

The future of fruit and vegetables in Benin's food system: visioning alternative scenarios toward 2060

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This report was written with the input and help of many people. We would like to acknowledge the National Platform of Actors in Vegetable Value Chains who actively participated in the workshop. This work was conducted as part of the CGIAR Research Initiative on Fruit and Vegetables for Sustainable Healthy Diets (FRESH). We would like to thank all funders who supported this research through their contributions to the CGIAR Trust Fund: <https://www.cgiar.org/funders/>



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List of abbreviations

ABSSA	Agence Béninoise de la Sécurité Sanitaire des Aliments
ACED	Centre Africain pour le Développement Équitable
ANaFEA-BENIN	Association Nationale des Femmes Entrepreneures Agricoles du BENIN
ANAN	Agence Nationale de l'Alimentation et de la Nutrition
ATDA	Agence Territoriale de Développement Agricole
CIPB	Conseil des Investisseurs Privés du Bénin
DDAEP	Direction Départementale de l'Agriculture, de l'Elevage et de la Pêche
DPV	Direction de la Production Végétale
FAO	Food and Agriculture Organization of the United Nations
FeNOMa	Fédération Nationale des Organisations de Maraîchers
FoSTr	Foresight for Food Systems Transformation
FNDA	Fonds National de Développement Agricole
FRESH	Fruit and Vegetables for Sustainable Healthy Diets
F&V	Fruits and Vegetables
GLV	Green Leafy Vegetables
GDP	Gross Domestic Product
HGT	Holland Green Tech
IFPRI	International Food Policy Research Institute
PAIA-VO	Projet d'Appui aux Infrastructures Agricoles dans la Vallée de l'Ouémé
PACOFIDE	Projet d'Appui à la Compétitivité des Filières Agricoles et à la Diversification des Exportations
PADMAR	Projet d'Appui au Développement du Maraîchage
PASCIB	Plateforme des Acteurs de la Société Civile du Bénin
PNOPPA	Plateforme Nationale des Organisations Paysannes et de Producteurs Agricoles
LMICs	Low- and Middle-Income Countries
LRIDA	Laboratoire de Recherche sur l'Innovation pour le Développement Agricole
NCD	Non Communicable Disease
SBCC	Social Behavior Change Communication
SDG	Sustainable Development Goal
SMEs	Small and Medium-sized Enterprises
SODECO	Société de Développement du Coton
SP/CAN	Secrétariat Permanent du Conseil National de l'Alimentation et de la Nutrition
WHO	World Health Organization
WUR	Wageningen University and Research
WorldVeg	World Vegetable Center

1. Introduction

Fruits and vegetables (F&V) share health benefits due to common phytochemicals (e.g., phenolics, flavonoids, carotenoids), vitamins (e.g., vitamin C, folate, pro-vitamin A), minerals (e.g., potassium, calcium, magnesium) and fibers (Kalmpourtzidou et al, 2020). According to World Health Organization (WHO) and Food and Agriculture Organization (FAO) guidelines (2003), the recommended consumption of fruits and vegetables is at least 400 g/day (WHO & FAO, 2003). Unfortunately, F&V intake is far below this recommendation, and the situation is alarming, especially in low- and middle-income countries (LMICs) (CGIAR, 2021). Poor diets are a primary cause of malnutrition and the leading cause of non-communicable disease (NCD) worldwide. Improving diets, including F&V intake, could save one in five lives annually. However, the extent and nature of the problem are poorly understood due to insufficient dietary data, particularly in LMICs. Increasing F&V intake will require starting with consumers, understanding dietary patterns, and addressing desirability, accessibility, affordability, and availability barriers through cost-effective solutions using the end-to-end approach. Solutions to the intractable problem of low F&V intake must be multifaceted and interconnected, requiring a holistic end-to-end approach such as the approach undertaken by the FRESH Initiative.

This report describes the results of expert and stakeholder consultations held from 4 to 8 March 2024, organized by the CGIAR Research Initiative on Fruit and Vegetables for Sustainable Healthy Diets (FRESH). The exercise aimed to explore the future role of fruits and vegetables in Benin's food system. These crops are critically important to healthy diets and generate income to value chain actors. It is, therefore, important to understand which trends and uncertainties may shape the future food system and what actors can do to steer developments in the desired direction. In this report, the approach to such foresight analysis is explained, as well as the current state of fruits and vegetables in Benin's food system. Alternative futures are explored regarding their consequences and options for anticipatory policy and stakeholder engagement.

1.1 FRESH and the national platform of actors in the vegetable value chain

The CGIAR FRESH Initiative was launched in Benin in 2022 and is locally coordinated by the World Vegetable Center. FRESH applies an end-to-end approach to increase F&V intake and improve diet quality, nutrition, and health while improving livelihoods, empowering women and youth, and mitigating negative environmental impacts. The end-to-end approach begins with consumers and works back through the food system, addressing barriers to F&V consumption through the improvement of vegetable biodiversity, seed systems, production inputs, food environments, market systems, and consumer behavior.

