# Consumer motives, skills, and perceived access for sourcing and consumption of safe vegetables in urban areas in Mali

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# Consumer motives, skills, and perceived access for sourcing and consumption of safe vegetables in urban areas in Mali

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Insights into consumer attitudes, knowledge, demands, and barriers can help food system researchers in designing interventions to more effectively increase healthy and safe food consumption. This report is part of a larger project and a series of reports, aiming to pilot and scale innovative approaches within the food systems of Benin, Mali and Burkina Faso to improve consumption of safe vegetables. The aim of this report is to obtain insights into consumers' perceptions of accessibility, acceptability and safety of vegetables in Mali. For this purpose a survey was conducted among 1,266 respondents in four urban and peri-urban areas in Mali. This report describes the results of the consumer survey for Mali and discusses potential entry points for enhancing the consumption of safe vegetables.

Key words: fruits and vegetables, consumption, Mali, consumer behaviour, food system

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# Contents

# Preface

Safe Locally-Produced Vegetables for West Africa's Consumers (SAFEVEG) is an action-research programme - launched in November 2020 and running till 2025 - and covers three West African countries – Benin, Burkina Faso and Mali. It was developed within the context of the EU initiative on Climate-relevant Development Smart Innovation through Research in Agriculture in developing countries (DeSIRA).

The SAFEVEG initiative aims to reduce undernourishment, improve the income and productivity of small-scale food producers – particularly for women and youth, and expand sustainable land use. The programme is implemented by the World Vegetable Center in collaboration with Wageningen University & Research (WUR) and CIRAD (French Agricultural Research Centre for International Development), and a multitude of national partners in the three focus countries.

The first year of the programme was dedicated to diagnostic research that explored barriers and opportunities for innovations across the vegetable value chain, including in production, marketing and consumption. Regarding vegetable intake, the research focused on why people do not eat enough of this nutritious food, which was overseen by the World Vegetable Center, University of Abomey-Calavi and WUR. The team carried out extensive literature reviews, consulted many different stakeholders in the three countries and implemented surveys among thousands of consumers.

The findings indicate that people in Benin, Burkina Faso and Mali eat below the recommended daily amounts, which results in micro-nutrient deficiencies, including anaemia, and has negative impacts for child development. The research also concluded that safe vegetable consumption can be enhanced by reducing costs and increasing availability and acceptability among consumers.

Households cannot always afford vegetables although they are perceived as reasonably priced. Also, people have limited trust in the safety of vegetables due to a growing awareness that they can be produced with high dosages of agro-chemicals or undergo unhygienic handling, including washing with water infested with microbes. Finally, access to safe vegetables is perceived as a main limitation for consumers.

In this publication series, we will share the results of the multiple studies and experimental interventions that have been undertaken to promote consumption of safe vegetables in the three focus countries. We hope these results will be of value to others also aiming to increase the accessibility, availability and affordability of healthy diets in West Africa and beyond.

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# Summary

The overall aim of the SafeVeg project is to pilot and scale innovative approaches within local vegetable food systems – to reduce malnutrition and improve income and productivity of small-scale food producers in (peri-)urban Benin, Burkina Faso, and Mali. SafeVeg's Work Package 2 contributes to this by assessing current vegetable consumption levels and concerns among consumers regarding vegetables in the food environment: the acceptability and accessibility of vegetables and vegetable food safety perception. The first step in achieving this objective was obtaining insights into consumer attitudes, knowledge, demands, and barriers regarding the acceptability, accessibility and food safety of vegetables. These insights can help food system researchers in designing interventions to more effectively increase healthy and safe food consumption. This report describes the results for Mali.

Consumer surveys were conducted among 1,266 respondents living in three (peri-)urban areas in Mali (Bamako, Kati, and Sikasso). Neighbourhoods were selected to represent degrees of urbanisation (urban and peri-urban; rural was excluded) and income levels (slum, low-, and middle-income neighbourhoods; high income was excluded). In these neighbourhoods, convenience sampling was administered through a door-to-door approach and included adult respondents who were responsible for vegetable shopping and/or cooking in their households. The sample included a large share of the respondents with low educational level (44% had not finished primary school) and roughly half of the households (53%) reported some degree of food insecurity ranging from mild to severe.

**Vegetables seem widely accepted and consumptions seem to meet the requirements**
Almost all respondents reported eating vegetables frequently, at least once a week – primarily cooked (99.8%), but also raw or in salad (75%). Vegetables were consumed frequently, even daily, by most consumers. On average, cooked vegetables were eaten 6.6 days per week and raw vegetables almost two days per week; with a large percentage of the sample (88%) reporting they eat cooked vegetables daily. Results on vegetable purchase were generally in-line with results on intake, showing frequent buying of vegetables (3-4 times per week, on average). A majority of the sample reported eating vegetables eating in the past 24 hours - vegetables in the 'other' category, including tomato, onion, and okra, were consumed 91% of the respondents, dark green leafy vegetables by 35%; and vitamin A-rich vegetables by 40% e.g. carrots, orange sweet potatoes). Overall, consumption seemed to meet the requirements.

**Safety perception of vegetables and chain actors providing them is moderate with most concerns about contamination and residues**
Food safety was an important motive perceived by the customers, comparable in importance to health and taste and scoring only slightly higher than affordability. Vegetables were generally judged as being somewhat 'safe' in the perception of the respondents. For specific aspects of safety, the scores for freshness and appearance were highest, while scores relating to contamination with pesticides and fertiliser were lowest. Meaning that respondents perceived the vegetables they eat as fresh and good looking but less safe when it comes to pesticides and fertiliser residues. Also, low affordability of vegetables was an issue for respondents. Around a third of the respondents ranked green leafy vegetables (38%) in the top three safest of the foods, while fruits were ranked most often as the top three safest (56%), followed by fish (47%) and other chicken (39%). In the top three least safe foods, groundnuts (48%), cassava and yam (47%), milk (45%), and egg (42%) were most often mentioned. Other vegetables were ranked on average intermediate on safety. Levels of trust in chain actors for the production, selling, and regulation of safe vegetables was somewhat positive for authorities, retailers, and farmers, with retailers scoring significantly higher. Attitudes towards the safety of vegetables at respondents' first and second most important purchase outlets were positive.

**Access to vegetables is generally good, fresh markets are the main outlet for all vegetables, followed by street vendors and neighbourhood shops that have less availability but better accessibility**

With regards to the sourcing of vegetables, only a minority of respondents (11%) grew their own produce in the past year. As for outlets, fresh markets were by far the most important place of purchase for consumers, followed by street vendors and neighbourhood shops. In particular, green leafy vegetables, vitamin A-rich vegetables, and other vegetables were sourced from fresh markets. The most bought vegetables were tomato, onion, African eggplant (N'goyo), green bell pepper, and okra fruit.

Access to vegetables was scored for respondents' first and second most common outlet of purchase on four elements: availability (selection, quality, and quantity), accessibility (travel time, efforts, and costs), affordability, and accommodation (services provided by the vendor). Access was generally perceived as good, with the exception of affordability and the lack of possibility to interact with the vendor. Neighbourhood stores scored especially high on accessibility compared to, for example, fresh markets, and also high on affordability and accommodation (including trust in seller). While street vendors scored high on accessibility, the availability of vegetables from street vendors scored lower.

Respondents were confident about their abilities in purchasing and consuming safe vegetables, such as the capacity to judge the safety of vegetables in stores and their kitchen skills. They did, however, feel less confident about their knowledge of safe vegetables, and also agreed with the statement that they would like to know more about vegetable safety.

**Focus points for interventions are variability of vegetables consumed, providing more information on vegetable production and safety, and access to safer but reasonable priced vegetables at all outlets**

Vegetables seemed to be a normal part of the diet since they were consumed frequently, almost daily, by most respondents. However, intake levels differ across cities and needs to be increased at Sikasso to meet health recommendations and possibly the intake of dark green leafy vegetables could be improved. The results provide several entry points for interventions. First, purchase variety could be also increased to include more diverse and nutrient-rich vegetables, such as sweet potato, squash, and cowpea leaves. Currently, a wider variety of nutrient-dense vegetables is bought by less than 16% of the sample. Although different aspects of vegetable safety could be improved, contaminations (including from fertiliser and pesticides) and not being what consumers consider 'naturally grown', seem to cause the greatest concerns. Another entry point is the consumer need for more information on the safety of vegetables. This seems to be related to how food is produced and contaminations (from chemicals, etc.), rather than handling at home. Although point of sales is the easiest point for information-based interventions, information provided by retailers might not always be trusted – since they were only 'somewhat trusted' by consumers, albeit more than farmers and authorities. Finally, consumers often thought that vegetables were not well priced, especially those are sold as 'safer' (for instance, organic vegetables which are often highly priced). This suggests there might be a need for safer but more reasonably priced vegetables at all outlets. Meanwhile, for street vendors, the selection of vegetables should also be increased to attract more customers; although this requires adaptations to the supply chain.

**Focus on demographic groups in interventions might be relevant, especially focused on urban neighbourhoods and on slum and low-income areas**

Interestingly, demographic analysis indicates that vegetable intake was lower in Sikasso, while food insecurity was higher in Bamako. Perceived importance of food safety and perceived knowledge on the safety of vegetables were also lower in Bamako compared to the other cities. Attention in possible future interventions is particularly required for consumers living in urban neighbourhoods, since they consume the least amounts of vegetables and reported higher food insecurity than peri-urban areas. However, the purchase of half of the types of vegetables, as well as purchase from fresh markets, were higher in urban neighbourhoods. Slum and low-income neighbourhoods seemed more at risk for lower vegetable intake, food insecurity, lower knowledge on food safety, and reduced access to fresh markets. Finally, interventions should benefit women especially since they seem to have a lower vegetable intake and higher food insecurity scores.

# 1 Introduction

## 1.1 Background

Foodborne diseases have a great impact on the health and well-being of citizens in Africa (Havelaar et al., 2015; WHO, 2015). After animal-based products, fruits and vegetables are an important source of bacterial and chemical contamination (Berger 2010; Raaijmakers et al., 2023; Rajwar et al., 2016). Yet, fruits and vegetables are crucial to a healthy diet and their intake is often below recommended levels in many low and middle income countries including Benin, Burkina Faso and Mali (e.g. Delisle et al., 2012; Frank et al., 2019; Traoré et al., 2018). In response to this challenge, the SafeVeg project aims to reduce undernutrition and micronutrient deficiencies, improve income and productivity of small-scale food producers, particularly for women and youth; and expand sustainable land use in Benin, Burkina Faso, and Mali.

SafeVeg's Work Package 2 is contributing to this aim by looking at concerns from the consumer's perspective. Consumers play a central role in the food system, since their choices define food system outcomes, through diets, in terms of nutritional status, health and food safety, sustainability, and economic impact (GLOPAN, 2020). In the food environment, such as fresh markets, retail, and out-of-home food outlets, consumers interact with other actors in the food chain such as farmers, vendors, and caterers. Consumers are influenced by policy, market, and environmental drivers of the system – and insights into their attitudes, knowledge, demands, and barriers can help researchers and policy makers design effective interventions which help increase healthy and safe consumption. SafeVeg aims to increase vegetable intake among urban and peri-urban consumers in Benin, Burkina Faso and Mali, by designing interventions to make locally produced vegetables more accessible, acceptable, affordable, and safe. In turn, we can learn through which mechanisms interventions contribute to consumer behaviour change by measuring the determinants of behaviour.

## 1.2 Research aim

The overall aims of the consumer survey were:
- To get insights into the vegetable consumption behaviour (peri-)urban consumers in Benin, Burkina Faso and Mali, and their interface in the food environment;
- To identify entry points for potential interventions.

## 1.3 Approach

During the course of 2022, consumer surveys were conducted in (peri-)urban Benin, Mali, and Burkina Faso, to investigate vegetable consumption behaviours and identify possible entry points for interventions. This report provides the results for the consumer survey conducted in (peri-)urban Mali, relating to vegetable consumption behaviour, perceptions regarding accessibility (including affordability), acceptability, and safety of vegetables. Differences between consumer groups are also reported, along with the motives and barriers related to the intake of, and access to, desired and safe vegetables, and the implications for interventions.

## 1.4 Outline of the report

This report is structured into three sections. Section 1 explains the study procedure and includes the measures. Section 2 presents the results and starts with a description of the study sample, followed by vegetable consumption and buying behaviour of the Malians, followed by results related to accessibility, acceptability and safety perception of vegetables. Finally, Section 3 provides overall conclusions and recommendations for further research and potential implications for interventions.

# 2 Methods

## 2.1 Study area and subjects

Consumer surveys were conducted in three urban and peri-urban areas of Mali (Bamako, Sikasso, and Kati). The study was achieved in Bamako between July 16 and July 21, in Sikasso between July 18 and July 20, and in Kati between July 16 and July 21, this period corresponded to the rainy season. During this period the vegetable availability is average, not particularly high or low compared to other seasons. A detailed description of the methodology is published separately (https://doi.org/10.18174/638784). A summary of the methodology used to select the study area and respondents is provided below (see Figure 2.1).

