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Identifying drivers of consumer behaviour and entry point for interventions

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WAGENINGEN UNIVERSITY & RESEARCH

DeSIRA PARTNERSHIPS FOR INNOVATION

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Ireen Raaijmakers[1], Harriette M. Snoek[1], Janvier Egah[2], Elisabeth Obeng[1], Patricia Jaspers[1], Yann Emeric Madode[3], Nadia Fanou-Fogny[4] and Bart de Steenhuijsen Piters[1]

1 Wageningen Economic Research
2 Laboratoire Société-Environnement (LaSEn), Faculté d'Agronomie, University of Parakou, Bénin
3 University of Abomey-Calavi, Laboratory of Food Sciences
4 University of Abomey-Calavi, Section of Human Nutrition

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Despite its health benefits, vegetable consumption in Sub-Saharan Africa is below recommended levels. This report is part of a larger project, 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 the vegetable consumption behaviour of urban consumers in Benin. For this purpose, a literature review was conducted. Results were reviewed and validated by relevant experts in the field of nutrition, health, and food safety in Benin. This was important as most relevant literature referred to the larger context of West Africa. This report describes the results for Benin and identifies potential entry points for enhancing the consumption of safe vegetables.

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

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

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Preface

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 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 far 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 can often not afford vegetables as they are simply too expensive. Also, people have little 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.

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 availability and affordability of healthy diets in West Africa and beyond.

Ir. O. (Olaf) Hietbrink
Business Unit Manager Wageningen Economic Research
Wageningen University & Research

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 availability and accessibility of vegetables and vegetable food safety perception. The first step in achieving this objective was obtaining insights regarding vegetable consumption and buying behaviours of urban consumers living in the focus countries. This was done by conducting an online literature search using multiple search queries. Articles found were screened for relevance based on title and abstract. The main literature findings were validated with relevant knowledge holders in the field of nutrition, health, and food safety. This was important as country-specific literature is lacking, so most relevant literature was placed in the larger context of West Africa. This report describes the results for Benin.

Promising role of priority nutrient-dense vegetables in decreasing nutrition deficiencies and overweight issues

Poor dietary habits, including low fruit and vegetable consumption, is a leading contributor to the burden of non-communicable diseases (NCDs). Recent accurate and reliable data on individual food intake in Benin are lacking. Available data show that vegetables are among the most frequently consumed food groups of urban Beninese consumers; however, consumption remains below recommended levels. The Beninese diet is likely inadequate in iron, zinc, calcium, and vitamins A, B11, and B12. Nutrient-dense vegetables have a promising role in decreasing nutrition deficiencies and overweight problems. Attention should be given to the so-called 'neglected vegetables' (e.g., Yantotoe, Cleomé), which are commonly consumed in Benin.

Role of (leafy) vegetables in foodborne diseases and low awareness of actors in the food supply chain

Foodborne diseases (FBDs) are a major public health problem, significantly impacting the health and well-being of individuals living in Benin. Fruits and vegetables are an important source of contamination. Raw, fresh, and ready-to-eat leafy vegetables and fruits are considered most risky and the source of many disease outbreaks. The causes are most often cross-contamination, unhygienic handling by processors, use of organic fertiliser (e.g. residues of human or animal faeces), and the use of sewage-contaminated water. There is low awareness among actors in the vegetable sector of hygiene issues and diseases associated with vegetable consumption. Additionally, (government) regulations in Benin for vegetables and/or on health safety are lacking.

Motives, drivers, and barriers to vegetable consumption were identified according to the motivation, ability, opportunity (MOA) framework

Health, taste, origin, and safety are the main motives behind West African consumers' vegetable purchases. Visible aspects, such as being damage free, appearing fresh, being a good size and colour, and feeling firm are the main considerations in vegetable purchasing. Beninese consumers are aware of food safety issues regarding vegetables. However, the main constraints to buying safer vegetables are a lack of availability and inability to recognise safe vegetables.

Role of Beninese food environment in making vegetable choices; out of home and supermarkets increasingly important

The current spread of supermarkets and modern retail outlets offer a limited range of vegetable and fruit products compared to traditional markets, including street food vendors in Benin. Out-of-home cooked foods are easily available and commonly consumed in Benin, especially by men. These dishes contribute few vegetables to the diet, though may contain tomatoes, onions, cabbage, or carrots in limited amounts.

Reliable information for consumers on the origin, production, availability, and consumption of vegetables is lacking. As a result, consumers base their purchasing decisions on aspects such as price or vendor relationships.

Importance of the identification of homogeneous consumer groups in promoting vegetable consumption

'Tailoring' is key in successful interventions and/or campaigns for improved vegetable consumption. Segmentation – the identification of homogeneous groups who share perceived preferences, needs, or wishes – can be a way to identify consumers. Correlational studies on vegetable consumption indicate the importance of sociodemographic data, such as income, age, and gender, in identifying consumer segments. Income is particularly significant, as it is considered a constraining factor in vegetable accessibility.

The literature study and knowledge holder meeting identified that the entry points for enhancing safe vegetable consumption in Benin should focus on:

- Vulnerable low-income groups, including both genders
- Both the at-home and out-of-home food environment
- The main food choice drivers, including health (including safety) and taste
- Accessibility within the local food environment
- Improving the ability (knowledge and skills) to recognise safer vegetables

1 Introduction

1.1 Background

1.1.1 The importance of vegetables and their downsides

Currently, most low- and middle-income countries (LMICs) face a multiple burden of malnutrition: undernutrition, micronutrient deficiencies, and overweight/obesity (Popkin et al., 2020). Improving the quality and healthiness of diets, including consumption of micronutrient-rich foods, is viewed as a key strategy in preventing or overturning these forms of malnutrition (Brouwer et al., 2021). Vegetables are considered as crucial in a healthy diet, due to their micronutrient density. Green leafy vegetables are particularly viewed as a priority micronutrient food source (Beal & Ortenzi, 2022). Yet, despite their healthiness, vegetables are not always safe or of a high quality. After animal-based products, vegetables are considered a source of many FBD outbreaks (see Box 1.1). This is especially the case with fresh and ready-to-eat vegetables, green leafy vegetables, and herbs (Berger 2010; Rajwar, Srivastava, & Sahgal, 2016).

Box 1.1 The major health impact of food borne diseases

The World Health Organization (WHO) estimated that, together, 31 major foodborne hazards caused 600 million foodborne illnesses, 420,00 deaths, and a loss of 33 million disability adjusted life years (DALYs) in 2010 (WHO, 2015). As such, FBDs are a major public health problem, greatly impacting health and well-being worldwide – especially in LMICs and Africa (Havelaar et al., 2015; WHO, 2015). The highest burden per population was observed in Africa among children under 5 years of age (40% of the FBD burden).

Definition of FBDs
An FBD can be defined as a disease commonly transmitted through ingested food (WHO, 2015). Most FBDs are infections – caused by a variety of bacteria, viruses, and parasites, or by toxins that naturally or chemically occur in food (Bashkar, 2017). Food hazards can develop at any stage of the food chain, from production and transportation to processing, sales, and consumption (Gizaw et al., 2019).

Emergence of foodborne diseases across the different components of the food system
FBDs are likely to increase in LMICs, due to increased consumption of perishable foods, lifestyle changes, increased population, urbanisation, and the increasing complexities of food supply chains (Bashkar, 2017; Gizaw, 2019; Grace, 2015; Makinde et al., 2020; Mostafidi, Sanjabi, Shirkhan, & Zahedi, 2020). All these factors can occur across different elements of the food system, including food supply chains, food environments, and consumer behaviour, as well as through external drivers (e.g., biophysical and environmental, political and economic, and socio-cultural) that push and pull the system. Box 1.2 provides an overview of potential factors (found in literature) which cause FBDs and how these transpire across the food system.

Box 1.2 Activities within food system elements that can contribute to FBD outbreaks