FRESH emphasizes the participation of stakeholders to create a sustainable mechanism that aligns research with national priorities. This involves integrating activities into ongoing programs and engaging with relevant groups such as the private sector, civil society, and the public sector.

The National Platform of Actors in Vegetable Value Chains was created on March 10, 2023. In alignment with national orientations in the agricultural sector, the extension service ATDA 1 (Agence Territoriale de Développement Agricole 1) has initiated the creation of the National Platform as the leader in vegetable value-chain promotion. The Platform's goal is to improve the coordination of interventions and facilitate exchanges between stakeholders in the fruit and vegetable supply chains to enhance the performance of demand and supply. The main objectives are: 1) to share research findings to guide evidence-based policy and strategies orientation and 2) to facilitate the exchange and co-learning among stakeholders to develop more competitive vegetable and sustainable value chains. This Platform has more than 309 members, including those from the private, public, and civil society sectors. The Platform is facilitated by the consortium of ACED-LRIDA-HGT (Centre Africain pour le Développement Équitable, Laboratoire de Recherche sur l'Innovation pour le Développement Agricole & Holland Green Tech) with financial support from the Kingdom of the Netherlands.

1.2 Foresight analysis

Policymakers and researchers increasingly use foresight analysis to explore the future and navigate between alternative scenarios in uncertain and turbulent times. Foresight analysis allows one to assess the implications of ongoing trends and future uncertainties. Nobody can predict the future, but we can extrapolate from current trends and imagine how possible uncertainties could impact our livelihoods and systems. We can then examine what actions are needed to 'nudge' food systems in a desirable direction. Scenarios offer a way to address future uncertainties by creating coherent, internally consistent storylines that explore future states of the world or alternative states of a system.¹

The Foresight for Food Systems Transformation (FoSTr) Programme² developed a guiding framework for applying foresight analysis to food systems (Figure 1). The process starts with a scoping exercise, asking participants questions about their interests. This step involves identifying key stakeholder groups and their current and future concerns to identify common interests and possible tensions between stakeholders.

A food systems model is critical for identifying and assessing key drivers, trends, and uncertainties and developing alternative scenarios. Data analysis and stakeholder views from the mapping exercise lay the groundwork for evaluating trends and uncertainties. The foresight process creates a dialogue between stakeholders about their assumptions on how the future food system may unfold and what this implies for their visions and aspirations.

Developing and analyzing future food system scenarios based on key trends and critical uncertainties is a central yet often challenging aspect of the approach; however, it also yields insightful results. Participants must "think outside the box" to imagine how the future of food systems could be fundamentally different and what the implications could be. These provide a foundation for exploring what directions for food systems change would be in the collective interest and how trade-offs or synergies between the specific interests of different groups can be best managed.

The final step in the foresight process is to develop practical and realistic pathways for change. Using a desirable future scenario as a goal, participants work together to create strategies that lead their food system in a positive direction.