*Study area:* Urban areas were chosen from the focussed cities within the project.

*Study sampling:* Three steps were used: (1) selection of districts in cities (if applicable); (2) neighbourhoods in districts; and (3) households in neighbourhoods. See also Figure 1 for a schematic overview of the sample selection.

1.  *Respondent selection:* To obtain insights into consumer behaviours and potential entry points for intervention, the respondent selection followed criteria including: age (must be an adult); responsibility for buying and/or decision-making of food purchases; and diverse socioeconomic status and geographic distribution. Within the household the person available and most responsible for food preparation and/or purchase was selected.

*Seasonality/timing:* Based on previous studies, seasonality of produce was taken into consideration as it influences the diversity and consumption of available foods.

**Districts**
- Procedure: Selected by country coordinator and field work team
- Criteria: 1. Coverage of main places of vegetables access such as large markets, production sites in and near the city. 2. Main facilities that attract a specific type of consumers such as university, government buildings, business centre, living areas, slums etc. And 3. Geographical issues such as city centre, near the river, etc.
- Included were 3 out of 6 districts in Bamako, in Kati and Sikasso there was only one district, so that district was included.

**Neighbourhoods**
- Procedure: together with a local government officer at district level, all neighbourhoods were classified as either urban or peri-urban and based on the average income category of inhabitants (slum, low/middle/or high income).
- Criteria: Based on average housing and living environment conditions in the neighbourhood such as: materials of walls and roofs, number of rooms, access to electricity and water, conditions of the roads. High income was excluded resulting in six categories of urbanisation and income combined. From each category in each district one neighbourhood was selected or replaced by a neighbourhood from a category that was most similar to this category.
- Included were 15 neighbourhoods in Bamako, 4 in Kati, and 6 in Sikasso.

**Households & respondent selection**
- Procedure: respondents were recruited through a door-to-door convenience sampling approach in the selected neighbourhoods
- Criteria: households within a 1 km radius of the neighbourhood center
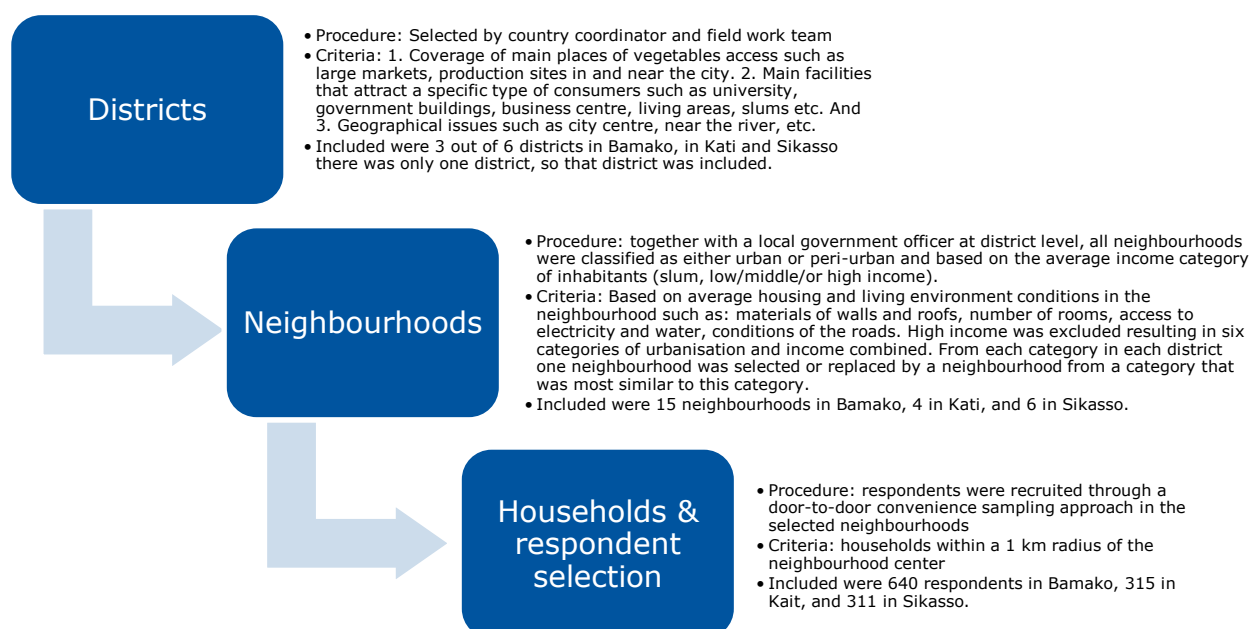- Included were 640 respondents in Bamako, 315 in Kait, and 311 in Sikasso.

**Figure 2.1** *Schematic overview of the sample selection in urban Mali*

## 2.2 Study procedure

*Data collection:* Structured face-to-face interviews were administered in respondents' home and data was entered in the mobile phones of the trained interviewers. KoboToolbox software was used to programme the survey in French and then translated to local language so that interviewers had access to both versions. After obtaining informed consent, face-to-face interviews were conducted in French or local language with an eligible respondent at each house. Respondents were given a small gift for their participation, either a vegetable voucher to be used at a local vegetable vendor or soap.

*Measures:* Table 2.1 summarises the scales used in the consumer survey, including their literature source. Most scales have been used in previous studies and validated elsewhere. However, two scales were developed for the purpose of this study: access to outlets and self-efficacy for consuming safe vegetables. The order of items within scales was randomised, apart from the Food (in)security scale, where items are presented as per the increasing level of food insecurity. Additionally, demographics, family composition, own production, vegetable purchase frequency, safety product attributes of vegetables, safety perception of vegetables, and out-of-home consumption were measured. Cards with photos of vegetables were used to facilitate respondents with their answers.

***Table 2.1*** *Summary of survey measures*

| Scale | Number of items/measures | Literature Source | Answer option/score |
|---|---|---|---|
| Diet Quality Questionnaire (DQQ) a) | 28 food groups | Herforth et al. (2019) | Yes/no |
| Food Choice Motives (FCM) | 11 items | Onwezen et al. (2019); Verain et al. (2021); Snoek et al. (2021); Cabral Cabral, de Almeida, and Cunha (2017); Dowd and Burke (2013) | 7-point Likert scale (1=strongly disagree to 7=strongly agree) |
| Multi-item Food Safety Motives | 7 items | Snoek et al. (2021) | |
| Food Frequency Questionnaire (FFQ) | Usual consumption frequency and amount of cooked and raw vegetables | Van Assema et al. (2002) | Number of days per week; number of serving spoons |
| Access to main outlets (availability, accessibility, accommodation, affordability) | 11 items | Newly developed based on Freedman et al. (2013); Snoek et al. (2021) | 7-point Likert scale (1=strongly disagree to 7=strongly agree) |
| General attitude to main outlets | 5 items | Adapted from Crites et al. (1994); Snoek et al. (2021) | |
| Safety perception (optimism/pessimism) | 7 items | Adapted from De Jonge (2008) | |
| Trust in actors | 3 items | Adapted from Macready et al. (2020); Li et al. (2021) | 7-point Likert scale (1=very little trust to 7=very high level of trust). |
| Subjective knowledge safety | 3 items | Adapted from Aertsens et al. (2011) | 7-point Likert scale (1=strongly disagree to 7=strongly agree) |
| Self-efficacy (consuming safe veg) | 8 items | Newly developed based on Wilson-Barlow et al. (2014) and World Health Organization (WHO) (2006) | |
| Food (in)security | 8 items | Nord et al. (2016); Smith et al. (2017) | Yes/no; scale (0=no food insecurity to 7-8=severe food insecurity) |

a) Global Dietary Recommendation score (GDR total, healthy and limit; possible range -9 to 9) and adequacy compared to WHO Fruit and Vegetable recommendations (WHO-FV; possible range 0 to 6) were calculated based on the DQQ food groups.

## 2.3    Analyses

Scale scores were calculated for all multi-item measures with mean and Cronbach's alpha's were calculated to check for scale performance. For the food access questions, the factor structure was tested to confirm the four dimension of availability, accessibility, accommodation, and affordability. Analysis confirmed the factor structure for availability, accessibility, affordability, and accommodation. This is with the exception of operation hours, which did not load on the accessibility factor and was therefore deleted from further analysis. The food (in)security scale was the only exception since a sum score rather than an average over the items was calculated in line with literature (Smith et al., 2017). Descriptive statistics were reported. In addition, differences were tested between cities, neighbourhood income groups, male or female gender, and urban versus rural neighbourhoods using either ANOVA (cities, income groups) with post-hoc or t-tests (gender and urban/rural). Finally, perceived access was compared between primary and secondary outlet with paired t-tests.

# 3 Results

## 3.1 Demographic characteristics of the sample and selection questions

### 3.1.1 Highlights and implications

- Consumer surveys were conducted among 1,266 respondents living in Bamako (n=640), Kati (n=315), and Sikasso (n=311).
- The study sample was diverse in terms of demographic characteristics; and included also a high number of vulnerable households with a low-income and educational level and some degree of food insecurity.
- More than half of the study sample was food insecure (51.5%). Food security was higher among females compared to men and in low-income neighbourhoods. Bamako has the highest food insecurity score, followed by Kati and Sikasso had the lowest average score.

In total, 1,266 respondents were included: 640 in Bamako, 315 in Kati, and 311 in Sikasso. Respondents were selected from a total of 25 neighbourhoods in 5 districts, which had a good geographical spread over the different cities (Figure 3.1).
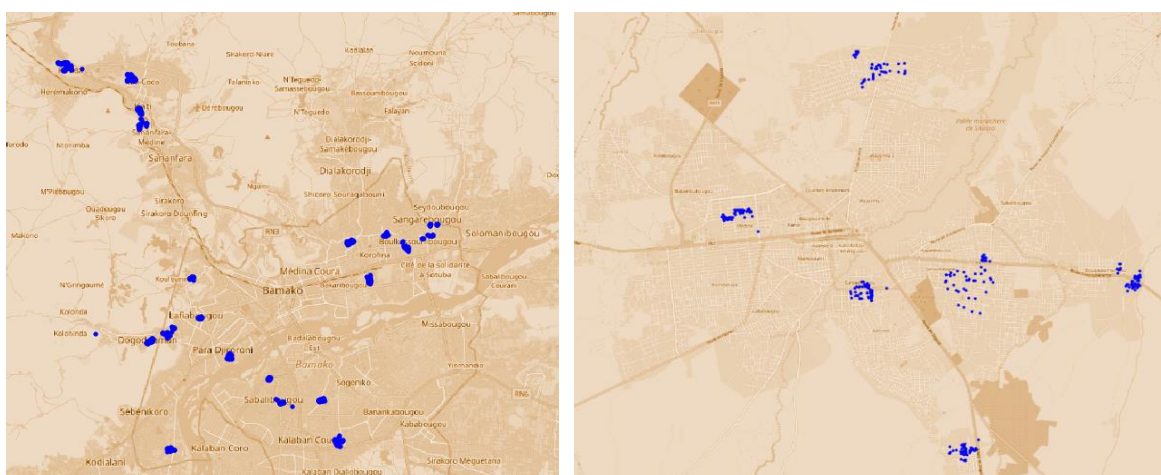


**Figure 3.1**    *Mapping of the GPS locations of the neighbourhoods in Bamako and Kati (left) and Sikasso (right)(n=1,266 in total)*

According to the sampling procedure, approximately one-third of the neighbourhoods were considered slum areas (n=420), one-third low-income settlements (n=419), and one-third middle-income settlements (n=427). Just over half of the sample were living in urban neighbourhoods (58.5%). All demographic characteristics of the sample are reported in Table 3.1.