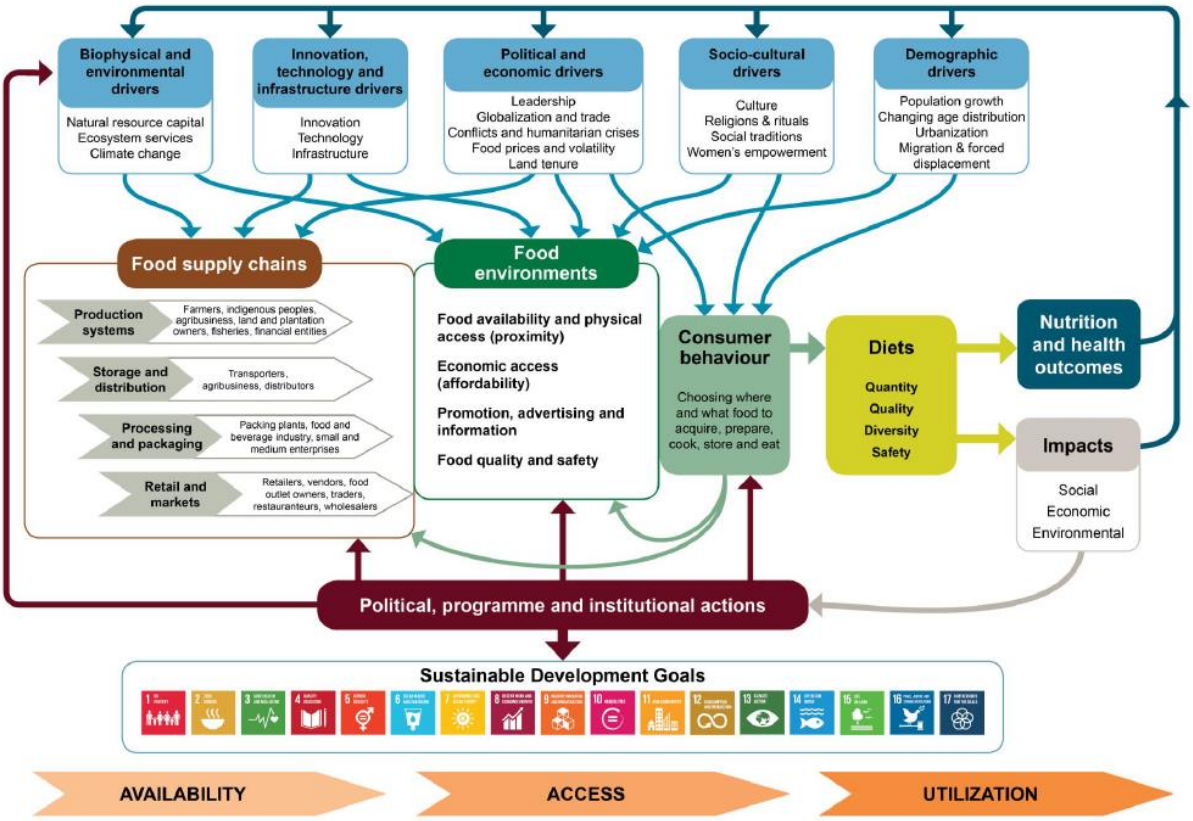

Figure 1 *Conceptual framework of food systems for diet and nutrition; copied from HLPE (2017)*

Food supply chains
- Increased lengthening, broadening, and complexity of food supply chains
- Exposure to contaminated water (irrigation or flood)
- Contaminated soils and groundwater
- Use of fertilisers (crude or organic fertilisers, hygienic quality of fertilisers)
- Microbiological and chemical contamination of foods
- Poor food handling after harvesting (e.g., use of wrong/unhygienic harvesting and processing equipment, wrong/infected storage locations, transportation)

Food environment
- Availability of outdated foods/foods past their use-by-dates
- Availability/use of low-quality foods (adulterated foods, (visibly)affected foods)
- Mislabelling
- Unhygienic vending practices (poor personal hygiene, use of potable water, food is not properly processed/prepared, improper washing of vending utensils)
- Dirty surroundings

Consumer behaviour
- Use of low-quality foods (adulterated foods, (visibly)affected foods)
- Unhygienic cooking practices
- Lack of insights and knowledge on the adverse effects of consuming contaminated foods
- Lifestyle changes

Drivers
- Pollution of air, water, and soil
- New/other food technologies
- Non-existent or inadequately enforced regulations
- Poverty
- Urbanisation
- Industrial growth
- Economic development

Sources: Bashkar (2017); Gizaw (2019); Grace (2015); Makinde et al. (2020); Mostafidi et al. (2020).

Considering the different elements of (local) food systems is crucial if the SafeVeg project is to achieve its aims.

Steering role of consumers within the food system
Local food systems are dynamic, complex, and constantly evolving. Consumers and their diets play a central role within these, as they can influence the system through food demand. Meanwhile, consumer food choices and perceptions are guided by physical, social, economic, and cultural structures within the food environment, together with other food environment characteristics (e.g., availability, affordability, advertisements, and food quality and safety), individual characteristics (e.g., attitudes, knowledge, demands, and barriers), and external drivers (e.g., politics, regulation, urbanisation). Having a better understanding of these drivers and the food environment will contribute to identifying and implementing interventions that can lead to greater access to affordable foods and the sustaining of healthy diets. This perspective is supported by Brouwer et al. (2021), who argue that taking a healthy diet perspective, instead of a production-focused approach, in food system transformation is essential to reversing current trends towards unhealthy and unsustainable diets. SafeVeg's Work Package 2 also takes this stance: looking at current levels of vegetable consumption and consumers' concerns regarding vegetables in the food environment.

1.2 Research aim and research questions

The overall aims of the literature study and the knowledge holder meeting were to:
- To get insights into the consumer vegetable consumption behaviour in the three focus countries of the SafeVeg project: Benin, Burkina Faso, and Mali
- To validate the results evolved from the literature search
- To fill identified knowledge gaps
- To shortlist potential interventions

The following research questions were formulated:
- What is the vegetable consumption behaviour of (peri-)urban consumers living in the focus countries?
- What are the motives, drivers and barriers for urban consumers to buy and consumer (safe) vegetables?
- What are consumer perceptions of health and food safety of vegetables?
- What is the consumer awareness on food safety of vegetables?
- What is the interface between the consumer and the food environment?
- What are consumer information sources for foo safety and how do they think about these sources?
- What are consumer segments that can support more targeted interventions?

1.3 Approach

This report on Benin includes the main results from the conducted literature search and knowledge holder meeting. A structured literature search was conducted in Scopus, CAP-abstracts, PubMed and Psych-info that combined search terms related to the region (including countries, cities, regional – e.g. sub-sharan Africa), vegetables (general and specific) (see Appendix 1). This search included all papers on vegetables in the research area, resulting in 2,011 results that were checked for duplicates and then for relevance based on title and abstract in relation to the research questions. The structured search was complemented with literature suggested by knowledge holders and by snowball technique. The knowledge holder meeting was organised on 27 January 2022 at the World Vegetable Center office in Benin. Twelve experts and knowledgeable persons in the field of nutrition, health, food safety, food systems, policy and research from different organisations (e.g. (local) governments, universities, research organisations, industries, NGOs) participated in the discussion. Based on the main findings of literature two statements per theme were formulated. In total five different themes were discussed: the role of vegetables in the diet, safety of vegetables, motives, drivers and barriers to vegetable consumption, food system drivers and consumer segmentation. A separate report of this meeting was drafted.

1.4 Outline of the report

The report is structured into two sections, which highlight vegetable consumption among urban consumers in Benin. Section 2 covers: the role of vegetables in the diet (Section 2.1); vegetables and food borne diseases (Section 2.2); motives, drivers, and barriers of vegetable consumption (Section 2.3); vegetables and the food environment (Section 2.4); and consumer segmentation (Section 2.4). Each subsection has the same structure:

1. Results of the literature search, applied as much as possible to the local context of Benin. However, it should be noted that results could be placed in the larger context of West African countries, as literature is lacking.
2. Reflection and validation of the literature results by experts and knowledgeable persons in the field of nutrition, health, food safety, food systems, policy, and research from different organisations.
3. Section 3 provides overall conclusions and recommendations for further research and potential interventions.

2 Results

2.1 Nutritional deficiencies in Benin and the bridging potential of priority nutrient-dense vegetables

Key messages

- Recent, accurate, and reliable data on individual food intake are lacking in Benin.
- Geographical area, age, educational level, and socio-economic well-being influences body mass index (BMI) levels. In Benin, underweight is an issue; however, overweight is increasing particularly among adults.
- Vegetables are among the most frequently consumed food groups in Benin, although recommended daily intake levels are below recommendations. Significant differences in intake between urban, peri-urban, and rural areas were reported in literature.
- Consumption of vitamins E, B11, and B12, iron, calcium, and zinc is inadequate in Benin.
- Nutrient-dense vegetables have a promising role in overcoming the identified micronutrient deficiencies.

2.1.1 Main results from the literature

Recent, accurate, and reliable data on individual food intake are lacking

Recent, accurate, and reliable data on individual food intake level in LMICs, including Benin, is lacking (e.g., Afshin et al., 2019; Global Panel on Agriculture and Food Systems for Nutrition, 2016; Micha et al., 2015). Studies into individual food consumption are mostly limited, scarce, and non-recurring, meaning estimated consumption levels may deviate from actual consumption. Moreover, study samples are not always representative and, due to the lack of standardised and validated dietary assessment methodologies, use different methods (e.g., dietary recall, 24H recall, Dietary Diversity Score (DDS)) to measure intake – and this makes comparisons difficult (Vila-Real, Pimenta-Martins, Gomes, Pinto, & Maina, 2018). Due to the lack of data, surveys in the field of nutrition and intake (the Demographic and Health Survey (DHS), Nutrition Landscape Information System (NLiS), and smaller studies conducted in Benin) were used to obtain insights into food and vegetable consumption among the Beninese and to identify nutrition gaps in adults and women. The findings of these studies are included in the subsections below.

Underweight is still an issue; however, overweight is increasing strongly

In a nationwide sample conducted in 2016, the average BMI of Beninese men was 22.7 and 24.6 for women (Abarca-Gómez et al., 2017). BMI levels differ across geographical area, age, educational level, and socio-economic well-being. Persons living in urban areas have a higher BMI than those in rural areas. In 2017, the mean BMI level among men living in urban areas was 23.4 – and, in rural areas, this was 22.1. For women, the mean BMI was 25.5 in urban areas and 23.3 in rural areas (NCD Risk Factor Collaboration, 2019). In both genders and geographical areas, mean BMI levels are increasing.

Looking at Beninese women of reproductive age (15-49 years) more specifically, the prevalence of both underweight (BMI ≤ 18) and overweight (BMI ≥ 25) increased from 2006 to 2017/2018 (INSAE & ICF, 2019): from 9% to 11% and 19% to 26%, respectively. BMI differences in this group were found between age, educational level, socio-economic well-being, and geographical area. Older Beninese women, living in an urban area, and with a higher educational level or higher socio-economic well-being, are more likely to be overweight (INSAE & ICF, 2019).