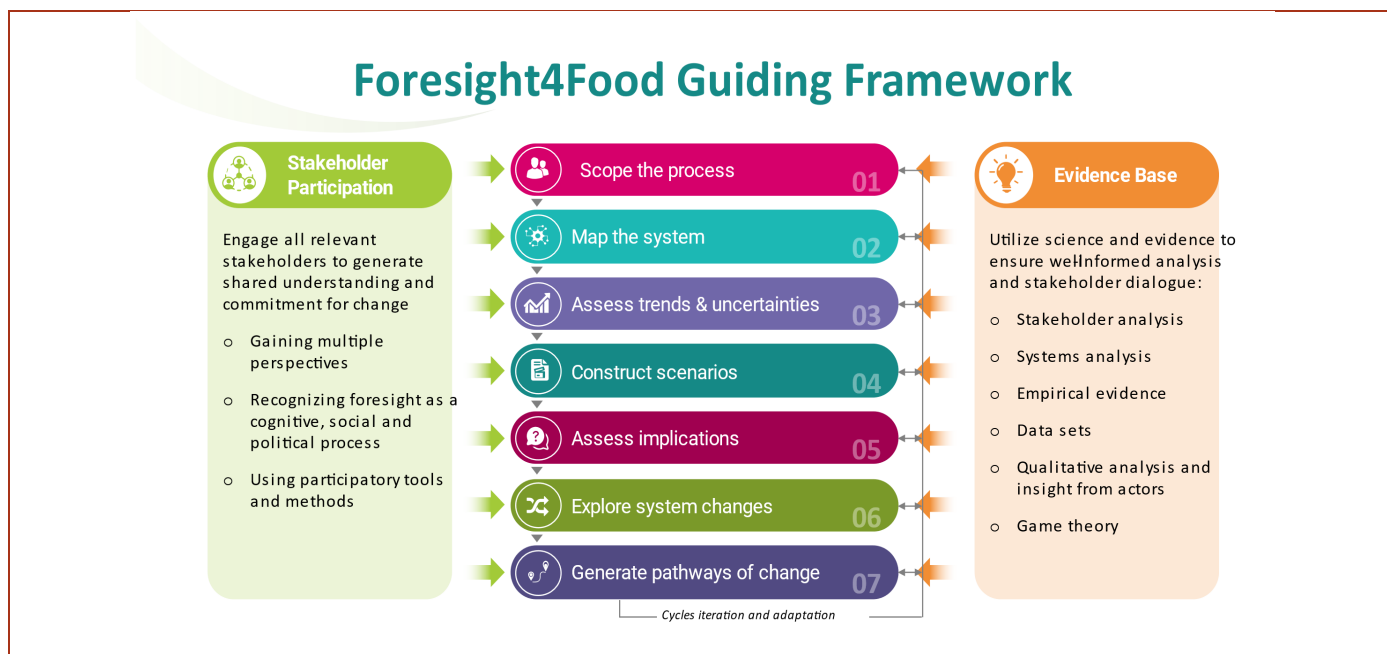


Figure 1. Foresight for Food Guiding Framework

Source: <https://foresight4food.net/foresight-framework/>

¹ Dr. Rathana Peou Norbert-Munns, Sustainable and agrifood development expert at FAO and board member F4F, presentation on 19-20 September 2023 at Kathmandu, Nepal.

² The Programme is managed on behalf of Foresight4Food by the University of Oxford's Environmental Change Institute (ECI) in partnership with Wageningen University and Research.

1.3 Approach to the foresight analysis in Benin

The analysis was conducted by eight Beninese researchers and 20+ members of the fruit and vegetables platform. A three-person team from the World Vegetable Center, IFPRI, and WUR facilitated the process.

An online training in foresight analysis was provided to the eight Beninese researchers to prepare them for the workshop. Each researcher was an expert within a specific domain of the food system. They gathered and synthesized information relevant to their domain of focus as input for the first step in the foresight analysis. The seven steps of the process were completed in three days. A collective understanding of the current food system and the roles of F&V was developed. Then, drivers and trends were assessed, as well as key change agents in or behind Benin's food system, with particular attention to F&V. This was followed by a session in which critical uncertainties driving future food systems were identified. Extrapolated trends and uncertainties were combined to create a set of scenarios. The implications of these scenarios on fruits and vegetables were explored using back-casting methods. Possible policies and stakeholder actions were discussed that could avoid undesirable scenarios or 'nudge' the system towards a more desirable direction.

Members of Benin's fruits and vegetables platform reviewed and validated the findings of these three days of analysis. They were introduced to the concept of foresight analysis and guided through all seven analysis steps. During each step, findings were presented, and feedback was obtained in a participatory manner. This resulted in further refinements of and complementary suggestions to the foresight analysis.

2. Fruits and vegetables in Benin's food system

2.1 Food systems

Food systems are composed of supply chains and support systems providing consumers with a variety of foods (HLPE, 2020). Food system components are populated by specific actor groups who manage, organize, govern, or benefit from certain activities (Figure 2).

- **Consumption:** Consumers are differentiated by criteria including income class, gender, ethnic background, and location (e.g. urban, peri-urban and rural).
- **Food retail and provisioning (food distribution):** all kinds of retailers, from supermarkets to home delivery agents, supplying food to consumers.
- **Food processing:** All types of private sector entrepreneurs transforming primary foods and supplying retailers and consumers with these processed foods.
- **Food storage, trade and transport:** A great diversity of small to large enterprises and workers, collecting foods from producers, transporting and trading them to markets and processing centers.
- **Food production:** Food producers in the different agroecological zones and farming systems.
- **Business services:** All small and large enterprises providing services to actors in the food supply system, ranging from inputs, and seeds to advisory services.

