${nr_marketvisit} times? | Select all that apply. |
| Select multiple | How do you normally store your fruits and vegetables? | Select all that apply. |
| Select one | Are the fruits and vegetables you buy washed in your household before consumption? | Read out the answer options to the respondent. |
| Select multiple | When are the fruits and vegetables washed? | Select all that apply. |
| Select one | Do you make juice out of the fruits that you buy? | Read out the answer options to the respondent. |
| Select one | Do you ever buy fruits and vegetables that have been (partly) processed? | E.g. that are already peeled, cut, cooked, or processed otherwise. Read out the answer options to the respondent. |
| Select multiple | Why not? | Select all that apply. |
| Select multiple | Which fruits and vegetables do you/would you like to buy (partly) prepared? | Select all that apply. |
| | **Module 7: Safety perception and information sources** | |
| Note | The next questions are about your perception of the safety of the fruits and vegetables you consume, and where you get your information. | |
| Select one | To what extent are you worried about the safety of the fruits and vegetables you consume? | Read out the answer options to the respondent. |
| Select multiple | Do you take any action to avoid consumption of fruits and vegetables that you think could be unsafe? | Select all that apply. |
| Select multiple | What kind of source do you trust to sell safe fruits and vegetables? | Select all that apply. |
| Select multiple | What makes you doubt the safety of fruits and vegetables? | Select all that apply. |
| Select one | If a vendor on this market would be offering certified safe fruits and vegetables, would you be willing to pay a premium price? | Read out the answer options to the respondent. |
| Select one | Suppose tomatoes usually cost 1000 shillings for 4 tomatoes, how much would you be willing to pay for certified safe tomatoes? | Read the answer options to the respondent. These are the **total** amounts that the respondent would be willing to pay for certified safe tomatoes. |
| Select one | How likely are you to try out new fruits and vegetables, if you find them at the market? | Read out the answer options to the respondent. |
| Select multiple | What are your main sources of information when it comes to advice on your fruit and vegetable consumption? | Select a maximum of 3. |

# Appendix 3 Documentation of ethical approval

Uganda National Council for Science and Technology

*(Established by Act of Parliament of the Republic of Uganda)*

**Our Ref: HS2552ES** **28 November 2022**

Peter Yiga
Technoserve Uganda
**Kampala**

**Re: Research Approval:** **Fresh fruit and vegetable consumption in Uganda; barriers, facilitators and current consumption practices**

I am pleased to inform you that on **28/11/2022**, the Uganda National Council for Science and Technology (UNCST) approved the above referenced research project. The Approval of the research project is for the period of **28/11/2022** to **28/11/2023**.

Your research registration number with the UNCST is **HS2552ES**. Please, cite this number in all your future correspondences with UNCST in respect of the above research project. As the Principal Investigator of the research project, you are responsible for fulfilling the following requirements of approval:

1. Keeping all co-investigators informed of the status of the research.
2. Submitting all changes, amendments, and addenda to the research protocol or the consent form (where applicable) to the designated Research Ethics Committee (REC) or Lead Agency for re-review and approval **prior** to the activation of the changes. UNCST must be notified of the approved changes within five working days.
3. For clinical trials, all serious adverse events must be reported promptly to the designated local REC for review with copies to the National Drug Authority and a notification to the UNCST.
4. Unanticipated problems involving risks to research participants or other must be reported promptly to the UNCST. New information that becomes available which could change the risk/benefit ratio must be submitted promptly for UNCST notification after review by the REC.
5. Only approved study procedures are to be implemented. The UNCST may conduct impromptu audits of all study records.
6. An annual progress report and approval letter of continuation from the REC must be submitted electronically to UNCST. Failure to do so may result in termination of the research project.