**Table 3.1**    *Demographic characteristics of the consumer sample in Mali (n=1,266)*

| **City** | Bamako | 640 (50.6%) |
|---|---|---|
| | Kati | 315 (24.9%) |
| | Sikasso | 311 (24.6%) |
| | | |
| **Gender** | Men | 161 (12.7%) |
| | Women | 1105 (87.3%) |

| Geographic location | Urban neighbourhoods | 740 (58.5%) | | |
| --- | --- | --- | --- | --- |
| | Peri-urban neighbourhoods | 526 (41.5%) | | |
| | | | | |
| **Neighbourhood by income level** | Slum settlement | 420 (33.2%) | | |
| | Low-income settlement | 419 (33.1%) | | |
| | Middle-income settlement | 427 (33.7%) | | |
| | | | | |
| **Age in years, mean (SD)** | | 34.6 (11.2) | | |
| | | | | |
| **Educational level** | Less than primary school | 575 (45.4%) | | |
| | Fundamental 1st cycle a) | 177 (14.0%) | | |
| | Fundamental 2nd cycle a) | 260 (20.5%) | | |
| | Secondary school (Lycee technique professionnel) | 201 (15.9%) | | |
| | More than secondary school | 53 (4.2%) | | |
| | | | | |
| **Ethnicity** | Bambara | 454 (35.9%) | | |
| | Malinke | 112 (8.8%) | | |
| | Peulh | 192 (15.2%) | | |
| | Sarakole Soninke Marka | 112 (8.8%) | | |
| | Sonraï | 50 (3.9%) | | |
| | Dogon | 46 (3.6%) | | |
| | Touareg Bélla | 6 (0.5%) | | |
| | Sénoufo Minianka | 169 (13.3%) | | |
| | Bobo | 29 (2.3%) | | |
| | Other Malian | 83 (6.6%) | | |
| | Pays Cedeao | 7 (0.6%) | | |
| | Other African countries | 3 (0.2%) | | |
| | Other nationalities | 3 (0.2%) | | |
| | | | | |
| **Religion** | Islam | 1239 (97.9%) | | |
| | Catholicism | 16 (1.3%) | | |
| | Protestantism | 10 (0.8%) | | |
| | Evangelicalism | 1 (0.1%) | | |
| | | | | |
| **Marital status** | Married or living together | 1172 (92.6%) | | |
| | Divorced or separated | 8 (0.6%) | | |
| | Widower | 46 (3.6%) | | |
| | Never married or cohabitating | 40 (3.2%) | | |
| | | | | |
| **Household size, mean (SD)** | | 8.56 (5.30) | | |
| | | | | |
| **Number of children (aged 1-18 years), mean (SD)** | | 4.85 (3.70) | | |
| | | **Main** | **Second** | **Third** |
| **Income source (number of respondents)** | Agriculture | 60 | 38 | 2 |
| | Trade in agricultural products | 30 | 37 | 5 |
| | Small trade (informal) | 290 | 333 | 54 |
| | Wholesale trade (formal) | 89 | 11 | - |
| | Real estate rental company | 7 | 3 | - |
| | Daily worker | 69 | 39 | 14 |
| | Small craftsmanship | 78 | 45 | 13 |
| | Transport (including motorbike taxi) | 83 | 16 | 3 |
| | Permanent civil servant | 107 | 17 | 2 |
| | Consultant contract employee | 130 | 32 | 4 |
| | Specialised work (mechanic, mason, tailor, hairdresser) | 180 | 49 | 10 |
| | Pension (retired) | 27 | 5 | - |
| | No other source of income | 6 | 349 | 430 |
| | Other | 110 | 31 | 289 |

a) In primary school, the first cycle is the first 3 years; the second cycle is the next 3 years.

According to the selection criteria, all respondents were between 18 and 70 years old with an average age of 34.6 years (SD=11.2). Almost all respondents were either involved in the preparation of food (85.8%), purchase of food (88.1%), responsible for the purchasing decisions (88.2%), or in charge of purchasing and/or purchasing decisions (84.4%). The sample was skewed to more women (87.3%) than men.

The sample was diverse in terms of education and ethnic background, but less on religion since most respondents were Islamic (97.9%). It had a high percentage of respondents who had not finished primary school (45.4%), which is unsurprising, given that the data was largely collected in slums and low-income neighbourhoods. Most respondents were married or cohabiting (92.6%), and the average household size was 8.6, with an average of 4.9 children aged between 1 and 18 years old.

Household food insecurity was common, with an average score of 1.6 (SD=2.2) with a score of 0 representing food security, 1-3 mild insecurity, 4-6 moderate insecurity, and 7-8 severe insecurity. Almost half of the sample (48.5%) could be considered food secure based on their scores. Other households reported some degree of food insecurity, ranging from mild (33.6%), to moderate (12.3%), to severe (5.6%). Food insecurity scores differed largely between the cities, with the highest average score in Bamako (mean of 2.1), followed by Kati (mean of 1.4); while Sikasso had the lowest average score (mean of 0.7) (F=43.3, $p$<0.001). As expected, food insecurity scores differed depending on the income level of the neighbourhood – however, highest scores were seen in the low-income neighbourhoods, not in the slums (F=37.9, $p$<0.001). The average scores were 2.3 in the low-income neighbourhoods compared to 1.2 in both the slums and the middle-income neighbourhoods (that did not differ significantly from each other). In urban neighbourhoods, food insecurity was higher (mean of 1.7) compared to peri-urban neighbourhoods (mean of 1.4) (t=1.8, $p$=0.035) – although the difference is scores was small. Finally, the food insecurity score was higher for female respondents compared to males (t=-4.9, $p$<0.001), but did not significantly correlate with respondent age or the number of children in the household.

## 3.2 Food intake and contribution of vegetables to the dietary quality

### 3.2.1 Highlights and implications

- Vegetables are an important part of the diet and commonly eaten, with a majority of the respondents eating vegetables daily. The consumption of fruits was lower than vegetables.
- Total vegetable intake differed largely between cities, with much lower average scores in Sikasso compared to Bamako and especially Kati.
- Intake was highest in the urban neighbourhoods compared to peri-urban; in low- and middle-income neighbourhoods compared to slums; and for men compared to women. Thus, more efforts are needed to increase intake of women and consumers in peri-urban and slum neighbourhoods, especially within Sikasso.

### 3.2.2 Vegetable intake and demographic differences

Almost all respondents typically eat vegetables. When asked about their usual consumption patterns, 99.8% responded that they generally ate cooked vegetables and 74.9% usually ate raw vegetables or salad. On average (mean), respondents ate cooked vegetables 6.6 days per week (SD=1.1) and raw vegetables or salad 1.9 days per week (SD=1.7); with 87.8% reporting eating cooked vegetables daily. Average portions (mean) consumed on such days was 4.9 for cooked (SD=1.9) and 5.8 for raw (SD=1.7). Portions were defined as a serving spoon (showed with the enumerator) of vegetables. The number of days was multiplied with portions to estimate total vegetable consumption. In turn, total vegetable intake was 43.6 portions per week (SD=21.3): 32.3 portions of cooked vegetables (SD=13.9) and 11.3 portions of raw vegetables (SD=11.8).

Total vegetable intake, calculated in portions per week, differed largely between cities, with the highest average scores in Kati (means of 53.3). This was followed by Bamako (mean of 47.1 portions per week),

while Sikasso had the lowest average score (mean of 26.5 portions per week) (F=183.0, $p<0.001$; all cities were significantly different from each other). Vegetable intake also differed according to neighbourhood income level (F=4.9, $p<0.01$), with the respondents from slums reporting a lower intake (mean of 41.1 portions per week) compared to low- and middle-income (means of 44.5 and 45.1 portions per week respectively and not different from each other). In urban neighbourhoods, vegetable intake was higher (mean of 44.7 portions per week) compared to peri-urban neighbourhoods (mean of 41.9 portions per week) (t=2.4, $p=0.008$). Finally, vegetable intake was higher for male compared to female consumers (mean of 47.3 versus 43.0; t=2.2, $p=0.027$), and did not significantly correlate with age or the number of children in the household.

### 3.2.3 Dietary quality

Due to an error, the wrong version of the dietary diversity questionnaire (DDQ) was administered in Mali. Instead of the DDQ tailored to Mali, the version tailored to Benin was mistakenly used instead. Although different versions of the DDQ include the same food groups (e.g., fruits), the specific types of foods from this food group provided (e.g., banana.) differ greatly between the versions for Mali and Benin, especially for green leafy vegetables (see for more details https://doi.org/10.18174/638784). These specific foods are based on the most common foods consumed in the country, meaning those from the Benin questionnaire were less relevant for Mali and might have resulted in underestimation. For this reason, no conclusions were based on the intake of green leafy vegetables and results on other food should also be interpreted considering the possible underestimation.

In general, vegetables were among the most frequently consumed food groups, together with staple foods. Almost all respondents (more than 90%) had eaten the common staples (rice, bread, pasta, or maize) and the most common vegetables (tomato, eggplant, okra, cabbage, or beet) in the previous 24 hours (Figure 3.2). Furthermore, consumption of warm sweet drinks (sugared coffee, tea, or cocoa drinks) in the previous 24 hours was reported by a high percentage of respondents. More than half of the respondents had eaten red or organic meat, other vegetables, milk, and fish within the previous day. Foods less often reported as being consumed were other meat types, non-citrus fruits, and ultra-processed foods, such as instant noodles, chips, and fast food.

The percentage of respondents consuming 'healthy' foods was somewhat low, at an average GDR-healthy score of 3.45 (SD=1.62) on a possible scale from 0 to 9. Positively, however, the percentage of consumption of unhealthy foods was even lower, with an average Global Dietary Recommendation (GDR)-limit score of 1.47 (SD=1.22). Yet, for unhealthy foods, the whole scale was not used since none of the respondents reported having consumed from all 9 unhealthy food groups in the past day; 7 was the maximum reported. Consequently, the GDR score –a combination of healthy and limit scores – ranged between 5 and 16, rather than between 0 and 18 (which is theoretically possible). The overall dietary diversity score was, on average, 10.97 (SD=1.55). As per the World Health Organization (WHO) fruit and vegetable index, 40.1% of the population scored equal to or above the cut-off point of consumption of 3 fruit and vegetables food groups. Vegetables were eaten more frequently than fruit.
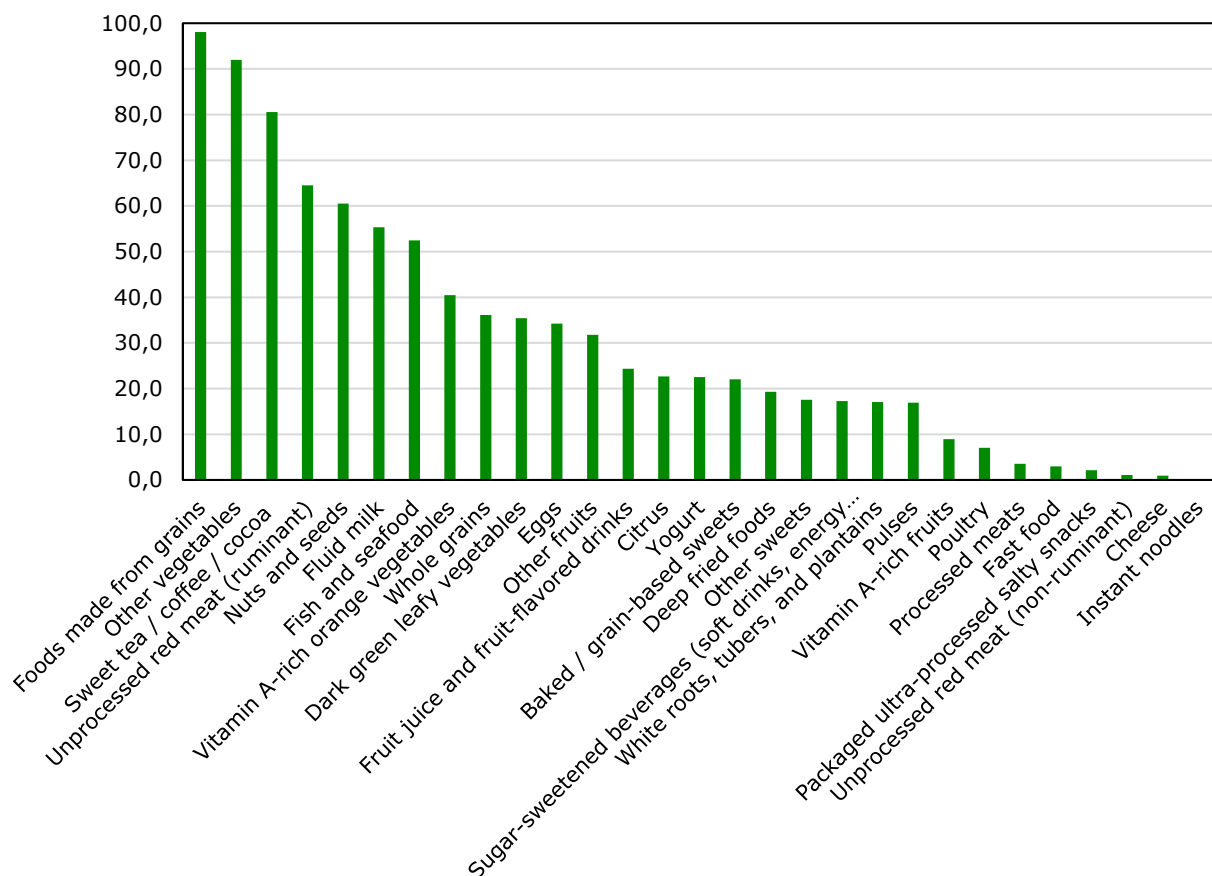
***Figure 3.2*** *Percentage of consumers reporting consumption of the food groups (n=1,266)*

## 3.3 Vegetable sourcing

### 3.3.1 Highlights and implications

- Fresh markets are by far the most important outlet for vegetables. However, since purchasing frequency is 3-4 times a week for most respondents, buying from street vendors and neighbourhood shops, the next most important outlets, could also be increased to support more frequent consumption of perishable vegetables, such as green leafy vegetables.
- Tomato, onion, African eggplant (n'goyo), green bell pepper, okra, cucumber, sweet potato leaves, carrot, cabbage, and eggplant were the most commonly eaten vegetables. In terms of quantity, onion was the most purchased raw vegetable and sweet potato leaves the most purchased green leafy vegetable. Differences in sourcing of vegetables were found between the cities, but it is unclear what underlies these: for instance, differences in food habits, taste preferences, seasonality, or access.