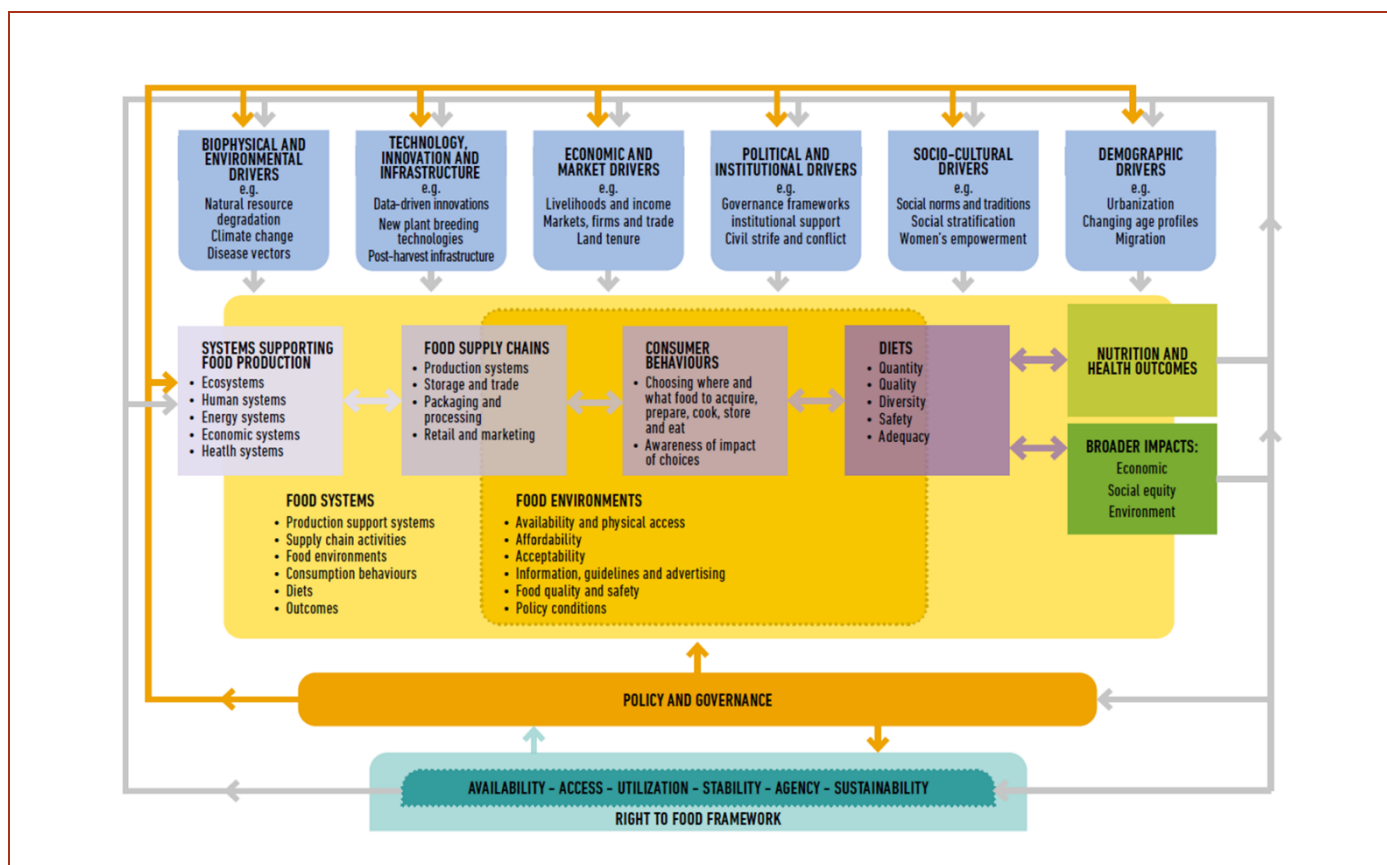


Figure 2. Framework of sustainable food system
Source: HLPE, 2020

2.2 How fruits and vegetables contribute to food system outcomes

Three main types of food system outcomes are economic and social well-being, food and nutrition security, and environmental sustainability. We expect food systems to deliver food, jobs, and income while shaping landscapes and ecosystems. Fruits and vegetables play a significant role in each of these outcome areas:

- **Human health-related contributions:** Fruits and vegetables are known for their contributions to human health, primarily by providing essential micronutrients crucial for overall human well-being. They are rich sources of vitamins, minerals, and antioxidants essential for healthy bodily functions (Miglio et al., 2008). However, it's important to acknowledge the potential adverse effects associated to exposure of F&V to heavy metals from exhaust gas and contamination with pathogenic bacteria (e.g., *Salmonella spp*) due to unhygienic practices throughout the production are pathways of exposure to human health risks (Chowdhury et al., 2018; FAO/WHO, 2016). Addressing food safety concerns is paramount to ensuring the positive health impacts of fruit and vegetable consumption outweigh the risks.
- **Socio-economic contributions:** Fruits and vegetables contribute significantly to socio-economic development by generating direct income for producers and stakeholders along the value chain. Smallholder farmers derive income from fruit and vegetable production, while employment opportunities are created in processing factories, transportation, retail, and other related sectors (FAO, 2020). Additionally, seed production and distribution companies play a vital role in supporting agricultural productivity and livelihoods in rural communities (Almekinders et al., 2019).
- **Contributions to the environment:** The environmental impacts of fruit and vegetable production can be positive or negative. On the positive side, certain vegetables, such as legumes, can fix atmospheric nitrogen, enhancing soil fertility and reducing the need for synthetic fertilizers (Giller et al., 2006). Moreover, diversified farming systems incorporating fruits and vegetables contribute to increased biodiversity and ecosystem resilience (Tschamntke et al., 2012). On the negative side, vegetable production often uses a lot of agrochemicals, including pesticides and fertilizers, which can lead to soil degradation, water pollution, and adverse effects on non-target organisms. These adverse effects can be avoided using sustainable practices, such as integrated pest and soil fertility management.