Vegetables are among the most frequently consumed food groups, although recommended daily intake levels are not being achieved

Several small studies identified the most often consumed food groups among urban Beninese consumers. However, comparison is difficult as most used different methodologies to assess intake and identified slightly different food groups. Overall, the following food groups are most often consumed (these were consumed by

more than 50% of respondents): grains/cereals (including wheat, rice, maize, sorghum etc.); vegetables; pulses; nuts and seeds; roots, tubers, and plantains; fish and seafood; oils and fats; and miscellaneous (spices, sweets, etc.) (Delisle, Ntandou-Bouzitou, Agueh, Sodjinou & Fayomi, 2012; Houessou, van de Louw & Sonneveld, 2020; Sodjinou, Agueh, Fayomi & Delisle, 2009). The most frequently consumed staple food in Benin is maize, and fish in the category of animal products (Leyvraz et al., 2018). Maize paste (owo) is the most common grain preparation and is always accompanied by a spicy tomato or vegetable sauce to which groundnut or red palm oil and fish are often added (Sodjinou et al., 2019).

Although vegetables are among the most frequently consumed food groups, a study conducted in 28 LMICs (including Benin) on fruit and vegetable consumption among individuals aged 15 years and above showed the average vegetable intake was 1.63 servings per day (1 serving was estimated at 80 g). In Benin, the combined fruit and vegetable intake was 3.81 servings per day, meaning that intake doesn't meet the recommendations of WHO's '5 servings a day' (Frank et al., 2019). Significant differences in intake between urban, peri-urban, and rural areas were found. Urban Beninese consumers eat significantly less of cereal, legumes and nuts, fish, and fruit and fruit juice. Meanwhile, consumption of meat, dairy, and vegetables is higher in urban areas (Desile et al., 2012).

Priority nutrients are vitamins E, B11, and B12, iron, calcium, and zinc

Fifty-eight per cent of reproductive age women in Benin suffered from anaemia in 2017/2018 (INSAE & ICF, 2019). The prevalence of anaemia decreased slightly in this group from 61% to 58% in the period 2006 to 2017-2018. It should be mentioned that the prevalence of anaemia is higher in pregnant women compared to other women in the same age category. Prevalence also differs per department in Benin. In the selected urban areas in Benin for the SafeVeg study, 51.1% of the women in Borgou (department of Parakou) suffered from anaemia, and this figure was 60.7% in Littoral (department of Cotonou). Numbers from the NLiS of WHO show that just under half of Beninese women of reproductive age suffer from anaemia, although agree that prevalence increases among pregnant women (WHO, 2019).

In LMICs, diets are often inadequate in iron, zinc, vitamin B11 (folate), vitamin A (retinol), calcium, and vitamin B12 (cobalamin) (Beal & Ortenzi, 2022). This largely corresponds with the results of studies conducted in Benin. Sodjinou and colleagues (2009) identified dietary patterns of urban Beninese adults living in Cotonou (N=200) and explored their link with overall dietary quality and socio-demographics. They found that less than 50% of the study sample met the recommended daily intake (RDI) of the following micronutrients: vitamin E (tocopherol), vitamin B11 (folate), vitamin B12 (cobalamin), calcium, iron, and zinc (Sodjinou, Agueh, Fayomi & Delisle, 2009). This was supported by Delisle et al. (2012), who conducted a study in Benin and found that a low proportion of their sample (N=541, including urban, peri-urban, and rural) met the RDI of these vitamins and minerals. This was also confirmed by another study conducted for the development of a food guide in Benin. Their revealed that dietary intake of iron, calcium, zinc, vitamin B12 (if no animal sources of protein are consumed), and vitamin B11 did not meet the recommendations (Levesque, Delisle & Agueh, 2015). The study by Delisle et al. (2012) found that residing in an urban area (Cotonou) was related to lower quality diet in terms of micronutrient adequacy, compared to peri-urban and rural areas. More specifically, it was found that participants living in Cotonou were less likely to meet the RDI of vitamins B1 (thiamin), B2 (riboflavin), B3 (niacin), and B5 (pathothenic acid), and iron, calcium, and zinc.

Nutrient-dense vegetables have a promising role in overcoming micronutrient deficiencies

Foods provide nutrients to the body. It is important that diets include a variety of foods with varying nutrients. Top sources of priority micronutrients in LMICs (iron, zinc, calcium, Vitamin B11 and Vitamin B12) are animal source foods, especially organs and small fish, and green leafy vegetables (Beal & Ortenzi, 2022). Vegetables are promoted as healthy due to their nutritional content, and their health benefits are well known and reported. Table 2.1 provides an overview of the different vegetable sub-groups, including the most commonly consumed sentinel vegetables, together with their typical health associations.

Table 2.1 *Overview of the different vegetable sub-groups and their health associations for sentinel vegetables in Benin*

Sub-group	Health associations	Sentinel vegetable types in Benin
(Dark) green leafy vegetables (GLV or DGLV)	Contribute to iron, vits C and A, and folate intake	Leaf sauce, crin, gboman, ironweed (vernonioa), cassava leaves, moringa leaves, bean leaves, okra leaves
Red, orange and yellow vegetables	Contribute to vit A and folate	Carrots, orange sweet potatoes,
Cruciferous vegetables	Positive association with coronary heart disease and total cancer	Cabbage
Other vegetables		Tomato, eggplant, okra, beet, cucumber, green bell pepper, green beans, mushrooms

Source: Sentinel fruit and vegetables (from the Dietary Quality Questionnaire).

2.1.2 Reflection by knowledge holders

The following statements match the main findings from literature and were discussed during the knowledge holder meeting:

1. SafeVeg should focus on green leafy vegetables, as these are rich in nutrients – and thus help reduce nutritional deficiencies and overweight problems.
2. Potential key vegetable types for SafeVeg are amaranth (fotètè), African eggplant (gboma), jute Mallow, bitter leaf (vernonia), cowpea leaves (vigna unguiculata), cabbage (brassicaceae), okra (fruit and/or leaves) (abelmoschus esculentus), tomato, and onion.
   Indicators, such as the potential effect on health, consumption, accessibility, and acceptability, are identified to select the most interesting vegetables for SafeVeg.

Both the above statements were validated by the Beninese expert panel, and their discussions show that:

- Focus should be on green leafy vegetables, as these are nutrient dense and contribute to decreasing nutrition deficiency and overweight problems. The above listed potential key vegetables were endorsed, although additional attention should be given to the so-called neglected vegetables (Yantotoe, Cleomé, etc.).
- In choosing vegetables for the project, the level of contamination by plant protection products needs to be considered.
- Method of preparation is important. Consumer awareness about preparation methods should be raised, as it would help improve vegetable consumption and ensure the bioavailability of nutrients in vegetable dishes.
- Documentation on vegetable nutrient content would be very useful to serve as a basis for vegetable selection.
- The vegetative cycle stage of the vegetable at time of harvesting must be studied in relation to nutritional value.

2.1.3 Conclusions

There is an agreed need among consulted stakeholders to promote vegetables that are nutrient dense and sources of priority micronutrients (e.g., green leafy vegetables) in Benin. Promoting these specific types of vegetables is related to increased accessibility, acceptability, and food safety perceptions. Attention should also be given to so-called neglected vegetables, which are commonly consumed in Benin.

2.2 Foodborne diseases and their relation to vegetables

Key messages

- Fresh and ready-to-eat vegetables, herbs, and fruits, are particular sources of many disease out-breaks caused by cross-contamination or contaminated water.
- Pesticide residues were found in prepared food that included tomatoes and leafy vegetables.
- For chemical contamination, highest risks are among staples, peanuts, oils, and smoked fish.
- In general, there is a lack of food safety regulation and a lack of registration of outbreaks.

2.2.1 Main results from the literature

Raw and fresh vegetables are the riskiest for cross-contamination

In developing countries, foodborne illnesses caused by contaminated fruits and vegetables are frequent – and, in some areas, account for a large proportion of foodborne illnesses (Grace 2015). Fresh, perishable produce sold at informal markets, and packaged ready-made foods are – despite their importance to health and food safety – considered to be high risk for contamination (Grace, 2015; Makinde et al., 2020; Mostafidi et al., 2020). Much research into foodborne human pathogens has focused on transmission from foods of animal origin. However, recent investigations have identified fruits and vegetables, especially fresh and ready-to-eat vegetables, herbs, and fruits, as the source of many disease out-breaks (Berger et al., 2010). Makinde and colleagues (2020) reviewed papers on microbial contamination of ready-to-eat foods in LMICs and showed that these foods are of great importance for health but are also high-risk for contamination. Fruits and vegetables, particularly leafy greens that are consumed raw, are important vehicles for transmitting human pathogens that were traditionally associated with foods of animal origin. Yet, the frequency of gastrointestinal illness associated with fruits and vegetables appears to be low compared to products of animal origin (Rajwar et al., 2016).