A minority of the respondents (11.1%, n=140) grew their own vegetables in the past year. The most-grown crops were: okra (57.1%), tomato (38.6%), African eggplant (n'goyo) (33.6%), and lettuce (29.3%). Respondents also reported growing sweet potato leaves, amaranth leaves, cabbage, green bell pepper, eggplant, cucumber, spinach, green beans, onion, beetroot, and carrot (crops grown by less than 10% of growers are not reported). Among those growing crops, 95.7% consumed them personally, while 52.1% also sold some vegetables and 28.6% gave crops as gifts to relatives and friends. The reasons for growing vegetables varied. A good majority (55.7%) found it less expensive than purchasing from sellers; more than half find it a good method to earn money through selling (52.9%); and others do so because they believe it to be healthier (39.3%) and better tasting (37.9%) than bought vegetables. Other reasons include habit/tradition (33.6%), convenience (23.6%), and being free from contaminations (e.g., pesticides, fertilisers, and chemicals) (10%).

The whole sample sourced their vegetables most often from fresh markets (88.3%), street vendors (14.7%), farmer's markets (1.9%), neighbourhood store/kiosks (4.9%), supermarkets (0%), or other places (0.2%). Almost all respondents (97.9%; n=1240) bought vegetables in the past week (Table 3.2). Since the supermarket and other places were only reported by three respondents, they are not included in further analysis.

On average, most of the sampled consumers purchase vegetables 3-4 times a week: from fresh markets (n=1095, mean=5.27, SD=2.21), street vendors (n=182, mean=3.68, SD=2.26), neighbourhood stores (n=61, mean=5.08, SD=2.40), farmer's markets (n=24, mean=2.04, SD=1.76), and other places (n=3, mean=3.33, SD=3.22). No vegetables were sourced from supermarkets. The five most purchased vegetables by more than half of the respondents were tomato (85.2%), onion (81.7%), African eggplant (N'goyo) (76.5%), green bell pepper (62.7%), and okra (52.6%). Other popular vegetables were cucumber, sweet potato leaves, carrot, cabbage, and eggplant (Table 3.2). In terms of quantity (i.e., portion), onion was the most purchased raw vegetable and sweet potato leaves the most purchased green leafy vegetable. Okra and moringa leaves were also bought in large quantities.

**Table 3.2**    *Number of buyers and portions bought per vegetable in the past week a), b), c) by respondents in urban Mali (n=1,266)*

| Vegetable | All outlets N=1240 (97.9%) | Fresh market N=1095 (86.5%) | | Street vendor N=182 (14.4%) | | Neighbourhood store N=61 (4.8%) | | Farmer's market N=24 (1.9%) | |
|---|---|---|---|---|---|---|---|---|---|
| | *Proportion of buyers* | *Number of buyers* | *Number of portions* | *Number of buyers* | *Number of portions* | *Number of buyers* | *Number of portions* | *Number of buyers* | *Number of portions* |
| Tomato | 85.2% | 998 | 7.54 (9.05) | 115 | 4.30 (5.75) | 43 | 3.53 (7.48) | 4 | 5.25 (2.50) |
| Onion | 81.7% | 949 | 12.46 (15.35) | 115 | 4.90 (8.30) | 36 | 3.61 (3.71) | 4 | 4.00 (2.31) |
| African eggplant | 76.5% | 890 | 3.91 (5.00) | 84 | 2.56 (2.81) | 38 | 1.97 (1.20) | 2 | 3.00 (1.41) |
| Green bell pepper | 62.7% | 752 | 3.86 (4.68) | 51 | 2.86 (3.29) | 22 | 1.59 (.50) | 1 | 4.00 |
| Okra | 52.6% | 624 | 9.34 (11.14) | 49 | 5.96 (5.93) | 19 | 2.95 (1.93) | 1 | 5.00 |
| Cucumber | 42.1% | 392 | 5.78 (6.86) | 27 | 4.41 (3.05) | 6 | 2.00 (.00) | 7 | 2.57 (.98) |
| Sweet potato leaves | 37.9% | 440 | 10.93 (12.52) | 30 | 4.57 (4.24) | 10 | 7.60 (2.68) | 8 | 3.00 (1.77) |
| Carrot | 34.2% | 414 | 3.36 (5.69) | 20 | 2.45 (2.56) | 8 | 1.63 (.52) | - | - |
| Cabbage | 32.5% | 744 | 2.63 (2.77) | 54 | 2.22 (2.35) | 24 | 2.42 (3.05) | 2 | 2.50 (.71) |
| Eggplant | 29.8% | 351 | 3.56 (5.07) | 27 | 2.78 (2.55) | 10 | 2.30 (1.64) | 1 | 6.00 |
| Amaranth leaves | 21.2% | 251 | 8.04 (9.62) | 14 | 4.36 (2.53) | 4 | 6.00 (2.83) | 1 | 2.00 |
| Lettuce | 19.7% | 230 | 5.81 (4.91) | 16 | 4.81 (4.14) | 5 | 4.60 (2.41) | 19 | 3.53 (3.20) |
| Fakoye (Malinese dish) | 15.9% | 193 | 8.80 (11.20) | 9 | 4.00 (1.66) | 2 | 5.50 (.71) | - | - |
| Spinach | 15.5% | 183 | 7.72 (10.19) | 15 | 3.20 (2.31) | - | - | - | - |
| Baobab leaves | 14.3% | 163 | 7.23 (9.58) | 18 | 3.00 (2.06) | 1 | 16.00 | - | - |
| Squash | 13.4% | 159 | 2.52 (2.70) | 13 | 2.00 (1.16) | 3 | 1.67 (1.16) | - | - |
| Green beans | 11.5% | 142 | 6.35 (12.73) | 3 | 3.33 (4.04) | 2 | 2.00 (.00) | - | - |
| Sweet potato | 10.9% | 129 | 8.19 (10.70) | 7 | 3.43 (2.51) | 3 | 9.33 (14.43) | - | - |
| Cowpea leaves | 9.8% | 112 | 5.28 (8.09) | 11 | 2.73 (2.24) | 1 | 1.00 | 1 | 3.00 |
| Cassava leaves | 6.9% | 83 | 9.17 (10.31) | 3 | 2.00 (1.00) | 1 | 1.00 | - | - |
| Beetroot | 6.2% | 75 | 2.96 (2.94) | 3 | 3.67 (1.16) | - | - | 1 | 1.00 |
| Eggplant leaves | 3.9% | 43 | 5.88 (8.83) | 6 | 3.00 (2.53) | - | - | - | - |
| Peanut leaves | 3.1% | 37 | 3.81 (6.74) | 1 | 2.00 | - | - | 1 | 6.00 |
| Moringa leaves | 1.7% | 21 | 14.57 (17.40) | 1 | 2.00 | - | - | - | - |

a) The categories 'other outlet' (n=3) and supermarket (n=0) were not included due to the small numbers; b) A cut-off point of 10 buyers was placed for number of portions calculated; c) Proportion of buyers was calculated by adding the number of respondents who had bought at any of the outlets in the past week.

*Note:* Outlets and vegetables have different sample numbers.

### 3.3.2 Demographic differences in purchase patterns

Purchases of vegetables from different outlets was compared between demographic groups. While the purchase of vegetables from outlets varied between cities, the differences were small. Firstly, the purchase of vegetables from fresh markets was lower in Kati (mean=.84) compared to Bamako (mean=.91), (F=4.31, $p$=.005). Secondly, more respondents from Kati (M=.21) and Sikasso (mean=.30) bought vegetables from street vendors compared to Bamako (mean=.04) (F=72.67, $p$<.001). Thirdly, respondents buying vegetables from neighbourhood stores was lower for Kati (mean=.13) and Sikasso (mean=.06) compared to Bamako (mean=.01) (F=32.77, $p$<.001). Lastly, vegetable purchases from farmer's markets were higher for Kati (mean=.06) compared to Bamako (mean=.00) and Sikasso (mean=.01) (F=20.08, $p$<.001).

As for neighbourhood type, the purchase of vegetables from different outlets varied between urban and peri-urban neighbourhoods. Fresh markets were more popular in urban (mean=.94) than peri-urban (mean=.81) neighbourhoods (t=6.99, $p$<.001). Neighbourhood stores were more popular in peri-urban (mean=.09) than urban (mean=.02) neighbourhoods (t=-6.06, $p$<.001). While farmer's markets were more popular in urban (mean=.03) than peri-urban (mean=.00) neighbourhoods (t=3.37, $p$<.001). No differences were found for street vendors according to type of neighbourhood.

The purchase of vegetables from the four outlets varied with neighbourhood income levels. The percentage of respondents that buy vegetables from fresh markets in middle-income neighbourhoods (mean=.93) was higher than in low-income (mean=.88) ($p$<.001) and slum (mean=.84) ($p$=.01) neighbourhoods (F=6.86, $p$<.001). Vegetables purchased from street vendors in low-income neighbourhoods (mean=.23) was higher than slum (mean=.10) and middle-income (mean=.11) neighbourhoods (F=18.30, $p$<.001). However, neighbourhood stores were more popular in slum (mean=.09) compared to low- (mean=.02) and middle-income (M=.03) neighbourhoods (F=12.37, $p$<.001). Lastly, farmer's markets were more frequented in low-income neighbourhoods (mean=.05) than slum (mean=.00) and middle-income neighbourhoods (mean=.01) (F=14.85, $p$<.001).

The purchase of vegetables from different outlets varied between female (n=1081) and male respondents (n=159) for two outlets: fresh market and neighbourhood store. The number of female respondents (mean=.90) who buy vegetables from fresh markets is higher than male respondents (M=.77) (t=-4.91, $p$<.001). More male respondents (M=.18) buy vegetables from neighbourhood stores more frequently than female respondents (mean=.03) (t=8.13, $p$<.001). The outlets had no significant correlations with household size or number of children in the household.

The type of vegetables bought was also compared among demographic groups in which vegetables were purchased by 3% of the sample or more. Purchase of vegetables differed among the three cities. In total, 20 out of the 24 vegetables showed significant differences between Sikasso, Bamako, and Kati (Table 3.3). Moringa leaves also showed significance, but it was not included due to the low number of consumers who purchased it.

**Table 3.3** *Difference in vegetable purchases by city in Mali (n=1,266)*

| Vegetable | Mean | | | F-value | P-value |
|---|---|---|---|---|---|
| | Bamako | Kati | Sikasso | | |
| Tomato | .87[b] | .90[b] | .76[a] | 14.13 | <.001 |
| Onion | .73[a] | .90[b] | .90[b] | 30.69 | |
| African eggplant | .71[a] | .81[b] | .83[b] | 10.82 | |
| Green bell pepper | .58[b] | .73[a] | .61[b] | 10.61 | |
| Okra | .49[b] | .44[b] | .67[a] | 19.23 | |
| Carrot | .38[a] | .47[b] | .13[c] | 46.91 | |
| Cabbage | .58[a] | .67[b] | .71[b] | 9.53 | |
| Amaranth leaves | .17[b] | .37[a] | .14[b] | 31.95 | |
| Lettuce | .24[b] | .20[b] | .11[a] | 11.91 | |
| Spinach | .11[a] | .21[b] | .19[b] | 9.29 | |
| Baobab leaves | .09[b] | .12[b] | .28[a] | 35.56 | |
| Squash | .10[b] | .08[b] | .27[a] | 34.84 | |
| Green bean | .09[b] | .20[a] | .08[b] | 15.45 | |
| Sweet potato | .14[b] | .12[b] | .03[a] | 14.66 | |
| Cowpea leaves | .03[a] | .10[b] | .24[c] | 60.63 | |
| Beetroot | .05[b] | .12[a] | .04[b] | 13.05 | |
| Eggplant leaves | .03[b] | .02[b] | .08[a] | 11.36 | |
| Peanut leaves | .01[b] | .03[b] | .06[a] | 7.95 | |
| Fakoye | .15[b] | .22[a] | .12[b] | 6.80 | .001 |
| Cucumber | .34[b] | .36[b] | .26[a] | 4.52 | .011 |

[abc] Within a row, means without a common superscript differ significantly from each other in host-hoc analysis (p<.05).