Fruits and vegetables offer significant benefits to human health, socioeconomic development, and environmental sustainability, addressing challenges related to food safety, labor conditions, and environmental stewardship, which is essential for realizing their full potential in contributing to resilient and sustainable food systems.

2.3 Current food and nutrition outcomes and fruit and vegetable consumption in Benin

Current food and nutrition outcomes

Every child has the right to good nutrition. Well-nourished children grow and develop to their full potential. They are better equipped to lead healthy lives, to be free from poverty, to learn and participate, and to continue thriving across the life course, with benefits that continue over generations (UNICEF et al., 2023). Malnutrition, in all its forms, continues to jeopardize children's ability to survive and thrive in Benin. The prevalence of stunting, wasting, underweight, and obesity in children <5 years old were 36%, 8.3%, 21.0 %, and 2.9%, respectively for 2023 in Benin (Table 1).

In Benin, recent surveys on infant and child feeding practices estimate that minimum dietary diversity is 22%, the minimum meal frequency is 32%, and the prevalence of the minimum acceptable diet is 9.3% (INSTaD, 2023). A study on infants and young children in southern Benin showed that unenriched porridges, mashed family diets, and low consumption of fruits and eggs characterize local diets. Most children (70%) were fed vegetables, with the most popular ones being jute mallow (*Corchorus olitorius*) (48%), okra (*Hibiscus esculentus*) (22%), and African eggplant (*Solanum macrocarpon*) (18%). Jute mallow (*Corchorus olitorius*) is a leafy vegetable frequently consumed by infants and young children (Mitchodigni et al., 2017).

Another study reported that of a population of 12.3 million people in Benin, 3.14 million are food insecure, including 2.9 million being moderately food insecure and 0.22 million being severely food insecure (WFP, 2022). The share of food security has reduced from 90.4% in 2017 to 74.5% in 2022, a drop of 15.9%.

Table 1. Types and levels of malnutrition among children <5 years old in Benin

Forms of malnutrition	Prevalence (%)	Prevalence of severe form (%)
Stunting	36.0	14.8
Wasting	8.3	2.4
Underweight	21.0	5.9
Obesity	2.9	1.0

Source: INSTaD, 2023- Rapport MICS Bénin 2021-2022

Beyond ensuring adequate access to daily sources of energy and proteins, “hidden hunger” or micronutrient deficiencies have to also be tackled for children and other population groups. There is insufficient progress toward UN Sustainable Development Goal (SDG) 2 “End hunger, achieve food security and improved nutrition and promote sustainable agriculture” due to chronic poverty, conflict, climate change, and the effects of the COVID-19 pandemic. Increased consumption of fruits and vegetables can contribute to fulfilling this goal.

Current levels and influencing factors of fruit and vegetable consumption in Benin

The consumption of F&V in Benin was estimated at 107 g per capita per day, meaning 40 kg of F&V per year, which is very far below the FAO yearly recommended intake (80-100 kg/capita/year). The World Health Organization (WHO) recommends the daily consumption of 5 fruits and vegetables corresponding to 400 g of fruits and vegetables (FAO & WHO (2003)). According to Tossou et al. (2012), the net consumption of locally grown mango in fruit farmer households of southern Benin could be estimated at 13.3 kg per capita per year. A consumer survey conducted by the Safe Locally produced Vegetables for West Africa’s consumers (SafeVeg) project among 1577 consumers in urban and peri-urban areas in Benin in 2022 (Cotonou, Porto-Novo, Parakou, and Abomey-Calavi) identified three groups of mostly consumed vegetables in Benin: green leafy vegetables (Leaf sauce, jute mallow, *Gboma* eggplant, ironweed (vernonia), cassava leaves, moringa leaves, bean leaves, okra leaves), red, orange and yellow vegetables (carrots, orange sweet potatoes) and cruciferous vegetables (cabbage). Tomato, cucumber, green bell pepper are some vegetables that have been classified as ‘other vegetables’ (Snoek et al., 2023). This study revealed that vegetables are an important part of the local diet with almost all consumers having eaten vegetables in the 24-hour recall of the survey (Snoek et al., 2023). On average, cooked vegetables were eaten 5 days per week and raw vegetables 1 day per week, with almost one-third of the sample reporting daily vegetable consumption. Results on vegetable purchases confirmed the results on intake, showing regular buying of vegetables (2-3 times per week, on average). Vegetables from the category ‘other’, including tomato, onion, and okra, were consumed by a large proportion of consumers (83%). The intake of dark green leafy vegetables (47%), especially vitamin A-rich vegetables (7%), was less, which is of concern since these are the most nutrient-dense.