Please note that this approval includes all study related tools submitted as part of the application as shown below:

| No. | Document Title | Language | Version Number | Version Date |
|---|---|---|---|---|
| 1 | informed consent - consumer survey | English | VERSION 2 | 01 November 2022 |
| 2 | Informed consent form - indepth interviews | English | VERSION 2 | 01 November 2022 |
| 3 | Informed consent consumer survey | Luganda | VERSION 2 | 01 November 2022 |
| 4 | Informed consent consumer survey | Rukiga | VERSION 2 | 01 November 2022 |
| 5 | Data collection tool - consumer survey - English | English | VERSION 2 | 01 November 2022 |
| 6 | Data collection tool - consumer survey | Luganda | VERSION 2 | 01 November 2022 |
| 7 | Data collection tool - consumer survey | Rukiga | VERSION 2 | 01 November 2022 |
| 8 | Project Proposal | English | VERSION 2 | |
| 9 | Approval Letter | English | | |
| 10 | Administrative Clearance | English | | |
| 10 | Informed consent consumer survey | English | version 2 | 01 November 2022 |

Yours sincerely,

Hellen Opolot
For: Executive Secretary
**UGANDA NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY**

# Appendix 4 Additional findings

**Fruit and vegetable consumption and sourcing**

Consumers were asked to report which fruits and vegetables they normally consume at any point in the year. Table 13 and Table 14 show which percentage of respondents indicated to commonly consume a product across the year, for vegetables and fruits, respectively. The crops are listed at alphabetical order.

***Table 13*** *Vegetables commonly consumed across the year*

| Parameter | Overall study area | Region surveyed | | |
|---|---|---|---|---|
| | Uganda (n=406) | Mt Elgon (n=134) | Victoria crescent (n=136) | Kigezi (n=136) |
| **Vegetables commonly consumed across the year** | | | | |
| Amalakwang | 3.9% | 9.0% | 2.2% | 0.7% |
| Bamboo | 16.7% | 46.3% | 3.0% | 1.5% |
| Bean leaves | 30.3% | 26.9% | 11.9% | 51.8% |
| Beetroot | 33.5% | 29.1% | 28.1% | 43.1% |
| Bitter tomato | 53.7% | 64.2% | 46.7% | 50.4% |
| Black jack | 10.1% | 9.0% | 8.1% | 13.1% |
| Broccoli | 5.9% | 5.2% | 3.0% | 9.5% |
| Cabbage | 87.2% | 94.0% | 75.6% | 92.0% |
| Carrot | 79.1% | 88.1% | 65.9% | 83.2% |
| Cassava leaves | 11.6% | 6.0% | 6.7% | 21.9% |
| Chinese Cabbage | 6.9% | 6.0% | 8.1% | 6.6% |
| Courgette | 2.7% | 2.2% | 2.2% | 3.6% |
| Cowpea leaves | 13.3% | 29.1% | 2.2% | 8.8% |
| Cucumber | 42.6% | 43.3% | 41.5% | 43.1% |
| Doodo | 83.0% | 94.0% | 62.2% | 92.7% |
| Eggplant | 66.5% | 77.6% | 54.8% | 67.2% |
| Ejjobyo | 38.4% | 71.6% | 38.5% | 5.8% |
| Ensuga | 37.4% | 35.8% | 25.2% | 51.1% |
| French beans | 39.2% | 30.6% | 43.0% | 43.8% |
| Garden eggs | 26.1% | 38.1% | 20.0% | 20.4% |
| Green amaranthus | 14.8% | 9.7% | 17.8% | 16.8% |
| Green beans | 36.7% | 40.3% | 22.2% | 47.4% |
| Green peas | 49.0% | 55.2% | 41.5% | 50.4% |
| Green pepper | 59.9% | 62.7% | 51.1% | 65.7% |
| Hibiscus | 18.5% | 26.1% | 21.5% | 8.0% |
| Lettuce | 5.9% | 3.7% | 5.9% | 8.0% |
| Mushroom | 49.0% | 59.7% | 42.2% | 45.3% |
| Nakati | 53.7% | 63.4% | 81.5% | 16.8% |
| Okra | 31.5% | 39.6% | 26.7% | 28.5% |
| Pumpkin | 65.0% | 76.1% | 54.1% | 65.0% |
| Red amaranth | 53.0% | 60.4% | 74.8% | 24.1% |
| Red onion | 73.2% | 70.9% | 71.1% | 77.4% |
| Red pepper | 19.5% | 17.9% | 17.0% | 23.4% |
| Spider plant leaves | 12.8% | 23.1% | 11.9% | 3.6% |
| Spinach | 39.9% | 44.8% | 22.2% | 52.6% |
| Spring onion | 25.9% | 25.4% | 25.9% | 26.3% |
| Sukuma wiki | 59.4% | 85.1% | 54.8% | 38.7% |
| Sweet potato leaves | 6.7% | 1.5% | 1.5% | 16.8% |
| Tomato | 87.2% | 90.3% | 87.4% | 83.9% |
| White onion | 19.2% | 19.4% | 14.8% | 23.4% |
| Yam leaves | 20.0% | 22.4% | 17.8% | 19.7% |