As for variations in neighbourhood income levels, 12 vegetables showed significant differences in purchasing between slum, low-income, and middle-income neighbourhoods (Table 3.4). Moringa leaves also showed significance, but it was not included due to the low number of consumers who purchased it.

**Table 3.4** *Difference in vegetable purchases by income level of neighbourhood in Mali (n=1,266)*

| Vegetable | Mean | | | F-value | P-value |
|---|---|---|---|---|---|
| | Slum | Low-income | Middle-income | | |
| African eggplant | .78[b] | .70[a] | .82[b] | 7.86 | <.001 |
| Carrot | .31[b] | .30[b] | .42[a] | 20.69 | |
| Amaranth leaves | .12[a] | .30[c] | .21[b] | 21.40 | |
| Cucumber | .28[b] | .29[b] | .41[a] | 9.52 | |
| Green beans | .08[b] | .09[b] | .16[a] | 7.99 | |
| Spinach | .08[a] | .20[b] | .18[b] | 14.59 | |
| Eggplant | .25[b] | .36[a] | .28[b] | 5.96 | .003 |
| Sweet potato leaves | .32[a] | .43[b] | .39[b] | 5.61 | .004 |
| Beetroot | .03[a] | .08[b] | .07[b] | 4.59 | .010 |
| Fakoye | .12[a] | .17[b] | 18[b] | 3.32 | .036 |
| Lettuce | .17[b] | .18 | 24[a] | 3.21 | .041 |
| Okra | .48[a] | .53 | .57[b] | 3.15 | .043 |

[abc] Within a row, means without a common superscript differ significantly from each other in host-hoc analysis ($p$<.05).

The kind of vegetables purchased also differed according to neighbourhoods. The purchase of 12 vegetables differed between urban and peri-urban neighbourhoods (Table 3.5). All vegetables mentioned in Table 3.5 had higher consumption in urban neighbourhoods compared to peri-urban neighbourhoods.

**Table 3.5** *Difference in vegetable purchases by neighbourhood type in Mali (n=1,266)*

| Vegetable | Mean | | T-value | P-value |
|---|---|---|---|---|
| | **Urban** | **Peri-urban** | | |
| Green bell pepper | .68 | .55 | 4.62 | <.001 |
| Cucumber | .37 | .27 | 3.69 | |
| Sweet potato leaves | .43 | .30 | 4.67 | |
| Fakoye | .20 | .11 | 4.32 | |
| Spinach | .19 | .10 | 4.35 | |
| Baobab leaves | .17 | .10 | 3.47 | |
| Green beans | .15 | .06 | 4.92 | |
| Cowpea leaves | .13 | .05 | 4.74 | |
| Beetroot | .09 | .02 | 5.13 | |
| Peanut leaves | .04 | .02 | 2.38 | .017 |
| Carrot | .37 | .31 | 2.16 | .031 |
| Okra | .55 | .49 | 2.03 | .043 |

Purchases of some vegetables correlated with household size and/or number of children in the household. Purchase of okra (r=.069, *p*=.014) and eggplant (r=.059, *p*=.036) showed weak positive correlation with number of children in the household. With regards to differences between genders, female respondents bought more of these 7 vegetables than male respondents: green bell pepper, cucumber, carrot, amaranth leaves, fakoye, green beans, and cowpea leaves (Table 3.6).

**Table 3.6** *Difference in vegetable purchases by gender in Mali (n=1,266)*

| Vegetable | Means | | T-value | P-value |
|---|---|---|---|---|
| | **Male** | **Female** | | |
| Green bell pepper | .40 | .66 | -6.55 | <.001 |
| Cucumber | .21 | .34 | -3.32 | |
| Carrot | .17 | .37 | -5.04 | |
| Amaranth leaves | .10 | .23 | -3.75 | |
| Fakoye | .09 | .17 | -2.44 | .015 |
| Green beans | .06 | .12 | -2.24 | .025 |
| Cowpea leaves | .05 | .11 | -2.21 | .027 |

### 3.3.3 Out-of-home purchase and consumption

Out-of-home meals were bought by 39.8% of the sample in the past week. The most often used outlets were street food vendor (fixed place) (31.8%), mobile street food vendor (14.4%), small informal restaurant (5.5%), restaurant (plate) (1.2%), canteen at work or school (1.1%), and fast food (boxes/paper) (4.1%). Purchase frequency was, on average, 2.31 (SD=1.58) days per week (range 1-7 days). In terms of frequency, street vendors were the most often used outlet, at an average of 2.40 (SD=1.61) days per week (Table 3.7).

**Table 3.7** *Consumption of out-of-home meals by outlet by respondents in urban Mali, where and frequency*

| Outlet | Proportion of respondents that bought here in past week (% of buyers) a) | Frequency bought in past week (includes only the buyers) |
|---|---|---|
| Street food vendor (fixed place) | 31.8% | 2.49 (1.66) times |
| Mobile street food vendor | 14.4% | 1.89 (1.25) times |
| Small informal restaurant | 5.5% | 1.56 (1.21) times |
| Restaurant (plate) | 1.2% | 1.73 (1.79) times |
| Canteen at work or school | 1.1% | 2.21 (1.81) times |
| Fast food (boxes/paper) | 4.1% | 1.73 (0.79) times |

a) Only respondents that bought out-of-home meals in the past week were included (39.8% of the total sample of 1,266).

## 3.4 Food safety perception and motives

### 3.4.1 Highlights and implications

- Food safety was an important motive for respondents – equally as important as healthiness and taste. This suggests that awareness creation around food safety is not crucial, since consumers are already considering this in their food purchasing.
- Vegetables are judged as 'somewhat' safe, which suggests that food safety should be improved to meet the consumers' standards.
- Retailers could play an important role in food safety perception, since they are most trusted by the consumer but also trust in farmers and authorities was somewhat positive.
- Safety concerns were particularly regarding contamination (including from fertilisers and pesticides) and not being grown naturally. From respondents' perspectives, this should be the focus for improved food safety. Also, they thought vegetables were often not well priced.

### 3.4.2 Food choice motives

When choosing what food to buy, health, safety, and taste were considered the most important factors, followed by affordability. All these factors obtained an average score of 5.8 and 5.9 on a scale from 1 (not important at all) to 7 (very important). Other motives considered as somewhat important when choosing food were familiarity, energy provision, convenience, local and/or seasonality, and naturalness, while environmentally friendly, mood, and weight control were considered somewhat unimportant (Figure 3.3).
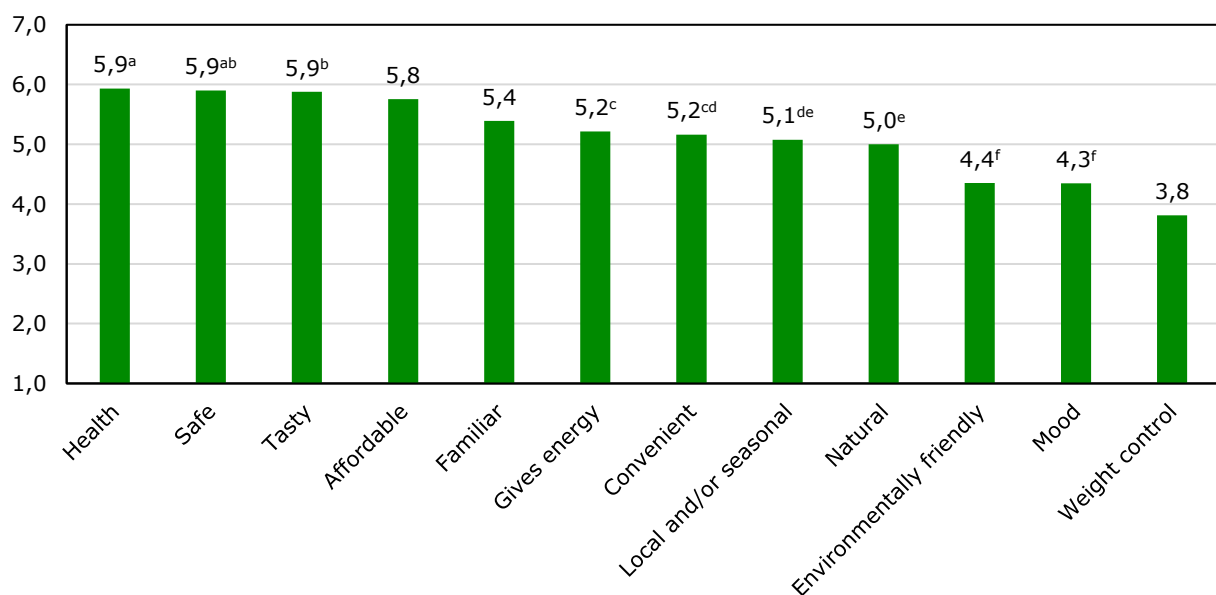


**Figure 3.3** *General food choices motives of respondents in urban Mali (average score on a scale from 1 (not important at all to 7 very important), based on a single item (n=1,266)). Similar letters mean not significantly different*

The importance of food safety in food choice was measured with an additional (multi-item) method. This multi-item measure of the food safety motive results in a similar score as the single item with an average score of 5.6 (SD=0.7). This suggests that safety aspects were important for respondents.

The importance of food safety differed between cities (F=22.5, $p<0.001$), with the highest average scores in Kati (mean=5.7, SD=0.6), followed by Sikasso (mean=5.6, SD=0.6), with Bamako having the lowest average score (mean=5.4, SD=0.7). Food safety motive scores also differed with neighbourhood income level, with lowest scores obtained in the slum neighbourhoods (F=14.0, $p<0.001$). However, the average

scores did not differ much, with an average of 5.4 in the slum compared to 5.6 in both the middle- and the low-income neighbourhoods (that did not differ significantly from each other). In urban neighbourhoods, food safety was more important (mean =5.6) than in peri-urban neighbourhoods (mean=5.5) (t=2.0, *p*=0.04). Finally, the importance of food safety was higher for male than female consumers (t=3.0, *p*=0.002), again with a small difference in the mean score (5.7 versus 5.5). However, it did not significantly correlate with consumer age or with the number of children in the household.

### 3.4.3 General vegetable safety perceptions

Overall perception of the safety of vegetables was somewhat positive, with an average vegetable safety optimism score of 5.1 (SD=1.0). At the same time, consumers slightly disagreed 'pessimistic statements' on vegetable safety that state serious concerns on food safety issues and were scored with an average score of 3.3 (SD=1.2) – indicating no serious concerns with the safety of vegetables at outlets where they usually buy. Trust was somewhat positive for all chain actors, especially retailers (mean of 4.6, SD=1.4) – but significantly less for farmers (mean of 4.5, SD=1.4) and authorities (mean of 4.4, SD=1.5).

Respondents were also asked to rank foods based on their safety. Fruits were ranked as the first choice most often, with 23.4% of respondents considering it the safest food from the provided list. Meanwhile, green leafy vegetables were ranked as the first choice by 9.1% of respondents. Fruits were ranked most often in the top 3 – so either first, second or third most safe foods – by 55.9% of respondents. Fish came second – ranked in the top 3 by 47.4% – followed by chicken (38.8%) and green leafy vegetables (38.3%). There was, however, great variation between respondents, with 38.3% ranking green leafy vegetables as the most safe (top 3 highest rankings) and 28.6% ranking them as least safe (top 3 lowest rankings). Groundnuts (48.0%), cassava and yam (46.5%), milk (44.8%), and eggs (42.1%) were ranked most often on the lowest three positions, so the least safe relative to the other foods. For animal products, there are thus large differences – with fish and chicken being ranked often in the highest positions, while milk and eggs were often ranked in lowest position. Green leafy vegetables were considered relatively safe but not safest, while other vegetables on average were ranked intermediate.