Outbreaks have been reported involving a range of bacterial, viral, and protozoan pathogens (Rajwar et al., 2016). A major source of vegetable contamination is organic fertiliser and faecal contaminated water. Many parts of Sub-Saharan Africa rely heavily on ecosystem services for water, and sewage water and sludge are used in agricultural production. Peri-urban vegetable producers in West Africa often use sewage water for irrigation (Kitinoja, Saran, Roy, & Kader, 2011). Infrastructural deficits, including lack of potable water, result in food contamination that leads to illness. Almost any ready-to-eat fruit or vegetable that has been contaminated with pathogens – either from the environment, human or animal faeces, or through storage, processing, and handling – could potentially cause disease (Rajwar et al., 2016). In a review study by Makinde et al. (2020) on ready-to-eat foods in LMICs, contaminations were found to often be due to poor personal hygiene of processors; poverty; lack of awareness into the adverse health effects that can arise from consuming contaminated foods; and non-existent or inadequately enforced regulations.

Chemical contamination and pesticide residues in the diet

WHO has published several reports and factsheets on the health hazards of pesticides. One line of research is to set maximum limits and good agricultural practices to protect agricultural workers that apply pesticides, along with those in the immediate area during and immediately after pesticides are spread at work, home, or in gardens (e.g., https://www.who.int/news-room/fact-sheets/detail/pesticide-residues-in-food). Risk of consumer exposure to pesticide residues in food are monitored by the Joint Meeting on Pesticide Residues (JMPR), facilitated by the Food and Agriculture Organization of the United Nations (FAO) and WHO.

Box 2.1 Methodologies for defining health impact

Residue exposure calculations are made via a combination of pesticide residue concentrations in foods and individual food consumption – but is complicated by unavailability of detailed, recent, and representative data in all countries. By combining such exposures with toxicological studies, the impact on health can be determined. However, determining the health effects of chemicals is very complex, due to various exposure routes and the multiple causes of health outcomes (Ingenbleek et al., 2020): 'Many food chemicals, including heavy metals, mycotoxins, pesticide residues, and industrial contaminants, are associated with a series of non-communicable diseases.'

An assessment of acute dietary exposure to 38 pesticides showed no appreciable risk among populations of adults and children in eight high-income countries (Crépet et al., 2021). In contrast, the occurrence of risky levels of pesticide residues in vegetables was reported in a review on studies conducted in Africa (Olisah, Okoh, & Okoh, 2020). Further, a recent study on exposure to chemicals in Sub-Saharan Africa countries including Benin showed multiple risks (Ingenbleek et al., 2020). In this study, risks were calculated based on prepared foods that covered 90% of typical diets in Cameroon, Benin, Nigeria, and Mali. For many of the chemicals analysed, human dietary exposures were below levels of toxicological concern thought to present risk of adverse effects. High exposure to several mycotoxins, polycyclic aromatic hydrocarbons, lead, and aluminium were identified. Some artisanal kitchen utensils made from recycled aluminium are likely to increase the lead and aluminium content of foods, particularly when preparing acidic foods, such as tomato that will cause extra dissolving of metals to the food. Pesticide residues were found in a range of prepared foods, including tomatoes and leafy vegetables. However, the main food contributors to resides and chemicals in the diet were staples (maize, sorghum, rice, millet, cassava), peanuts, oils, and smoked fish (Ingenbleek et al., 2020). Finally, a seasonal effect has been reported, with pesticides more frequently detected in samples collected during the wet season (Ingenbleek et al., 1999).

Lack of food safety regulations and a lack of registration of outbreaks

In addition to poor capacity for enforcing regulations, epidemiological traceability is difficult for fruits and vegetables as carriers of foodborne pathogens. (Rajwar et al., 2016). Due to the lack of FBD investigation and surveillance in many LMICs, most outbreaks go undetected and the scientific literature reports only a few cases. In their review, Chatziprodromidou and colleagues (2018) found only two reported outbreaks in Africa.

2.2.2 Reflection by knowledge holders

The following statements match the main findings from literature and were discussed during the knowledge holder meeting:

1. Leafy vegetables and tomatoes can contribute to FBDs (micro-biotics and chemicals) in Benin. It is unknown if other vegetables contribute (types/species of vegetables and treatment). It can be assumed there are no regional differences.
2. (Government) regulations on health safety are lacking in Benin.

Both statements were validated by the Beninese expert panel, and their discussions show that:

- Leafy vegetables and fruits contribute to foodborne illnesses, especially in the raw or fresh state.
- Awareness among actors in the vegetable sector on issues of hygiene and diseases associated with the consumption of contaminated leafy vegetables and fruits is low.
- Burkina Faso seems to have already put in place microbiological controls of street food, whereas in Benin the experts mentioned that there needs to make greater efforts in this area.
- Regulations specific to vegetables or street food are lacking in Benin. In the meantime, one can apply national regulations on food hygiene and international standards, pending their adaptation to the context of Benin.

2.2.3 Conclusions

According to the literature, vegetables are not the main source of foodborne contamination, but leafy vegetables and fruits do contribute to foodborne illnesses – especially in their raw or fresh state. Stakeholders consulted in this study agreed and added that awareness of the risks among actors in the Beninese vegetable production and vending chain is low. Another finding in literature, supported by stakeholders, is that (government) regulations on food health and safety are lacking in Benin and international standards should be tailored to the country. Future research could explore consumers' views on the food safety risks of vegetables (see also paragraph 2.3), along with trust in chain actors for producing and in authorities for regulating vegetable safety.

2.3 Motives, drivers, and barriers

Key messages

- Effective behaviour change interventions combine Motivation, Ability, and Opportunity (MOA) and for that reason, the MOA framework was used to identify drivers of consumer vegetable intake behaviour.
- Research in Benin or West African countries comparing motivations related to different types of vegetables is lacking.
- Food choices are driven by personal values and preferences: for vegetables, appearance was the main motive for consumers, although safety and nutritional content were also important.
- Opportunity is related to accessibility, availability, and affordability; in general, access to safe vegetables is a constraint.
- Ability to recognise safer vegetables is related to knowledge and skills: consumers are aware of food safety issues, but lack the skills and information.

2.3.1 Main results from the literature

The motivation, ability, opportunity framework was used to identify drivers of behaviour

One of SafeVeg's aims is to reduce undernourishment by increasing vegetable intake through making them more accessible, acceptable, and safe. To provide input for the innovative pilots and scaling up of interventions, we include a behavioural framework for behavioural change: the Motivation, Opportunity, and Ability (MOA) framework (ThØgersen, 1995; Flynn et al., 1999). According to this framework, people need the motivation and the environmental or contextual opportunity to perform healthy behaviours, such as eating healthily. Additionally, they need to be able to conduct the intended behaviour – making ability the third factor. Ability refers to skills and knowledge related to healthy behaviours. On one hand, these include more practical skills, such as cooking techniques for preparing vegetables; while, on the other, it includes more general knowledge on healthy diet (such as recommended vegetable intake, safety risks, etc). In this chapter, we review studies that included elements of the MOA framework. Outcomes are structured with motivation, ability, and opportunity separately, although there is interconnection and overlap between them. When possible, studies included focus on safe and healthy vegetable consumption in LMICs, but some more general studies were also included. Studies on organic foods were also included, since this is a widely researched category that is relevant to consider – as organic foods are free from chemicals such as fertilisers (Vihotogbe-Sossa et al., 2012). Few studies specifically addressed Benin, one on attributes of tomatoes (Adegbola et al., 2019), one organic vegetables preferences (Couliabably et al., 2011), one on chemical contamination awareness and willingness to pay for organic vegetables (Probst et al., 2012), and one on willingness to pay for cabbage with minimal pesticide residues (Vidogbéna et al., 2015). Therefore, also other studies in African populations and general review studies were included.

Choosing vegetables: health, taste, origin, and safety are main motives for consumers; appearance is a main product attribute

Food choices are motivated by personal values and preferences, and are therefore closely related to how consumers value certain product attributes. An important factor is characteristics – such as appearance and price – which can be judged by looking at a product; while extrinsic attributes are those that can only be judged by experience, such as taste. Product attributes, such as taste, colour, price, availability, nutrition, and health benefits are considered important when making food choices for tomatoes in urban Benin

(e.g., Adegbola et al., 2019). Interestingly, the importance of these variables is related to income or socio-economic status (see chapter 2.5). In Ouagadougou (Burkina Faso), demand for organic vegetables was higher if consumers prioritised their health. Health prioritisation significantly increases the probability that consumers will frequently buy organic vegetables at production sites. In other words, consumers who care more about the healthy attributes of food for consumption are more likely to be motivated to frequently buy organic food from production sites. The main reason respondents gave for buying organic foods were: health-related attributes, clean water used to irrigate the crops, and hygiene practices surrounding the production process (Kini, Pouw, & Gupta, 2020). Similarly, in urban Mali, health value was a significant predictor of health behavior identity, which was in turn related with attitudes toward behavior and perceived barriers for fonio grain consumption (Fanou-Fogny, 2011).

In a study focused on tomatoes, six major attributes were posed to Beninese consumers during their decision to choose a tomato: colour, duration of conservation, conservation, taste, origin of varieties, and price (Adegbola et al., 2019). The origin and taste represent the two most important attributes, accounting for 27% and 23%, respectively, of the total preference. These attributes were followed by the colour of the tomato, contributing to 22% of the total preference. The consistency of the varieties and their price were relatively less important (8% and 1% of the total preference, respectively). Four market segments were identified, based on the expressed preferences and the socioeconomic and demographic characteristics of the Beninese consumers. Two segments have a great preference for local tomatoes, those that can be conserved over a long period, and a third segment consisted of consumers that preferred tomatoes with a firm consistency. Only one segment of consumers prioritised price in their preference.