***Table 14*** *Fruits commonly consumed across the year*

| Parameter | Overall study area | Region surveyed | | |
|---|---|---|---|---|
| | Uganda (n=406) | Mt Elgon (n=134) | Victoria crescent (n=136) | Kigezi (n=136) |
| **Fruits commonly consumed across the year** | | | | |
| Apples | 38.8% | 35.1% | 37.5% | 43.8% |
| Avocado | 84.5% | 91.8% | 72.8% | 89.1% |
| Bitter berries | 25.8% | 20.1% | 30.1% | 27.0% |
| Bogoya | 71.5% | 85.1% | 58.1% | 71.5% |
| Ejuga | 0.5% | 0.0% | 0.0% | 1.5% |
| Guava | 52.1% | 61.9% | 42.6% | 51.8% |
| Jackfruit | 66.1% | 82.8% | 67.6% | 48.2% |
| Jambula | 11.1% | 20.9% | 8.8% | 3.6% |
| Lemons | 56.0% | 68.7% | 38.2% | 61.3% |
| Limes | 12.3% | 16.4% | 10.3% | 10.2% |
| Mangoes | 88.9% | 97.0% | 86.0% | 83.9% |
| Melon | 17.2% | 9.7% | 16.9% | 24.8% |
| Ndinzi (apple banana) | 53.6% | 61.2% | 54.4% | 45.3% |
| Oranges | 80.1% | 94.8% | 61.0% | 84.7% |
| Other | 1.0% | 0.7% | 0.7% | 1.5% |
| Owelo | 1.0% | 1.5% | 0.0% | 1.5% |
| Passion fruit | 70.3% | 73.9% | 53.7% | 83.2% |
| Pawpaw | 56.8% | 69.4% | 46.3% | 54.7% |
| Pear | 10.8% | 13.4% | 5.1% | 13.9% |
| Pineapples | 78.1% | 86.6% | 66.9% | 81.0% |
| Raspberries | 4.4% | 3.0% | 2.2% | 8.0% |
| Sour sop | 21.1% | 31.3% | 23.5% | 8.8% |
| Straw berries | 9.1% | 9.0% | 1.5% | 16.8% |
| Tangerines | 40.5% | 60.4% | 40.4% | 21.2% |
| Watermelon | 80.6% | 86.6% | 80.9% | 74.5% |
| Watermelon | 80.6% | 86.6% | 80.9% | 74.5% |
| White melon | 4.9% | 5.2% | 1.5% | 8.0% |
| Wild berries | 4.9% | 3.7% | 4.4% | 6.6% |

Wageningen Centre for Development Innovation
Wageningen University & Research
P.O. Box 88
6700 AB Wageningen
The Netherlands
T +31 (0)317 48 68 00
wur.eu/wcdi

Report WCDI-23-250

Wageningen Centre for Development Innovation supports value creation by strengthening capacities for sustainable development. As the international expertise and capacity building institute of Wageningen University & Research we bring knowledge into action, with the aim to explore the potential of nature to improve the quality of life. With approximately 30 locations, 7,200 members (6,400 fte) of staff and 13,200 students, Wageningen University & Research is a world leader in its domain. An integral way of working, and cooperation between the exact sciences and the technological and social disciplines are key to its approach.

To explore the potential of nature to improve the quality of life

Wageningen Centre for Development Innovation
Wageningen University & Research
P.O. Box 88
6700 AB Wageningen
The Netherlands
T +31 (0) 317 48 68 00
wur.eu/wdci

Report WCDI-23-250

The mission of Wageningen University & Research is "To explore the potential of nature to improve the quality of life". Under the banner Wageningen University & Research, Wageningen University and the specialised research institutes of the Wageningen Research Foundation have joined forces in contributing to finding solutions to important questions in the domain of healthy food and living environment. With its roughly 30 branches, 7,200 employees (6,400 fte) and 13,200 students and over 150,000 participants to WUR's Life Long Learning, Wageningen University & Research is one of the leading organisations in its domain. The unique Wageningen approach lies in its integrated approach to issues and the collaboration between different disciplines.