A cross-sectional study of 612 students (8-17 years of age) from 26 primary schools in southern Benin showed that 84% of students ate fruits and 68% irregularly ate vegetables (Sagbo et al., 2023). Another cohort study on women’s dietary diversity before pregnancy and during each trimester of pregnancy (n=234) in semi-urban settings in southern Benin indicated that consumption of “other vegetables” was nearly universal, but the consumption of other F&V food groups was low. Consumption of “other fruit” ranged between 20 and 30%, and consumption of “dark green leafy vegetables” between 15 and 25%. At preconception, the mean women’s dietary diversity score (WDDS) was low (4.3 ± 1.1 food groups), and the diet was mainly composed of cereals, oils,

vegetables, and fish. The mean WDDS did not change during pregnancy and was equally low during all trimesters (Djossinou et al, 2020).

The consumption of fruits by fruit-producing households does not depend only on their availability but also on factors such market value as farmers prefer to sell their produce to earn money, knowledge of the health benefits of these foods. The self-consumed part would correspond to the excess of production or unsold goods (Tossou et al., 2012).

In Benin, various factors affecting the consumption of F&V. Bello et al. (2023) and Sossa et al. (2023) reported the low knowledge of the importance of F&V consumption among school children and pregnant women. Sossa et al. (2023) emphasized education and knowledge in terms of food and nutrition during pregnancy. According to Nagassi et al. (2023), the availability (and even accessibility) of fruits throughout the whole year influences their consumption. He supported this statement with the fact that, in the Northwestern Benin the consumption of fruits and other products changed by season (Nagassi et al., 2023). Bankole et al. (2023) and Achigan-Dako et al. (2010) also reported the effect of season on vegetable consumption (e.g. basil leaves). In addition to the season, Bankole et al. (2023) reported mother's age, ethnicity, knowledge of use, and easy physical access as factors influencing F&V consumption. According to Alaofè et al. (2016), the installation of solar market gardens contributes to increasing the diversity of F&V in terms of production and consumption. Literature reported other factors such as the influence of parents' perceptions (Nago et al., 2012), and sociocultural and demographic factors (Achigan-Dako et al., 2011) which also affect F&V consumption in Benin. Regarding the socio-demographic factors, particular attention should be paid to cultural prohibitions restricting the consumption of some vegetables. In addition to these factors, it was also reported that living with his parents could improve regular fruit intake (Sagbo et al., 2023). Some of the factors reported above were also reported by FAO with other factors affecting consumption of F&V. It is the case of availability, affordability, education and culture, lack of knowledge, competition with alternatives, food safety and national policies. Nago et al. (2012) also reported safety as a key determinant of F&V consumption.

Location was identified as one of the factors influencing vegetable consumption (Snoek et al., 2023). Porto-Novo had the highest food insecurity, low vegetable consumption, and the lowest food safety knowledge compared to the other surveyed cities. The lowest levels of vegetable intake were reported in Parakou, while access to fresh markets was higher in that city – an interesting contradiction since fresh markets are a primary source of fresh vegetables. Other factors, such as habits and culture, may explain the lower intake of Parakou (Totin et al., 2024). Analysis of demographic differences showed that people in peri-urban areas consume less vegetables and experience higher food insecurity than people in urban areas. Slum residents are also a risk group regarding food insecurity. They are less likely to consider food safety when purchasing fruits and vegetables, suggesting that safety awareness interventions should target slum neighborhoods. Vegetables labeled as safe may have less market demand in slum neighborhoods than in higher-income neighborhoods.

Strong actions including nutritional education for school children, pregnant women, and mothers about the importance F&V should be initiated to increase F&V consumption in Benin. Legba et al., (2023) also suggest that to promote vegetable production and consumption in Benin, efforts must be made to address challenges related to production technology, efficiency, marketing, and food safety. The reduction of purchasing price and efforts on availability will enhance the consumption of F&V (Raaijmakers et al., 2023).