Several consumer motivations to eat organically were reported in literature reviews: environmental concerns, health concerns, and nutritional value of organic foods; ethical concerns and animal welfare for organic meat; perceived food quality, including taste; food safety; and symbolism and status, such as a new lifestyle trend (Eyinade, Mushunje, & Yusuf, 2021; Katt & Meixner, 2020; Pacho, 2020). Additionally, consumers also consider other aspects (motives) when choosing food, such as appearance and freshness (shelf-life) and information such as labels. For example, willingness to pay was higher when products had an organic label, were certified, and had a traceability label. The relevance of such motives for LMIC consumers was reviewed by Pacho (2020). They concluded that a main motive in developing countries for consuming organic foods is taste, in contrast to developed countries, where health concerns have been reported as the main motive. Most consumers are convinced that organic food tastes better. In addition to taste, freshness, the colour of fruits and vegetables, and the perception of high nutritional value positively influenced willingness to purchase organic foods in developing countries. In a study conducted in urban Benin and Ghana on organic vegetables, consumer preferred vegetables that were damage free, and also selected vegetables according to freshness, size, colour, and firmness (Couliabably, Nouhoheflin, Aitchedji, Cherry & Adegbola, 2011). In a South African study, organic foods were also considered more environmentally friendly, safer, and of higher quality (see Pacho, 2020, for details). Finally, in a Tanzanian study, locality seems an important attribute, since organic tomatoes produced in their own country were preferred over imported ones from South Africa. Pacho (2020) concluded that, in general, interest around organic foods is rising in developing countries, partly because of consumers have become more knowledgeable about food safety and health. Similarly, in a recent review study by Eyinade et al. (2021), human health, food safety, attitudes and perceptions, and willingness to pay for a price premium, are some factors influencing willingness to consume organic foods. Research comparing motivations related to different types of vegetables is lacking.

Opportunities for safe vegetable consumption: in general access is a constraint for consumers
Opportunity is related to accessibility, availability, and affordability. In a study in Ouagadougou, the distance travelled by consumers and the expected utilisation of food were two major determinants of organic vegetable demand (Kini et al., 2020). Distance negatively affected demand, especially among women who are poorer and have fewer transportation options than men. In another study in Ouagadougou, urban consumers ranked six major constraints to accessing fresh vegetables, with inadequate supply being the most pressing (Shafiwu, Donkoh, & Alhassan, 2018). The second-ranked constraint was lack of trust in market vendors: consumers perceive that vegetable vendors are driven by profit motives and charge high prices for vegetables under the pretence that they are safe. The other constraints were: 3. Distance to the purchasing outlet/point of safe vegetables; 4. Higher prices; 5. Lack of adequate information on safe vegetables; 6. Cultural barriers. In a Ugandan study on pesticide-stained tomatoes, the main reason these

tomatoes are bought is because the majority of consumers (59%) lacked an alternative (Sekabojja, Atuhaire, Nabankema, Sekimpi & Jors, 2021).

Several studies have investigated demographic differences in willingness to pay. A recent review assessed global consumers' willingness to pay for organic foods. Although, in general, willingness could not be related to a demographic profile, in developing and emerging countries, a substantially higher share of studies found a positive association between income level and willingness to pay (Katt & Meixner, 2020). In a study in two cities of Benin, all consumers were willing to pay a price premium (average of 38%) for cabbage with minimal pesticide residues. Women, older, highly-educated consumers, and those able to distinguish cabbage qualities were willing to pay the most (Vidogbéna et al. 2015). Willingness to pay premium prices for safer vegetables was also related to higher income-generating employment in Ghana (Cobbinah, Donkoh, & Ansah, 2018). In a study in Burkina Faso, a very high percentage of respondents (99%) were willing to pay more for safer vegetables. In this study, safer was defined as being produced with clean irrigation water, pesticide-free, free-from agrochemical usage, and the soil was tested. For different types of vegetables, consumers were willing to pay between 59% and 100% extra. Willingness to pay for safer vegetables was significantly influenced by consumers' income, education, household size, and health concerns (Shafiwu, 2017; Shafiwu et al., 2018). Similarly, in a study in urban Benin and Ghana, consumers were willing to pay a premium of more than 50% for synthetic pesticide-free vegetables, and willingness to pay was positively related to income level (Couliabably et al., 2011).

Many urban consumers in Ouagadougou (Burkina Faso) buy vegetables at traditional markets (roadside and farm gate), but there has been rapid expansion of 'non-traditional' retail outlets – and research interest around these is building (Shafiwu et al., 2018). Most consumers in this study (53%) considered roadside markets the preferred outlet to buy safer vegetables, 31% preferred the supermarket, and the remaining 16% the farm gate. This suggests that other outlets than traditional markets could be further explored as possible points of selling safer vegetables. Another option is through out-of-home consumption. Probst et al. (2012), studied consumers' willingness to pay for organic vegetables in urban Benin, Ghana, and Burkina Faso, and suggest concentrating marketing efforts on the educated 'elite' who frequent restaurants. However, restaurant owners in the study exhibited a lower preference for organic certification than lower-class food vendors.

Ability: consumers are aware of food safety issues regarding vegetables, but recognising safer vegetables is an issue

Awareness

Consumers only take food safety precautions when they perceive a risk. If they lack awareness, knowledge, and skills to buy, prepare, store, and consume food in a safe way, they may be acting out of habit and make food handling mistakes because they lack 'cues to action'. Several studies have addressed the issue of awareness when it comes to vegetable safety. Probst et al. (2012), found that, generally, awareness of chemical contamination risk was low in urban Benin, Ghana, and Burkina Faso. In contrast, Couliabably et al. (2011) found that urban consumers in Benin and Ghana were aware of the heavy use of synthetic pesticides on vegetables. Awareness of chemical residues and health risks was also related to higher willingness to pay for organically grown vegetables, showing potential demand for synthetic pesticide-free vegetables. Similarly, in a study in urban Benin, results indicated that consumers are aware of the health risks associated with intensive pesticide use (Vidogbéna et al., 2015). In a recent study by Sekabojja and colleagues (2021) in Uganda, only 5% of consumers reported a high risk perception towards tomatoes stained with pesticide residues. The rest (95%) bought pesticide-stained tomatoes despite awareness about the possible health effects because they lacked an alternative. Consumers generally had a negative attitude towards pesticide-stained tomatoes, with 67% of consumers disagreeing with a statement that tomatoes sold at the market are safe. Consumer risk perception was significantly associated with consumer awareness about residues in the tomatoes: consumers who were aware of the risk of pesticide stained tomatoes were 42.8 times more likely not to buy stained tomatoes compared to those who were not aware.

The dimension of ability to eat healthy foods is not only about awareness: consumers also require the knowledge and skills to act. However, not much research has been reported on this topic for vegetable consumption in our focus countries. Also, consumers are only to some extend able to judge safety from the

product, especially when this related to production processes. For example in a study by Vidogbéna et al. (2015), respondents were unable to recognise the difference in quality between cabbages produced under nets and those on which pesticides had been used. At the same time, consumer were aware of pesticide health risks and those who felt able to distinguish cabbage qualities were willing to pay the most for cabbages with minimal pesticide residues. One opportunity lies in building relationships with vendors, to increase insights around where vegetables were produced and thus increase trust in safety.

Consumer – vendor relationships, trust, and traceability
Maintaining loyal social ties with customers is a strategy used by vendors, especially by small businesses, to better sell vegetables and perishable products in a highly competitive context (Adéchian, Baco, Olarinde, Moumouni, & Natcher et al., 2021). In addition to the social value that consumers appear to attach to vendors and production sites, the traceability and possibility of producer interaction also increases the likelihood of consumer demand (Kini et al., 2020). To ensure customer loyalty and improve customers' satisfaction, courtesy visits to market retailers and, in some cases, the establishment of credit based on future sales, are strategies aimed at maintaining trust and links between producers and customers (Adéchian et al., 2021). In a study by Cobbinah et al. (2018), the Ghanaian consumers willing to pay premium prices are those who trust traders and care about the use of untreated wastewater for irrigation. In a study in Ouagadougou, organic foods were bought directly by 98% of consumers, rather than through resellers or intermediaries. This shows that consumers value the quality and traceability of the food they eat. For instance, consumers asserted: 'Here, it is better because the products are directly harvested and sold at the farms compared to the market place' or 'it is because of the good quality of the food compared to what is sold at the market place as it is difficult to know if the food there is organic or not' (Kini et al., 2020). Short food chains provide an opportunity to build producer-consumer relationships by giving clear signals about the origin (traceability) of food products.

2.3.2 Reflection by knowledge holders

The following statements match the main findings from literature and were discussed in the knowledge holder meeting:

- Appearance is the main aspect on which consumers base their choices. Safety and nutritional content are also important, but more insights are needed about how consumers judge this and the differences between types of vegetables.
- The most effective intervention combines increased availability of vegetables with increased consumer ability to recognise safer vegetables. There is no need to increase consumers' awareness or motivation.

The experts validated these two statements as being applicable to the consumption of vegetables in Benin, but noted that awareness raising on the benefits of vegetable consumption is still needed. Differences in consumer behaviour by segments of consumers and prevailing social norms and forms of prejudice must be considered. It was also highlighted it is important to educate consumers in good practices when preparing vegetables, including reducing cooking time.