### 3.4.4 Safety attributes of vegetables

Respondents rated their perception of safety attributes of vegetables sold at places where they (or their household members) usually buy (see Figure 3.4).
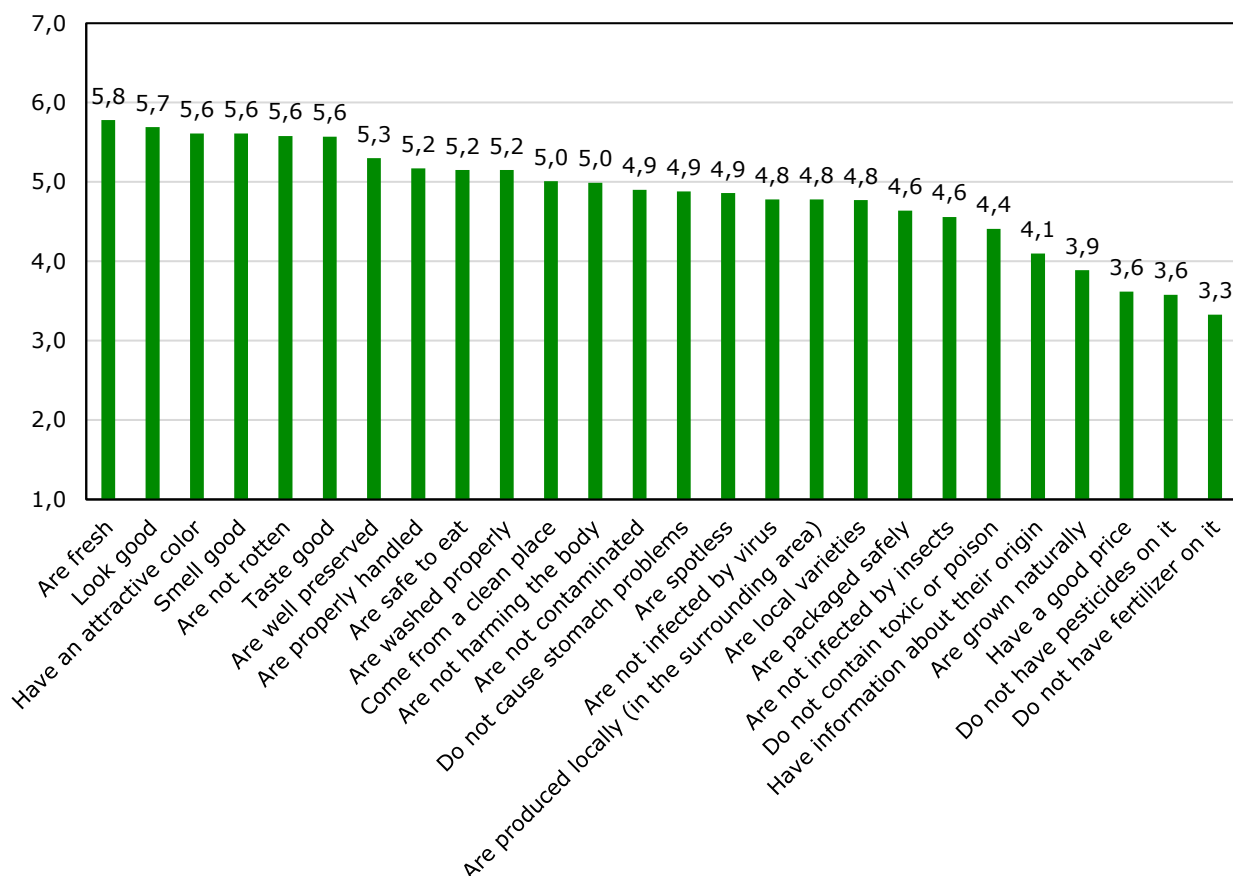
**Figure 3.4** *Perception of product attributes by respondents in urban Mali of the vegetables sold at places where they usually buy (n=1,266)*

Vegetables were judged most positively on appearance (look good, attractive colour), freshness (are fresh, not rotten, well preserved), good taste and smell, cleanliness (washed properly, properly handled, come from a clean place), and general safety (safe to eat, not harming the body). Respondents judged those aspects with an average score between 5 and 6, indicating that they (somewhat) agreed with the statement. On average, they also somewhat agreed that the vegetables were unaffected (not contaminated, spotless, not infected by virus, not contain toxic or poison), don't cause stomach problems, were local, and packaged safely – represented by a slightly positive score. Beliefs that the vegetables do not contain pesticides and fertiliser, are grown naturally, and have a good price average scores, were slightly negative.

### 3.4.5 General attitude safety of vegetables at outlets

Attitudes towards vegetable outlets were measured in terms of cognitive attitude (safe, fresh, neat) and affective attitude (good, of high quality) for the primary and secondary most important outlets for buying vegetables of each respondent. In general, attitudes towards the safety of vegetables at respondents' primary and secondary outlets for purchasing were positive. Average scores (means) for both primary and secondary outlets showed that vegetables were considered safe ($M_{Primary}$=5.6, SD=0.8; $M_{Secondary}$=5.6, SD=0.7), fresh ($M_{Primary}$=5.7, SD=0.7; $M_{Secondary}$=5.8, SD=0.8), neat ($M_{Primary}$=5.5, SD=0.8; $M_{Secondary}$=5.6, SD=0.8), good ($M_{Primary}$=5.7, SD=0.6; $M_{Secondary}$=5.7, SD=0.7), and of high quality ($M_{Primary}$=5.3, SD=0.9; $M_{Secondary}$=5.3, SD=0.9). Attitude scores did not differ significantly between outlets (Figure 3.5).
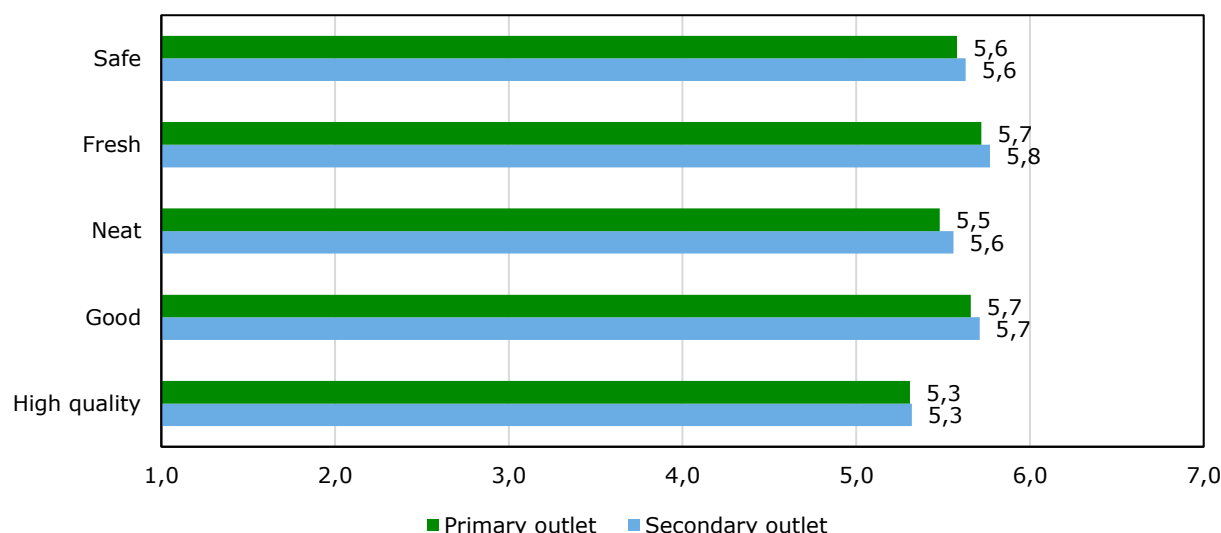
**Figure 3.5** *General attitude of vegetables by respondents in urban Mali per outlet where they usually buy. Note: sample size differed significantly with all respondents (n=1,266) reporting about their primary outlet and a subsample also reporting about their second outlet (n=200). No significant differences between the primary and secondary outlets.*

## 3.5 Accessibility, safety knowledge, and skills

### 3.5.1 Highlights and implications

- Respondents were confident about their skills to purchase and consume safe vegetables, including regarding their kitchen skills. This suggests they would not perceive to benefit from a general information campaign on food safety skills.
- They did, however, feel less confident about their knowledge of safe vegetables, so information campaigns targeting this area might be valuable.
- In general, perceived access to vegetables was good but the affordability of the vegetables and the lack of possibility to interact with the vendor were an issue for consumers.
- Neighbourhood stores scored especially high on accessibility compared to, for example, fresh markets, and also high on affordability, and accommodation (including trust in seller). This suggests that these locations are an interesting entry point to increase vegetable purchase.
- Street vendors scored high on accessibility. However, the availability of vegetables from street vendors scored lower and should be improved to attract and retain consumers.

### 3.5.2 Abilities related to safe vegetable consumption

Respondents felt they do not have much knowledge on the safety of vegetables (mean=3.9, SD=1.0). When asked 'Would you like to know more about the safety of vegetables?', 96.5% replied in the affirmative. On average, respondents felt confident they were able to purchase and consume safe vegetables (mean=5.3, SD=0.8) and were also confident in their safe kitchen skills (mean=5.7, SD=0.6).

Subjective knowledge about food safety differed between the cities, with the lowest average score in Bamako (mean=3.7) compared to Kati and Sikasso (both with means of 4.0) (t=15.3, *p*<0.001). Subjective knowledge was higher in urban (mean of 4.0) compared to peri-urban neighbourhoods (mean=3.7; t=6.5 *p*<0.001), and for female than male respondents (means=3.9 and 3.5; t=5.3, *p*<0.001, respectively), and was significantly correlated with number of children in the household; although the correlation was low in strength (.1). Subjective knowledge did not differ with income level of the neighbourhood or consumers' age.

### 3.5.3 Perceived access to safe vegetables

Respondents were asked about different aspects of access regarding their primary outlet and (if applicable) secondary outlet for vegetable purchasing (Figure 3.6). Most consumers (91.2%) stated fresh markets are their primary outlet, and an additional 2.9% said it was their secondary outlet. The majority of the respondents (81.2%), however, stated they did not have a secondary outlet for buying vegetables. Combined data for primary and secondary outlets resulted in 1,192 cases for fresh markets, 178 for street vendors, 61 for neighbourhood stores, and 26 for farmer's markets. Other outlets (n=9) and supermarkets (n=0) were not included due to their small numbers.

With the exception of services for buying on credit, possibility to interact with the seller, and affordability of vegetables, access was, on average, considered somewhat good to good (average scores between 5 and 6). At fresh markets – the most commonly used outlet – availability (selection, qualities, and quality) and accessibility (access from the road, travel time, and distance) were particularly rated as good. For affordability and accommodation, scores were mixed; with some aspects rated positive (operation hours, trust in seller, price in relation to quality), while others were rated neutral to slightly negative (affordability, services to buy on credit, possibility to interact with the seller). Compared to the other outlets, street vendors scored lower with regards to selection of vegetables and quality (availability), but better on distance, travel time, and access from the road (accessibility). Neighbourhood stores had an interesting pattern, scoring equally well on availability as fresh markets, very high on accessibility, relatively high in affordability (only farmers' markets scored higher), and also highest on operation hours and trust in seller. Finally, farmer's markets stood out on availability, with its highest scores on quantities and quality of vegetables. Moreover, this outlet scored highest on affordability and possibility to interact with the seller about the vegetables. However, access to farmer's markets scored considerably lower than other outlets.
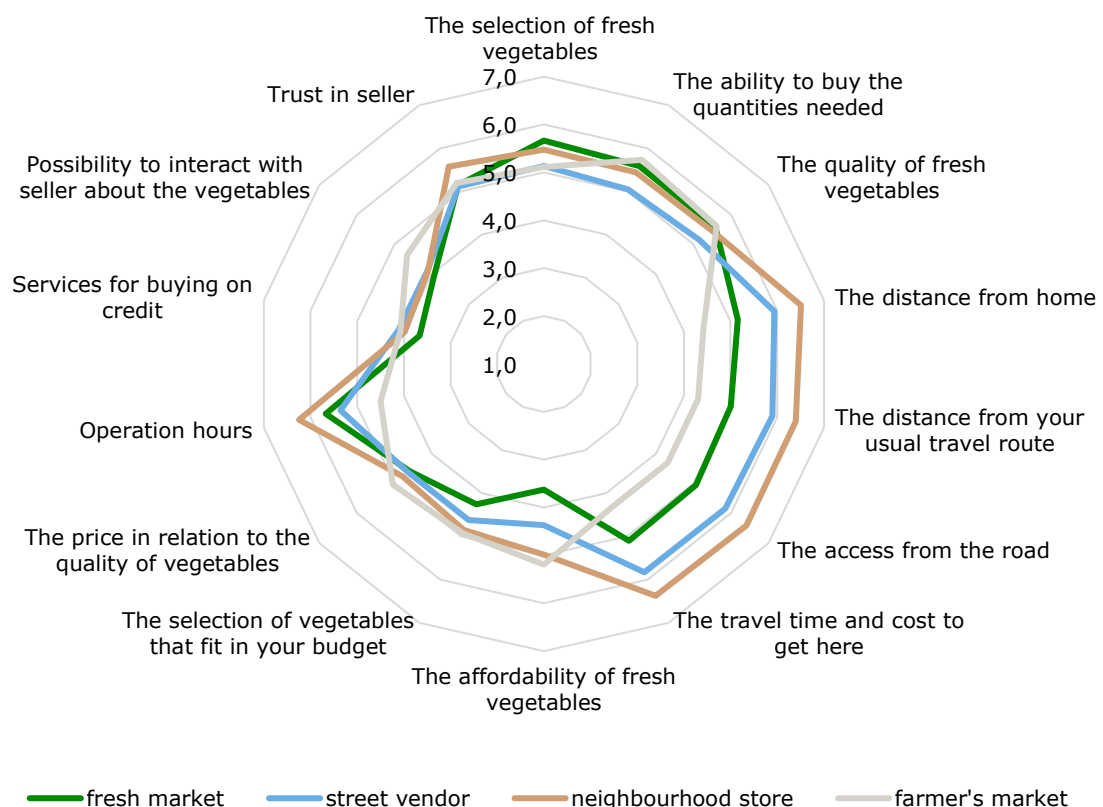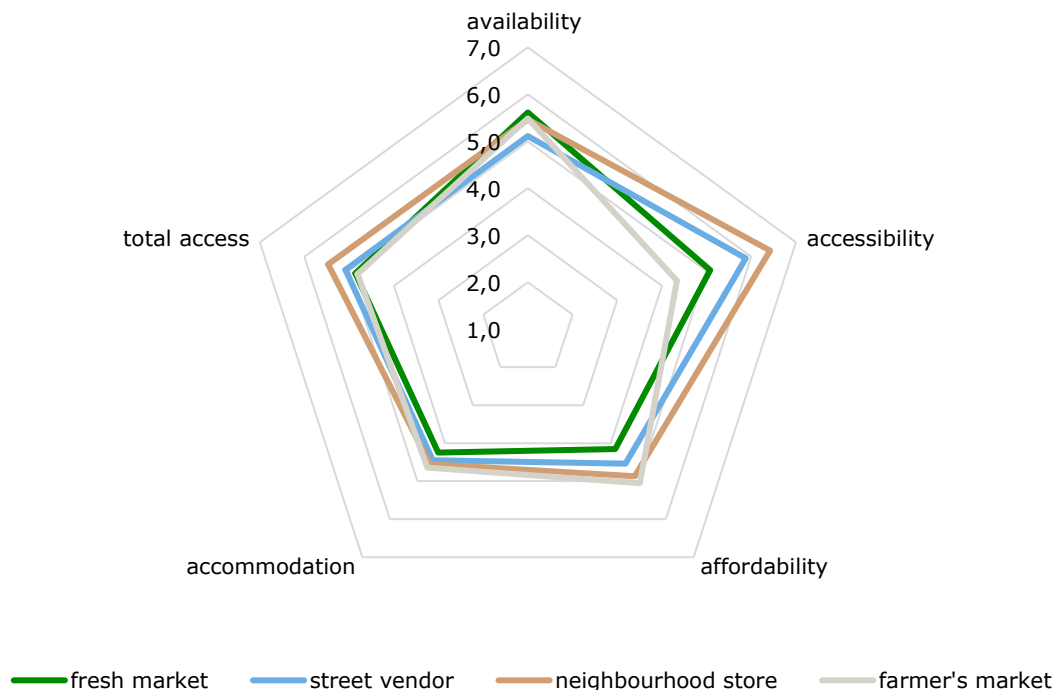