2.4 Most important fruit and vegetable supply chains and their contributions to food system outcomes

A study by Egah et al. (forthcoming) identified five crucial fruit and vegetable supply chains: A) international export-oriented trade, B) regional export- and import-oriented trade, C) domestic, longer-distance trade in less perishable fruits and vegetables, D) short-distance trade in urban and peri-urban produced vegetables, and E) rural to urban trade in home garden produced fruits and vegetables. These value chain types cover most fruits and vegetables produced, processed, and traded in Benin. The five types are described below, including how they contribute to food system outcomes (human health and nutrition outcomes, socio-economic and environmental contributions).

A. International export-oriented trade

International export-oriented trade involves the production, handling, and trade of pineapples from Benin to China, Europe, the United States, and other countries. These are highly formalized value chains with stringent government regulations, quality standards, and export controls. Foreign companies dominate these chains, contributing 0.42% to Benin's Gross Domestic Product (GDP) and 1.95% to its agricultural GDP (VCAD, 2020). Products need to meet strict international safety and quality standards. These value chains create income and jobs upstream, mainly for young men and women, notably in the production and processing of pineapple. These export-oriented value chains contribute to household income generation and, through that, to food and nutrition security.

Despite its success, the pineapple value chain faces notable challenges. Informal contracts between processors and producers create occasional supply shortages. Gender dynamics within the industry require further examination to understand the roles and contributions of women in production, processing, and marketing. Environmental problems with excessive water usage, land management, and pesticide application are common. Efforts to mitigate environmental impacts, such as adopting organic farming methods, are being implemented for the industry's long-term sustainability.

In conclusion, Benin's international export-oriented trade, notably the pineapple trade, exemplifies the country's potential for agricultural transformation and export-led growth. Its success underscores the importance of formalized value chains, strategic export partnerships, and sustainable practices in driving economic development and enhancing global competitiveness. The environmental challenges are significant because farmers use many chemical inputs and practice monoculture.

B. Regional export- and import-oriented trade

Important cross-border trade in tomatoes, peppers, onions, other vegetables, and less perishable fruits takes place between Benin and Nigeria, Burkina Faso, Niger, and Togo. Nigeria mainly receives Beninese produce, but trade flows with other countries in the region are two-directional, depending on the season. Although produce may be sourced from various farming systems in Benin, tomatoes, peppers, and onions usually come from semi-specialized production systems with irrigation facilities. Small-scale farmers usually operate in cooperatives, while larger-scale farms may be operated by a manager and owned by an absentee investor.

The contribution of this value chain to local food and nutrition security is mainly through the income and employment it generates, as little to none of the produce enters the local market. The contribution to Benin's GDP is limited due to its informal nature and because most traders are Nigerian rather than Beninese (Egah et al. forthcoming).

The governance of these value chains is mainly informal, with very little regulation and oversight. Informal networks, often dominated by powerful traders, govern the value chains, shaping market dynamics and terms of trade. Small-scale farms often have mixed-gender operations, while larger-scale farms are predominantly managed by male owners. Unskilled manual laborers, including young men and women, are employed during peak periods, highlighting the gendered nature of labor in the industry.

Production challenges, such as the cost and availability of fertilizers, pose significant risks to farmers and contribute to production constraints. Oversupply in the market puts downward pressure on farm-gate prices, suppressing the income of producers and laborers (Houessou, 2021). Environmental concerns are also present within the production systems, particularly regarding the use of pesticides and soil degradation. Efforts to explore alternative, environmentally friendly practices support ongoing concerns about environmental sustainability in the industry.

In summary, while export- and import-oriented trade offers opportunities for income and employment generation at the farm level, its contribution to food and nutrition security, GDP, and environmental protection is relatively small. Its governance structure and high level of informality present obstacles to the sustainable growth of related value chains and their contribution to important food system outcomes.

C. Domestic, long-distance trade in less perishable fruit and vegetables

This type of value chain concerns the north-south trade in fruit and exotic vegetables like tomatoes, onions, garlic, pepper, and cabbages, but also melons, mangos, pineapples, oranges, and pawpaw, primarily catering to urban and peri-urban markets. This trade of less perishable fruit and vegetables contributes significantly to the dietary diversity of urban and peri-urban consumers in Benin, providing essential vitamins, minerals, and dietary fibers. The availability of these vegetables helps meet the demand for fresh produce in densely populated areas.

While the overall economic impact of the trade in these fruits and vegetables is limited compared to other economic sectors, it plays a vital role in providing income and employment to smallholder farmers, wage laborers, and traders, contributing to livelihood security and poverty alleviation.

Value chains combine formal and informal elements, with smallholder farmers sometimes engaging in formal agreements with traders and transporters. Informal market vendors also distribute vegetables to consumers, particularly in urban areas (FAO, 2016). The value chains consist of a high diversity of firms involved. While smallholder farmers may operate individually or cooperatively, traders and transporters form informal networks to facilitate trade (FAO, 2016). Gender dynamics within these value chains vary, with women often involved in vegetable cultivation and marketing and men dominating transport and trade (FAO, 2016).