2.3.3 Conclusions

The MOA framework was useful in identifying drivers of consumer vegetable intake behaviour. In literature, health and taste are reported as the main motives for West African consumers, including in Benin, and also include safety and nutritional content; appearance is the main aspect consumers can actually judge at an outlet and often base their choice on. Stakeholders consulted in this study supported this finding, but disagreed that Beninese consumers are aware of food safety issues regarding vegetables. In their opinion, awareness raising around the benefits of vegetable consumption remains important, and this should consider differences in behaviour, social norms, and forms of prejudice. Regarding level of opportunity, literature findings suggest that, in general, access to safe vegetables is a constraint. There is also a gap in literature on the ability (skills and knowledge) of consumers to recognise safer vegetables.

2.4 Role of the food environment in making vegetable choices

Key messages

- Socio-economic drivers, including economic growth, political stability, and urbanisation have influenced food environments in Sub-Saharan countries, subsequently contributing to changes in food outlets and consumer behaviour.
- Informal markets, such as traditional markets, including street food vendors, are the main outlets for buying fruit and vegetables in Benin. Supermarkets are rising in importance, although they offer a limited range of vegetable and fruit products compared to traditional and informal outlets.
- Out of home, ready-to-eat food is commonly consumed, especially by men, and includes vegetables such as tomatoes, onions, cabbage, and carrots.
- Consumer information on vegetables is lacking and food advertisements rarely focus on vegetables.

2.4.1 Main results from the literature

Changing food environments in Sub-Saharan Africa as a result of socio-economic drivers

Food environment research seems to be more advanced for high-income countries compared to LMICs (Turner et al., 2018). However, regional insights on the current and possible future development of food environment have been explored and reported in academic and grey literature.

Food environments in Sub-Saharan Africa have been changing as a result of drivers such as steady economic growth, political stability, and urbanisation. This has stimulated the spread of new types of food outlets in major cities (e.g., Accra), such as supermarkets and modern food retail outlets (Aryeetey et al., 2016). As a result of these food environment changes, consumer behaviour has also been influenced – leading to a surge in the prevalence of obesity over the last three decades, which has also been driven by sedentary lifestyles, lack of access to healthy foods like fruits and vegetables, limited structures to support healthy and active lifestyles, and excess calorie consumption (through sweetened carbonated soft drinks and fast foods) (Dake, Thompson, Agyei-Mensah, & Codjoe, 2016). As a Sub-Saharan West African country, Benin is also experiencing a change in the food environment, which is represented by a rising number of local supermarkets and modern retail food outlets. This has been particularly occurring in cities such as Porto Novo and Cotonou (Lloyds Bank, 2022). The biggest supermarket chain is Erevan Bénin, operating with the French chain Carrefour. Less educated people and households without a vehicle are reportedly less likely to purchase food from supermarkets (Aryeetey et al., 2016).

Informal markets are the main outlets for buying vegetables; supermarkets are rising in popularity but offer a limited range of vegetables

While vegetables and fruits are sold at different outlets in Benin, the main outlets are informal markets such as traditional markets, including street food vendors. The factors which drive preference for traditional markets are identified as: greater product variety, lower prices, and proximity to the source (Aryeetey et al., 2016). Products sold at traditional markets range from fresh foods to various types of processed foods. In general, Beninese households purchase unprocessed foods with longer shelf lives and perishable foods (vegetables and fruits) from traditional markets, with the latter more often being a reason for sourcing groceries from this selling point (Aryeetey et al., 2016).

Formal markets, such as supermarkets, minimarkets, and convenience stores, hardly sell fresh products – and, if they do, quantities are limited compared to informal markets. In Benin, traditional vegetables are more available in peri-urban markets than urban markets, mainly due to preferences of local consumers and demand (Gbenato et al., 2010). The Sahelian region, including Mali and Burkina Faso, is considered as having difficulties in accessing vegetables – partly due to geography and road infrastructure (Ganry, 2009). In general, supply chains are differently organised depending on the locations and length of the supply chain, but the main actors are usually producers, (collectors, for the large-scale production sites), wholesalers, and retailers (Gbenato et al., 2010). In Benin, the commercialisation of vegetables is mostly conducted by women under 30 years of age in rural areas and under 40 years of age in urban areas.

Among these outlets, there is also a difference in the type of vegetables consumed. In effect, vegetables differ per customer type as, for example, restaurant owners and small food businesses have a lower

preference for organic certification compared to food vendors (Probst et al., 2012). Thus, lower-class consumers might purchase more organic products than the educated 'elite'. The appearance and shelf life of fruits and vegetables are considered 'better' compared to organic products, and thus attract the attention of restaurant owners who associate higher quality with these characteristics. On the other hand, street food vendors that do not consider these aspects to be relevant as the food purchased is immediately processed. Results of a study conducted by Dake et al. (2016) of outlets belonging to informal markets in Accra (Ghana), specifically in urban poor communities such as James Town, Ussher Town and Agbognloshie, showed there is an abundance of out of home-cooked foods that are ready to eat) (street food vendors) compared to fruit and vegetables, where selling points seem to be limited. There is also a high density of the same type of outlets in one single area. Street vendors' food is commonly available in the area at any time of the day, exposing residents to a wide quantity of ready to eat foods.

Modern outlets, such as supermarkets, can contribute to the increase in obesity prevalence, as these locations lack, or have a reduced number of, healthy alternatives such as fruits and vegetables.

Out-of-home, ready-to-eat food is commonly consumed, especially by men, and includes vegetables such as tomatoes, onions, cabbage, and carrots

As mentioned earlier, street food vendors are among the main food outlets in Benin. There are also fast food outlets, 'maquis', and restaurants, which are recognised as consumption channels for vegetables in West African countries (Ganry, 2009). These food outlets are mostly situated in open air spaces and managed by small-scale retail entrepreneurs (Aryeetey et al., 2016). Street food vendors mainly sell ready-to-eat food prepared in public places – and they are either eaten where prepared (for example, in informal outlets such as 'chop bars') or taken away in plastic bags, polystyrene packs, or leaves. These products are potentially more exposed to food contamination (e.g., oro-faecal pathogens), since they undergo a series of preparations and handling practices (e.g., water used, cutlery or equipment, hands, ingredients, bowls or storage containers, etc.) in the places they are cooked – such as school compounds, lorry stations, and along busy roads (Larbi et al., 2021).

In Ghana, the type of food sold by street food vendors is mainly boiled rice (fried rice, waakye, and jollof rice) and local staple foods (fufu, banku, and kenkey). These are accompanied by either different types of soups (mainly fufu) and fried fish and uncooked sauce (mixture between pepper, tomato and onion), but also stewed sauce and soup (Dake et al., 2016). In the Dake et al. study, it was noted that out-of-home cooked food does not seem to contribute to weight gain of residents, as seen in other studies. These foods are made from whole unpolished ingredients, thus are less obesogenic. In the same Ghanaian study, where vegetable selling points were available (in lower-level compared to out-of-home foods), the main fruit products were oranges, pineapple, watermelon, apple, and blackberries. Vegetables are mostly tomatoes, onions, cabbage, and carrots. Fruits are sold cut into pieces and served in polythene bags or transparent plastic containers on the street, and are usually purchased from food vendors while consumers are stuck in vehicular traffic (Dake et al., 2016).

Consumer information on vegetables is lacking and food advertisements rarely focus on vegetables

The availability of fruit and vegetables is currently very low in Sub-Saharan Africa, and the issue has been given little attention by governments and funding agencies (Ganry, 2009). Overall, it also seems that information on vegetables in lacking among both vendors and consumers. Among food vendors, the main sources of information are television and radio (Probst et al., 2012). In a study conducted in Accra city (Ghana) on food advertisements, results showed they rarely focus on vegetables and fruit: almost half of all advertisements were for sugar-sweetened beverages (48.3%), and there was also higher exposure to alcohol adverts than other items (28.5%) (Green et al., 2020). Consumers can base their decision of one vegetable over another for different reasons (see also Chapter 2.3), and these reasons differ between consumer groups and among West African countries. For example, in rural areas of Benin, consumers typically buy certain vegetables for four main reasons: taste, ease of preparation, availability, and quantity of required condiments (Dansi et al., 2008). In peri-urban areas of Ghana, consumers base their decisions from which vendor to buy food products on price, vendor relationships, appearance of the environment, vendor appearance, taste, and accessibility. However, food safety and basic food hygiene were not a major concern or priority for either consumers or vendors (Larbi et al., 2021). Some regional differences were found; for

instance, awareness of microbial contamination of vegetables was slightly higher in Cotonou and Ouagadougou than in Accra (Probst et al., 2012).

2.4.2 Reflection by knowledge holders

The following statements match the main findings from literature and were discussed during the knowledge holder meeting:

- Supermarkets are rising in importance. However, they contribute to a less healthy diet due to poor vegetable supplies. The supply of vegetables through these modern outlets should be increased.
- Out-of-home food consumption is increasingly important in (peri-)urban Benin. The main consumer group is formed by men. The dishes served by such outlets are generally deficient in vegetables, while rich in carbohydrates and fats.

The experts agreed with and validated both statements and observed that, even if the number of supermarkets is increasing, low levels of vegetable supplies could be linked to producers finding it difficult to ensure a regular supply of traceable quality. Therefore, it is necessary to evaluate the constraints and induce a constant supply of quality vegetables. One of the constraints is assuring product quality is up to consumers' standards.