**Figure 3.6**  *Aspects of accessibility per outlet perceived by respondents in urban Mali (n=1,192 for fresh market; 178 for street vendor; 61 for neighbourhood store; 26 for farmer's market) (score from 1, extremely bad, to 7, extremely good)*
*Note: Differences could not be tested since respondents had different combinations of outlets (primary and secondary outlet) and numbers became too small.*

Scores on availability, accessibility, affordability, and accommodation. were and compared between outlets (fresh market compared to others only, due to sample sizes). The patterns for the accessibility factor scores were similar to that of the separate aspects of accessibility, but were also tested for significance. Fresh markets did relatively well on availability, but scored lowest on accessibility, affordability, and accommodation (Figure 3.7). Street vendors scored especially highly on accessibility, but also on affordability and accommodation (only farmer's markets did better). Street vendor's scores were intermediate on all aspects of access, and particularly low on affordability.



**Figure 3.7** *Accessibility per outlet perceived by respondents in urban Mali (n=1,192 for fresh market; 178 for street vendor; 61 for neighbourhood store; 26 for farmer's market) (score from 1, extremely bad, to 7, extremely good)*
*Note: All differences significant expect for fresh market versus farmer's market; test on paired data including only cases that reported both outlets while bars include all data.*

### 3.5.4    Demographic differences in access to markets

Access to fresh markets was compared between demographic groups. Total access differed according to neighbourhood income level, with lowest scores seen in the slum neighbourhood and low-income group (F=6.2, $p$=0.002). However, the average scores did not differ much, with an average of 4.8 in the slum and low-income neighbourhoods compared to 4.9 in the middle-income neighbourhoods. In urban neighbourhoods, perceived access was higher (mean=4.9) compared to peri-urban neighbourhoods (mean=4.8) (t=3.5, $p$<0.001), although the difference was small. Male respondents (mean of 5.2) perceived better access compared to males (mean=4.8) (t=6.2, $p$<0.01). Finally, perceived access correlated significantly but weakly with the age of respondents ($r$ of .1), with higher perceived access among older respondents than younger. The access score did not differ between cities and did not significantly correlate with the number of children in the household.

For other outlets, the sample sizes, and thus statistical power, was lower – but some demographic differences were found in the access scores for street vendors. Access to street vendors was lower in Bamako compared to Sikasso and Kati (F=3.1, $p$<0.05). In peri-urban areas, respondents had higher access to street vendors compared to those in urban areas (t=3.5, $p$<0.001), and male respondents reported higher access to compared to females (t=2.8, $p$=0.006).

# 4 Discussion and implications

Through the SafeVeg project, we aim to improve vegetable consumption by increasing the accessibility, affordability, and acceptability of safe vegetables. This study provided insights regarding the acceptability of vegetables and perceptions of vegetable safety, and highlighted possibilities for consumers to purchase, prepare, and consume safe vegetables. In addition, it showed how these factors differ between the demographic characteristics and geographic locations (cities, urban, and peri-urban) of consumers. A strength of the study was its large sample, diverse in terms of education and ethnic background – while less diverse on religion, with most respondents being Muslim. The sample included a high percentage of vulnerable households, since a large share of the data was collected in the slums and low-income neighbourhoods. A large proportion of those questioned had not finished primary school (45%) and household food insecurity was prevalent among half of the households, ranging from mild (34%), to moderate (12%), to severe (6%).

Below, we summarise the main outcomes of the study, discuss their limitations and implications, and suggest directions for interventions.

## 4.1 Acceptability

To acquire insights into what is common and 'fits' in the culture (acceptability), vegetable consumption and purchase behaviour were measured. The results showed that vegetables are an important part of the diet and almost all of the sample reported usually eating vegetables, especially cooked (99.8%) but also raw vegetables or salad (74.9%). Consumption frequency was also high, with 87.8% of the sample reporting eating cooked vegetables daily. On average, cooked vegetables were reported being eaten as frequently as 6.6 days per week and raw vegetables 1.9 days per week. Vegetables from the 'other' category, including tomato, onion, and okra, were consumed by a large share of the consumers (92%). Vitamin-A rich vegetables and dark green leafy vegetables were consumed by a majority of the sample (40% and 35%, respectively) in the past 24 hours. Due to an error, the wrong version of the DDQ was administered in Mali: instead of the DDQ tailored to Mali, the version tailored to Benin was mistakenly used instead and might have resulted in underestimation of all food groups (especially green leafy vegetables). Overall, consumption seemed to meet the requirements. Results on vegetable purchase were generally in-line with those on intake, showing the frequent buying of vegetables at an average of 3-4 times per week. The vegetables most often bought by consumers were tomato (85.2%), onion (81.7%), African eggplant (76.5%), green bell pepper (62.7%), and okra (52.6%). In terms of quantity, onion was the most purchased raw vegetable and sweet potato leaves the most purchased green leafy vegetable.

Our study was not designed to quantify the portions eaten or bought by respondents. We can only conclude that on the days respondents ate vegetables, most reported eating 1 or 2 portions of cooked and 2-4 portions of raw vegetables. The average number of portions (43.6 per week, 6.2 per day) is more than what is recommended by WHO, nut we do not have insights into the portion sizes and therefore total intake of vegetables.

## 4.2 Safety perception

Perception of safety was measured in relation to other food choice motives, for specific vegetable product attributes, for different chain actors, and related to outlets. The results showed the importance of food safety to consumers overall, although specifically for vegetables. Its significance is comparable to healthiness and taste and slightly higher than affordability. Many studies have shown that taste, health, and affordability are

important motives driving consumer choice (e.g., Adegbola et al., 2019; Pacho, 2020; Raaijmakers et al., 2018, 2023), and this study highlights that, in Mali, safety should be added to this list.

With regards to vegetables, this food is generally judged as being somewhat safe. Scores for vegetable safety were positive, but not very high – demonstrating that consumers have concerns but, on average, are not overly worried about safety. This is further supported by the scores obtained on food safety pessimism statements, such as 'You worry about the safety of vegetables'. Consumers slightly disagreed with these, which indicates no strong concerns about the safety of vegetables. Vegetables were generally ranked as relatively safe compared to other food, with fruits scoring highest. However, there was great variation between respondents, with 38% ranking green leafy vegetables as most safe (top 3 highest rankings) and 29% ranking them as least safe (top 3 lowest rankings). Interestingly, green leafy vegetables were considered a bit safer than other vegetables. In terms of interventions, the scores of product attributes provide more specific entry points on what is needed to increase the safety of vegetables, from the consumer's perspective. The figures show that, on average, most attributes scored somewhat positively: scores on freshness and appearance were most positive, while those on contamination and chemicals (including pesticides, fertiliser, toxic chemicals or poison, and insects) and 'grown naturally' scored lowest. So, although vegetable safety in all aspects could be improved in the perception of the consumer, contamination and not being naturally grown seems to cause the greatest concern. It should be noted that this is the consumer perception of safety and does not necessarily correspond with actual safety of products. Also, consumers often thought that vegetables were not well priced, especially vegetables that are sold as 'safer' (such as organic vegetables, which are often highly priced). This suggests that there might be a particular need for safer but reasonably priced vegetables. Trust in governments, farmers, and retailers for keeping food safe was somewhat positive for all chain actors – but highest for retailers. Fresh markets could be a useful outlet in implementing trust-related interventions, e.g. labelling interventions, since they are the primary one used for purchasing vegetables. Safety and high-quality attitudes were rated highly, but not as high as fresh, good, and neat.

## 4.3    Accessibility, knowledge, and skills

Results on vegetable sourcing showed that, in this sample, only a minority of the respondents (11%) had produced their own vegetables for personal consumption in the past year. Several interventions have been developed to support homegrown vegetables (e.g. Merrey and Langan, 2014), although it is unclear from our data if these have the potential to reach a larger proportion of consumers. Almost all respondents (98%) bought vegetables from outlets in the past week. Fresh markets are by far the most relied on, followed by street vendors and neighbourhood stores, and a small percentage bought from farmer's markets (2%). Supermarkets were not seen as suitable outlets for buying fresh produce. Vegetables gathered from the wild or given as gifts/in kind were not included in this study, since this was not considered an important entry point for intervention.

To obtain more insights into respondents' ability to eat safe vegetables, we measured their knowledge and skills (self-efficacy) around eating healthy and safe vegetables. We also assessed their perceived access to vegetables at different outlets.

Respondents were confident about their skills to purchase and consume safe vegetables, such as their ability to judge the safety of vegetables in the store and their safe kitchen skills. However, they felt less confident about their knowledge of safe vegetables and said they would like to know more about this topic. These results suggest a perceived gap in knowledge contrasting with a high sense of confidence in their own skills. A possible explanation for this discrepancy is an overestimation of their own skills. Earlier research showed that consumers have an optimism bias about their own safety-related behaviour and think food contamination mostly occurs outside their homes, rather than due to their own handling of food (Wilcock et al., 2004). The results show the respondents themselves feel a need for information on vegetable safety, but perhaps more in relation to how the food is produced than home storage or cooking. Qualitative consumer research (such as interviews) is needed to obtain more insights into specific information needs. The current question of "Would you like to know more about the safety of vegetables?" was a single-item

question and needs further exploration. Results on product attributes suggest consumers would like to know more about contaminations, since this was a product attribute they were less positive about.