Aside from men who increasingly purchase food from street vendors, significant numbers of consumers obtain their food at work places. However, the supply of vegetables through collective catering services is often very limited. This could be an area of intervention by SafeVeg, while drawing on experiences elsewhere.

Besides improvement in the food environment, the experts consider it of importance that consumers are educated on various aspects of vegetable consumption, which may have an impact on their consumer behaviour.

2.4.3 Conclusions

Literature shows that socio-economic drivers and changes have influenced food environments in Sub-Saharan countries, including Benin, and contributed to changes in consumer behaviour. The current spread of supermarkets and modern retail outlets offer a limited range of vegetable and fruit products compared to traditional outlets, including street food vendors. In Benin, most vegetables are purchased at wet markets and other retail outlets at more affordable prices. Knowledge holders agreed with this, and also mentioned the issue of sustaining regular supplies of foods of traceable quality. Further research is needed to diagnose supply chain constraints in terms of constant supply and quality in Benin.

Out-of-home food is mainly ready-to-eat food that includes vegetables such as tomatoes, onions, cabbage, and carrots. Consumer information sources seem to lack reliable data on fruit and vegetable production, availability, and consumption. Thus, Beninese consumers base their purchasing decisions more on price, vendor relationships, appearance of environment, vendor appearance, taste, and accessibility. Further, food advertisements rarely focus on vegetables and fruit. Stakeholders agreed that street vendors and collective catering services are becoming increasingly important, but often supply limited amounts of vegetables in the diets they offer. These could be areas of intervention by SafeVeg.

2.5 Consumer segments

Key messages

- Segmentation is a useful tool to target the needs, wishes, and/or demands of specific consumer groups.
- Few to no segmentation studies are available on vegetable intake in our countries of research.
- Correlational studies provide entry points to define target groups based on income, gender, and age:
  - *Income*
    Income influences the accessibility of vegetables, especially short-term income in some cases. Since a large group of people have a low or fluctuating income and are therefore focused on basic needs, this should be taken into account.
  - *Gender*
    Men should be influenced, because they make decisions about what to buy in a lot of households. However, women should also be targeted, because they actually buy the vegetables and have more deficiencies.
  - *Age*
    The average age of people is these countries is low. Therefore, when targeting the 'older' group, this is still – by western standards – a younger target group.

2.5.1 Main results from the literature

Segmentation is a useful tool to define specific consumer target groups

The food market is considered heterogeneous, with consumers having different wishes, needs, desires, and expectations. To improve vegetable consumption, it is important that vegetable products or interventions closely match consumer requirements. Segmentation, the identification of homogenous consumer groups who share perceived needs, wishes, or motivations, is considered a useful tool for successfully identifying markets, communication strategies, and interventions (e.g. Gunden & Thomas, 2012; Kotler, 2009; Steenkamp, 1990; Wedel & Kamarua, 2000). The identification of distinct groups is necessary to cater to the particular needs, wishes, or demands of different segments. Four segmentation bases – the variables the segmentation is based on – have emerged in literature as the most popular: (i) geographic segmentation, (ii) demographic segmentation, (iii) psychographic segmentation, (iv) behavioural segmentation. See Table 2.2 for more information about these segmentation bases. It should be noted that, although demographic segmentation is commonly used, it is considered an untrustworthy segmentation strategy. Demographic variables have been shown to be poor predictors of choice behaviour (Wansink, Sonka & Park, 2004). Consumers with the same demographic factors may greatly differ from each other in their behaviours, preferences, and attitudes. To positively influence vegetable consumption behaviours, it's important to know what influences consumers' behaviour. Psychographic segmentation is considered a more accurate strategy, as it attempts to create a better picture of the consumer segments. However, demographic variables are necessary to describe the emerged groups.

Table 2.2 *Overview of the most popular segmentation bases found in literature (e.g., Beane & Ennis, 1987; Kotler, 2009)*

Segmentation base	Explanation
Geographical segmentation	Consumers are divided into different geographical units, such as region (continent, country, neighbourhood), size of metropolitan area, population density, or climate.
Demographic segmentation	Consumers are divided into segments based on demographic variables, such as age, gender, family size, family life cycle, income, occupation, education, generation, religion, ethnicity, or social class.
Psychographic segmentation	Consumers are divided into different groups based on their values, personality traits, interests, lifestyles, activities, attitudes, beliefs, or opinions. This type of segmentation is also called 'lifestyle segmentation'.
Behavioural segmentation	Consumers are divided into different segments based on consumption or buying behaviours towards a certain product. It includes variables related to the sought benefits, usage, brand loyalty, user status, or readiness to buy.

Few to no segmentation studies are available on vegetable consumption in West Africa

Only two segmentation studies in the field of vegetable consumption in West Africa have been found: other segmentation studies focused on health interventions, behaviour in general, or covered other fields, such as HIV/AIDS innovations, and are therefore not included. Sodjinou et al. (2009) conducted a cluster analysis of the dietary pattern of urban Beninese adults, and revealed two types of dietary patterns: transitional and traditional. These clusters differed in the food groups they consume, macro- and micronutrient intake, and socio-demographic variables. More specifically, 'transitional diet' subjects had a higher socio-economic status (SES), higher education level, and were more likely to be born in the city compared to 'traditional diet' subjects. The diet of transitional subjects was more diversified compared to the traditional subjects, and contained more animal products (e.g., meat, eggs, milk, and milk products), local roots and tubers, white bread and pasta, nuts and seeds, and sweets. Traditional consumers consumed more fruits. No significant differences were found regarding vegetable consumption. Adegbola et al. (2019) showed that the origin, taste, and colour of tomatoes were the most important attributes for purchasing by urban Beninese consumers, followed by duration of conservation, consistency, and price. Based on these attributes, four segments were identified, all consisting mostly of women. Only one group (the second segment in terms of size) spent a relatively high amount on tomatoes, with their primary criteria for choosing being the conservation duration of tomatoes; taste was rated second in importance and consistency last. Another segment had the same pattern for attributes with duration of conservation first and taste second but spend less on tomatoes. For two other groups, the most important criteria for choice were tomato consistency, followed by conservation duration of tomatoes and taste.

Other studies have described consumer groups. For example, Hatch et al. (2011) divided African consumers into basic survivors, working families, rising strivers, cosmopolitan professionals, and the affluent. The results reveal different purchase patterns and expenditures in combination with (demographic) characteristics. However, unlike segmentation studies, the groups were based on high level groupings rather than statistical patterns (Hatch, Becker & van Zyl, 2011).

Correlational studies provide entry points to define target groups based on income, gender, and age

Given the lack of segmentation studies, other studies addressing vegetables intake in relation to consumer (demographic) characteristics have been included to identify potential entry points for further research. Most studies used correlational analysis to determine associations between intake and consumer characteristics, and studies mainly included demographic variables, especially gender, age, and income.

Income

Many studies included income as a variable. It is found that income influences the accessibility of healthy foods, such as vegetables, and food variety (Custdoio et al., 2020; Djossinou et al., 2020; Torheim et al., 2004). More specifically, a more diversified diet is better accessed by people with a higher income and socio-economic status. A note here is that short-term income might influence the diet diversity score more than proxies used to determine groups with different socio-economic status (Custdoio et al., 2020).

Gender

Women seem to have the most micronutrient deficiencies and a lower diet diversity compared to men (Djossinou et al., 2020; Levesque et al., 2015; Sodjinou et al., 2009). However, Brouwer et al. (2021) found that women are more inclined to eat healthy foods. Acceptability seems to be related not only to product acceptance by women, but also by her family, household head, and her husband. In many households, the household head and/or husband makes the most decisions regarding purchases, and mothers of young children are less mobile and rely on their family (Fanou-Fogny, 2011; Heckert, 2019).

Age

A few studies showed that the age of the household head was related to diet diversity (Custdoio et al., 2020; Tornheim et al., 2004). Diet diversity and vegetable consumption declines with age. It should be noted that the mean age of respondents in different Sub-Saharan African studies was quite low compared to study samples in Western countries.

2.5.2 Reflection by knowledge holders

The following statements match the main findings from literature and were discussed in the knowledge holder meeting:

- Demographic group to focus on:
  - Gender (male, *female*, decision-maker, vegetable purchase/meal preparation)
  - Income *(low, middle*, high)
  - Age (*younger*, older)
- Identifying consumer segments can be helpful for more targeted interventions. These segments are most meaningful when based on the importance of product attributes (like taste, price, colour, consistency, conservation duration, and healthfulness).

The experts agreed with the two statements and highlighted that decisions regarding what is consumed by the household are made by women. If enhancing product quality is associated with a higher price, this will create a barrier to consumers from low-income households. It is necessary to target young people/adolescents, because their adoption of vegetable consumption has a high likeliness of being sustained over time. These consumers could be inspired by positive deviance.

2.5.3 Conclusions

Segmentation is a useful tool to identify homogeneous groups of consumers but, so far, only a few studies have described segments of vegetable consumers in West-Africa. Meanwhile, other correlational studies have mainly addressed demographic characteristics in relation to vegetable purchase and consumption. Based on the literature, the focus of consumer groups might be placed on income, age, and gender. Knowledge holders consulted in this study agreed with this finding and supported the importance of income as restricting food choice in Benin. Income influences vegetable accessibility, particularly short-term income in some cases. Since a large group of Beninese people has a low and fluctuating income so focus on basic needs, this should be taken into account. The knowledge holders also emphasised Beninese adolescents as an important target group, since adoption of vegetable consumption by them has a high likeliness of being sustained over time. Meanwhile, in literature, older age seems to be related to lower vegetable intake and reduced dietary diversity. Finally, in literature, the importance of including men in interventions is highlighted since they influence decisions about what to buy. Knowledge holders supported the inclusion of women as well, since they make the final purchasing decisions in most Beninese households.

3 Conclusions

The literature study supported the focus of SafeVeg by showing that – from both a nutritional point of view and in terms of safety – interventions are needed to promote safe vegetable consumption in urban Benin. In chapter 2.1, the role of vegetables in dietary intake was reviewed. Although vegetables are among the most frequently consumed food groups in Benin, consumption is below recommendations. It should be noted that reliable and accurate data is lacking in Benin. Vegetables that are nutrient dense and a source of the priority micronutrients (iron, calcium, zinc, and folate) need to be promoted. Focus should be on green leafy vegetables due to their nutrient density and their contribution to decreasing nutrition deficiency and overweight problems. This finding was supported by knowledge holders, who also suggested that special attention should be given to neglected vegetables which are commonly consumed in Benin.

Despite their healthiness, the literature shows that vegetables are not always considered safe or of a high quality. Vegetables are not the main source of foodborne contamination, yet raw and fresh leafy vegetables contribute to foodborne illness. The different elements within and the drivers of the local food system contribute to FBD outbreaks, as awareness of risks by actors in the vegetable production and vending chain is low in Benin. Most vegetables are purchased at informal markets (e.g., wet markets, street vendors, traditional markets) or are part of the out-of-home food culture. Reliable consumer information sources on vegetable production, availability, and consumption in Benin are lacking. Also, (government) regulations on health safety and tailoring of international standards are lacking. Knowledge holders also mentioned a low awareness of vegetable safety among Beninese producers and vendors. Overall, the results support the importance of interventions that increase vegetable support. However, such interventions are complicated by the fact that vegetables are acquired almost entirely through informal systems that lack monitoring, formal standards, and safety awareness.

In this literature search, the MAO framework showed to be useful to identify and structure drivers of vegetable consumption behaviour, since this framework supports the design of effective behaviour change interventions. Health and taste, together with safety, nutritional content, and appearance, are considered the main motives for vegetable choice by Beninese consumers. This suggests that safety is an important motive and there is no direct need for information campaigns; although knowledge holders mentioned that Beninese consumer awareness about the health benefits of vegetables remains important. Outcomes further suggest that accessibility to safe vegetables is also relevant, as the lack of safe vegetables is perceived as a constraint by consumers. There is a gap in how consumers' recognise safe vegetables, and more knowledge on this topic needs to be obtained. Within the projects, access to safe vegetables and consumers' ability to recognise them could be an important point of intervention in Benin.

When looking at the type of urban Beninese consumers that should be targeted in the project, demographic variables such as income, gender, and age need to be considered. Income restricts food choices and influences the accessibility of vegetables, especially among that with fluctuating incomes. Interventions should therefore focus on vulnerable low-income groups. The outcomes further suggest that interventions focus on both genders, as both influences purchasing decisions. It should be noted that out-of-home foods are mainly consumed by men. Meanwhile, older women living in an urban area and with a higher educational level or socio-economic well-being are more likely to be overweight. Finally, adolescents are considered an important target group, since adoption of vegetable consumption by them has a high likeliness of being sustained over time. Further, older age seems to be related to a lower vegetable intake and dietary diversity. Significant differences in food intake have been found between urban, peri-urban, and rural areas in Benin. The consumption of meat, dairy, and vegetables seems to be higher in urban areas, suggesting a higher vulnerability for low-intake in peri-urban areas.

We conclude that entry points for enhancing the consumption of safe vegetables in Benin, should focus on:

- Vulnerable low-income groups, including both genders
- Both the at-home and out-of-home food environment
- The main food choice drivers, including health (including safety) and taste
- Accessibility within the local food environment
- Improving the ability (knowledge and skills) to recognise safer vegetables

We therefore suggest the following potential interventions:

- *Increasing the portion of healthy vegetables in street food dishes.*
  Increasing the portion of vegetables in street food dishes is likely to impact various types of consumers, especially the poorer segments. The consumption of out-of-home cooked food is becoming increasingly important in urban Benin and these meals are generally deficient in vegetables. Moreover, this intervention may have positive economic impacts on street food vendors, which are mainly women, and their suppliers, traders, and producers.
- *Labelling the origin of vegetables.*
  Labelling of vegetables is likely to have a positive impact on various types of consumers, including the poorer segments, as the vegetables are sold at the traditional outlets (e.g., wet market). Applying a label on vegetables to inform Beninese consumers on the origin makes them more capable and more confident to recognise and select safer vegetables.

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Appendix 1 Search terms literature search

Scopus:
(TITLE-ABS-KEY (benin OR beninese OR burkina OR burkinan OR mali OR malian OR cotonou OR "Porto Novo" OR parakou OR ouagadougou OR "Bobo Dioulasso" OR koudougou OR bamako OR segou OR sikasso)) AND (TITLE-ABS-KEY (vegetable OR tomato OR onion OR amaranth OR "African eggplant" OR jute OR "bitter leaf" OR "cowpea leaf" OR cabbage OR okra OR gombo OR gboma OR gbolo OR "african basil" OR "sweet potato leaf" OR bean OR shallot OR roselle OR sorrel OR carrot OR "black nightshade" OR pumpkin OR squash OR "black-eyed peas" OR "cassava leaf" OR pepper OR peppers OR lettuce)) >> **688 results**

CAB:
(exp leafy vegetables/ or vegetable? or tomato*2 or onion? or amaranth? or African eggplant? or jute or bitter leaf or bitter leaves or (cowpea adj3 leaf) or (cowpea adj3 leaves) or cabbage? or okra or gombo or gboma or african basil or (sweet potato adj3 leaf) or (sweet potato adj3 leaves) or bean or beans or shallot? or roselle? or sorrel? or carrot? or black nightshade? or pumpkin? or squash or black-eyed pea? or (cassava adj3 leaf) or (cassava adj3 leaves) or pepper? or lettuce? or gbolo).mp. AND (Benin or beninese or Burkina or burkinan or Mali or malian or Cotonou or Porto Novo or Parakou or Ouagadougou or Bobo Dioulasso or Koudougou or Bamako or Segou or Sikasso).mp.>> **2,035 results**

PubMed:
(vegetable[MESH] OR "vegetable*"[Title/Abstract] OR "tomato*"[Title/Abstract] OR "onion*"[Title/Abstract] OR "amaranth*"[Title/Abstract] OR "african eggplant*"[Title/Abstract] OR "jute"[Title/Abstract] OR "bitter leaf"[Title/Abstract] OR "cowpea leaf"[Title/Abstract] OR "cowpea leaves"[Title/Abstract] OR "cabbage*"[Title/Abstract] OR "okra"[Title/Abstract] OR "gombo"[Title/Abstract] OR "gboma"[Title/Abstract] OR "african basil"[Title/Abstract] OR "sweet potato leaf"[Title/Abstract] OR "sweet potato leaves"[Title/Abstract] OR "bean*"[Title/Abstract] OR "shallot*"[Title/Abstract] OR "roselle*"[Title/Abstract] OR "sorrel*"[Title/Abstract] OR "squash"[Title/Abstract] OR "carrot*"[Title/Abstract] OR "black nightshade*"[Title/Abstract] OR "pumpkin*"[Title/Abstract] OR "black eyed pea*"[Title/Abstract] OR "cassava leaf"[Title/Abstract] OR "cassava leaves"[Title/Abstract] OR "pepper"[Title/Abstract] OR "peppers"[Title/Abstract] OR "lettuce"[Title/Abstract] OR "gbolo"[Title/Abstract]) AND ("benin"[Title/Abstract] OR "beninese"[Title/Abstract] OR "burkina"[Title/Abstract] OR "mali"[Title/Abstract] OR "malian"[Title/Abstract] OR "cotonou"[Title/Abstract] OR "porto novo"[Title/Abstract] OR "parakou"[Title/Abstract] OR "ouagadougou"[Title/Abstract] OR "bobo dioulasso"[Title/Abstract] OR "koudougou"[Title/Abstract] OR "bamako"[Title/Abstract] OR "segou"[Title/Abstract] OR "sikasso"[Title/Abstract]) >> **210 results**

PsycInfo (gezocht in All text + Apply equivalent subjects)**:**
(vegetable OR tomato OR onion OR amaranth OR "African eggplant" OR jute OR "bitter leaf" OR "cowpea leaf" OR cabbage OR okra OR gombo OR gboma OR gbolo OR "african basil" OR "sweet potato leaf" OR bean OR shallot OR roselle OR sorrel OR carrot OR "black nightshade" OR pumpkin OR squash OR "black-eyed peas" OR "cassava leaf" OR pepper OR peppers OR lettuce) AND (benin OR beninese OR burkina OR burkinan OR mali OR malian OR cotonou OR "Porto Novo" OR parakou OR ouagadougou OR "Bobo Dioulasso" OR koudougou OR bamako OR segou OR sikasso)>> **6 results**

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

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

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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, 7,200 employees (6,400 fte) and 13,200 students and over 150,000 participants to WUR's Life Long Learning, Wageningen University & Research is one of the leading organisations in its domain. The unique Wageningen approach lies in its integrated approach to issues and the collaboration between different disciplines.