Access was scored on four dimensions: availability (selection, quality, and quantity), accessibility (travel time, efforts, and costs), affordability, and accommodation (services provided by the vendor). Access of vegetables was generally perceived as being (somewhat) good: aspects of selection, quantities and qualities of vegetables (availability), travel time, distance, and costs (accessibility), operation hours, and trust in seller scored just above 5, indicating these were seen as somewhat good to good. Services to buy on credit, possibility to interact with the vendor, and affordability aspects were scored lower (around 4). Fresh markets did relatively well on availability and accessibility. Street vendor stores scored especially high on accessibility but lower on availability. Compared to other outlets, street vendors scored higher on accessibility but lower on availability. Neighbourhood stores had a very positive pattern, scoring equally well on availability as fresh markets, very high on accessibility, relatively high in affordability (only farmer's markets scored higher), and highest on operation hours and trust in seller. While the farmer's market results should be considered with some caution as this included fewer cases, they still show that this outlet holds appeal for consumers in terms of high product availability at a (relatively) low price; although accessibility scored lower. Expanding farmer's markets and increasing their access might be a way to achieve higher vegetable purchase. Another opportunity perhaps lies in further exploration of possibilities for neighbourhood stores. This outlet scored highly on all aspects of access by respondents who reported this to be their main or secondary source of vegetables; yet it is not as common an outlet for buying vegetables. Finally, improving the selection, quality, and quantities of vegetables at lower prices at street vendors might be a way to achieve higher vegetable purchase, although this requires adaptations to the supply chain.

In light of the results, information shared by governments, farmers, and retailers might not be highly trusted. This poses challenges for interventions, since information provided on safety should come from a trustful source. Neighbourhood stores might be a good outlet since trust in seller was highest at those outlets.

## 4.4    Demographic differences in linkage to accessibility

Clear differences were found between cities but with a mixed pattern. Sikasso is seemingly most at risk for low consumption of safe vegetables, with lowest average vegetable consumption. Meanwhile, highest levels of food insecurity, lowest perceived importance of food safety, and lowest perceived knowledge on the safety of vegetables were found in Bamako, where vegetable intake was higher. There were no reported differences in access to vegetables between the cities. Analysis on demographic differences showed that attention is particularly required for respondents living in urban neighbourhoods, since they consume the least amounts of vegetables and reported higher food insecurity compared to peri-urban areas. In peri-urban neighbourhoods, food safety was considered less important, perceived knowledge on food safety was lower, and access to fresh markets was also lower than in urban areas; although vegetable intake was higher. Access to markets and knowledge and motive on vegetable safety is not a likely explanation for low vegetable consumption. Instead, a possible explanation for lower intake in Bamako and in peri-urban areas might be related to other factors, such as habits and culture. Consumers from slum and low-income neighbourhoods can also be deemed a risk group when it comes to food security (low-income) and vegetable intake (slum), as well are lower access to markets. Respondents from slum neighbourhoods consider food safety less when making choices compared to those in low- and middle-income neighbourhoods – suggesting that safety awareness interventions should target these neighbourhoods. Yet, when using food safety as a selling point, those in slum neighbourhoods might be less receptive than those in other areas. The differences seen between income areas might indicate that safety is considered an expensive luxury, and therefore not for the poor – and may also be associated with lower educational levels, since this has been related to lower knowledge of food-related topics. The other characteristics considered in this study – age and household size – seem less relevant for demographic profiling in relation to selling, since only few differences were found and associations were weak. Some differences were seen between male and female respondents, with findings showing mostly higher vulnerability among women: men had higher intake of vegetables, lower food insecurity, better access to fresh markets, and were more driven by food safety in

their food choices. That said, women reported a higher knowledge on the safety of vegetables. It should be kept in mind that the results are based on a small sample of men.

Some differences in purchase patterns were found. Purchases numbers of vegetables varied among cities, with Sikasso being low in tomato, carrot, lettuce, sweet potato, and cucumber. Purchases of green bell pepper, carrot, amaranth leaves, green beans, beetroot, and fakoye were highest in Kati. Less procurement of spinach, sweet potato leaves, beetroot, fakoye, and okra in slum neighbourhoods was reported. Purchase of half of the types of vegetables, as well as purchase from fresh markets, was higher in urban compared to peri-urban neighbourhoods. It is not clear what underlies these variations – whether it's differences in food patterns, taste preferences, seasonality, or access. Another point for discussion is that few differences in eating and buying patterns were found between men and women in this sample. In general, cultural differences regarding men and women's responsibilities for food purchases and cooking are common in Mali. To be included in our sample, all respondents – male or female – had to be responsible for cooking and/or purchase of foods, suggesting that this is a specific group of men. Men reported higher vegetable intake, higher value of food safety in the choice of food, and more and subjective knowledge – which might also be related to differences in income and/or educational level, with men, on average, more highly educated. Women, on the other hand, reported higher access to neighbourhood stores, which might reflect the fact their daily activities are closer to their homes. However, more women bought vegetables from fresh markets compared to men, while more men bought from neighbourhood stores than women. Interventions targeting neighbourhood stores should keep in mind that women are an important clientele. Interestingly, no differences were found between men and women in access to fresh markets, the main outlet for vegetables.

## 4.5    Entry points for interventions

The results provide several entry points for interventions. Intake of vegetables was common and frequent, but more insights are needed on actual portion sizes. Moreover, purchase variety could be increased for most consumers to include more diverse and nutrient-rich vegetables, such as sweet potato and cowpea leaves. Although the safety of vegetables could be improved in all aspects, the greatest concerns seem to be around contamination (including from fertiliser and pesticides) and produce not being 'naturally grown'. Another entry point is the consumer's need for information on the safety of vegetables and the potential to interact with the vendor on this matter. Information needs seem to be more related to how food is produced than about handling at home, particularly in terms of contamination. While point of sale is the easiest route for information-based interventions, trust in farmers, authorities, and retailers might inhibit their efficacy. In general, access to vegetables was (somewhat) good, but possibilities lie in those outlets that are less often used for buying vegetables – especially neighbourhood stores, since this outlet scored high on all aspects of access. For farmer's markets, decreasing travel time, distance, and effort might be a way to achieve higher vegetable purchase. Finally, enhancing the affordability of vegetables at fresh markets, the outlet most commonly used for purchases, might be a way to achieve higher vegetable purchase.

# Sources and literature

Aertsens, J., Mondelaers, K., Verbeke, W., Buysse, J., and Van Huylenbroeck, G. (2011). The influence of subjective and objective knowledge on attitude, motivations and consumption of organic food. *British food journal*, *113* (11), 1353-1378.

Beal, T., and Ortenzi, F. (2022). Priority micronutrient density in foods. *Frontiers in nutrition*, 379.

Berger, C.N., Sodha, S.V., Shaw, R.K., Griffin, P.M., Pink, D., Hand, P., and Frankel, G. (2010). Fresh fruit and vegetables as vehicles for the transmission of human pathogens. *Environmental microbiology*, 12(9), 2385-2397.

Cabral, D., De Almeida, M. D. V., and Cunha, L. M. (2017). Food choice questionnaire in an African country– application and validation in Cape Verde. *Food quality and preference*, *62*, 90-95.

De Jonge, J. (2008). *A monitor for consumer confidence in the safety of food*. Wageningen University and Research.

Delisle, H., Ntandou-Bouzitou, G., Agueh, V., Sodjinou, R., and Fayomi, B. (2012). Urbanisation, nutrition transition and cardiometabolic risk: The Benin study. *British Journal of Nutrition, 107* (10), 1534-1544

Dowd, K., and Burke, K. J. (2013). The influence of ethical values and food choice motivations on intentions to purchase sustainably sourced foods. *Appetite*, *69*, 137-144.

Frank, S.M., Webster, J., McKenzie, B., Geldsetzer, P., Manne-Goehler, J., Andall-Brereton, G., … and Jaacks, L.M. (2019). Consumption of fruits and vegetables among individuals 15 years and older in 28 low-and middle-income countries. *The Journal of nutrition*, *149* (7), 1252-1259.

Freedman, D. A., Blake, C. E., and Liese, A. D. (2013). Developing a multicomponent model of nutritious food access and related implications for community and policy practice. *Journal of community practice*, *21*(4), 379-409.

GLOPAN. (2020). Future food systems: For people, our planet, and prosperity. Global Panel on Agriculture and Food Systems for Nutrition.

Havelaar, A.H., Kirk, M.D., Torgerson, P.R., Gibb, H.J., Hald, T., Lake, R.J., ... and World Health Organization Foodborne Disease Burden Epidemiology Reference Group. (2015). World Health Organization global estimates and regional comparisons of the burden of foodborne disease in 2010. *PLoS medicine*, *12* (12), e1001923.

Herforth, A., Martínez-Steele, E., Calixto, G., Sattamini, I., Olarte, D., Ballard, T., and Monteiro, C. (2019). Development of a diet quality questionnaire for improved measurement of dietary diversity and other diet quality indicators (P13-018-19). *Current Developments in Nutrition*, 3 (1), 3013575.

Li, S., Wang, Y., Tacken, G.M., Liu, Y., and Sijtsema, S.J. (2021). Consumer trust in the dairy value chain in China: The role of trustworthiness, the melamine scandal, and the media. *Journal of Dairy Science*, *104*(8), 8554-8567.

Macready, A.L., Hieke, S., Klimczuk-Kochańska, M., Szumiał, S., Vranken, L., and Grunert, K.G. (2020). Consumer trust in the food value chain and its impact on consumer confidence: A model for assessing consumer trust and evidence from a 5-country study in Europe. *Food Policy*, *92*, 101880.

Merrey, D.J., and Langan, S. 2014. Review paper on 'Garden Kits' in Africa: lessons learned and the potential of improved water management. Colombo, Sri Lanka: *International Water Management Institute (IWMI)*. 60p. (IWMI Working Paper 162). doi: 10.5337/2015.202

Nord, M., Cafiero, C., and Viviani, S. (2016, November). Methods for estimating comparable prevalence rates of food insecurity experienced by adults in 147 countries and areas. In *Journal of Physics: Conference Series, 772* (1).

Onwezen, M.C., Reinders, M.J., Verain, M.C.D., and Snoek, H.M. (2019). The development of a single-item Food Choice Questionnaire. *Food quality and preference*, *71*, 34-45.

Pacho, F. (2020). What influences consumers to purchase organic food in developing countries?. *British Food Journal, 122* (12), 3695-3709.

Raaijmakers, I., Snoek, H., Maziya-Dixon, B., and Achterbosch, T. (2018). Drivers of vegetable consumption in urban Nigeria: Food choice motives, knowledge, and self-efficacy. *Towards Sustainable Global Food Systems*, *124*, 258-273.

Raaijmakers, I., Snoek, H.M., Obeng, E., Jaspers, P., Madode, Y., Fanou-Fogny, N., & de Steenhuijsen Piters, B. (2023). *Vegetable consumption in the food system of Benin: identifying drivers of consumer behaviour and entry point for interventions* (No. 2023-057). Wageningen Economic Research.

Rajwar, A., Srivastava, P., and Sahgal, M. (2016). Microbiology of fresh produce: route of contamination, detection methods, and remedy. *Critical reviews in food science and nutrition*, *56* (14), 2383-2390.

Snoek, H.M., Pamuk, H., Raaijmakers, I., Janssen, V.C., Chowdhury, K.B., Akter, S.M., and Sijtsema, S.J. (2021). *Consumers' health and food safety perceptions in the Dhaka metropolitan area*. Wageningen University & Research.

Smith, M.D., Rabbitt, M.P., and Coleman-Jensen, A. (2017). Who are the world's food insecure? New evidence from the Food and Agriculture Organization's food insecurity experience scale. *World Development*, *93*, 402-412.

Traoré, K., Parkouda, C., Guissou, A.W.D.B., Kamga, R., and Savadogo, A. (2018). Production, consumption and nutritional content of five neglected vegetables in two secondary cities of Burkina Faso. International Journal of Advanced Research, 6(12), 1144-1155.

Van Assema, P., Brug, J., Ronda, G., Steenhuis, I., and Oenema, A. (2002). A short Dutch questionnaire to measure fruit and vegetable intake: relative validity among adults and adolescents. *Nutrition and Health*, *16* (2), 85-106.

Verain, M.C., Snoek, H.M., Onwezen, M.C., Reinders, M.J., and Bouwman, E.P. (2021). Sustainable food choice motives: The development and cross-country validation of the Sustainable Food Choice Questionnaire (SUS-FCQ). *Food Quality and Preference*, *93*, 104267.

Wilcock, A., Pun, M., Khanona, J., and Aung, M. (2004). Consumer attitudes, knowledge and behaviour: a review of food safety issues. Trends in food science & technology, 15(2), 56-66.

Wilson-Barlow, L., Hollins, T.R., and Clopton, J.R. (2014). Construction and validation of the healthy eating and weight self-efficacy (HEWSE) scale. *Eating behaviors*, *15*(3), 490-492.

World Health Organization. (2006). Five keys to safer food manual. Geneva: World Health Organization.

World Health Organization. (2015). WHO estimates of the global burden of foodborne diseases: foodborne disease burden epidemiology reference group 2007-2015 (No. 9789241565165). World Health Organization. Available online: https://apps.who.int/iris/handle/10665/199350 (accessed on March 18 2021).

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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, 7,600 employees (6,700 fte) and 13,100 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.

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