The production of less perishable fruit and vegetables generally has a higher environmental impact than, for example, perishable leafy vegetables. As such, there are challenges regarding pesticide use and soil degradation in these value chains. Fassinou-Hotegni et al (forthcoming) assessed the sustainability of 200+ vegetable farms in major vegetable growing areas in southern and northern Benin and none of them met sustainability scores considering social, ecological and economic aspects. Sustainable farming practices and resource management strategies are essential for mitigating environmental pressures and ensuring the long-term sustainability of the value chains (FAO, 2016).

D. Short-distance trade in urban and peri-urban produced vegetables

Short-distance trade in urban and peri-urban produced vegetables concerns vegetables mainly supplying urban consumers in Benin. Urban and peri-urban areas surrounding major cities like Cotonou and Porto-Novo serve as hubs for producing and trading perishable fruit and vegetables such as lettuce, cucumber, green leafy vegetables (GLV), and various indigenous vegetables. Smallholder farmers, mainly young men and women, play a crucial role in cultivating exotic fruits and vegetables in these urban and peri-urban areas. They employ a combination of traditional and modern farming methods to meet the demands of urban consumers. These farmers face various challenges, including access to land, water, inputs, and extension services, which impact the productivity and sustainability of their operations. They often have no land titles, making their business and livelihoods highly insecure. This may negatively impact their ability and willingness to invest in longer-term land and soil improvements.

The trade of perishable vegetables in peri-urban areas involves traders and vendors distributing the produce in local wet markets or to caterers, such as restaurants, schools, and street food vendors. These actors operate within formal and informal channels, but regulations and standards only apply to the formal trade. Young men and women actively participate in vegetable cultivation and trade, but gender disparities exist in access to resources, decision-making power, and income distribution, highlighting the need for gender-sensitive interventions and support mechanisms.

Environmental sustainability is a key concern in urban and peri-urban vegetable production, given the intensive use of inputs such as water, fertilizers, and pesticides. Sustainable farming practices, including integrated pest management, water conservation, and soil health management, are essential for minimizing environmental impacts and ensuring the long-term viability of the value chains.

E. Rural to urban trade fruit and vegetables produced in home gardens

In most of Benin's many different farming systems, women produce a large diversity of crops in home gardens for home consumption. These gardens feature many types of fruits and vegetables. Gardeners sell their surplus to local markets or collectors. Women do not use purchased inputs or improved seeds; most varieties are local, although gardens may include exotic crops such as tomatoes, garlic, peppers, and onions.

Trade in these crops occurs in rural markets where women may sell their surplus themselves or through collectors, who can be either villagers or outsiders working for wholesalers, aggregators or other value chain agents. Once aggregated, these products end up on urban wet markets. Although in many cases, they are produced under environmentally friendly conditions – yet do not ensure any standards – they cannot be distinguished by end customers as to their origins and production quality.

Women produce most fruits and vegetables in these value chains and are also highly present in retail. In between stages, women are also represented except for transportation. As such, value chains of this type are the most inclusive regarding women's involvement in economic activities and benefit sharing.

2.5 Food system drivers

Drivers are influencing factors or factors that drag the food system activities and outcomes in a particular direction. The food system operates within a broader context of human systems and natural systems, with multiple interactions and feedback loops between these systems. These broader systems create a set of external drivers and their trends that shape the behavior and evolution of the food system, though each actor in the system will be influenced and thus react differently.

Multiple drivers can be identified that influence the food system differently. They may include population, wealth, consumption preferences, technological developments, markets, environmental factors, and politics. While looking at the key factors that could significantly affect the positioning of fruits and vegetables within the food system in Benin, five could be pointed out: investment, institutional support, supply, market, and consumption.

For fruits and vegetables to gain importance in the Benin food system, the quality of specific **investments** made in the sector by the public or private actors represents an important driver. The last 20 years, initiatives or investment programs such as Projet d'Appui à la Compétitivité des Filières Agricoles et à la Diversification des Exportations (PACOFIDE), Projet d'appui au développement du maraîchage (PADMAR), Projet d'Appui aux Infrastructures Agricoles dans la Vallée de l'Ouémé (PAIA-VO), Projet de Développement des Périmètres irrigués en milieu Rural (PDPIM), SafeVeg, FRESH, IG - Kona sugarloaf have impacted the development of fruits and vegetable sector. Moreover, the installation of private investing groups for developing the fruit and vegetable sector (modernization of Les Fruits Tillou and IRA, Agricorp Resources Group, Blue Skies, etc.) has increased the production and supply of F&V.

Institutional support is also a key promoting factor for fruit & vegetable development within the food system. Several actions performed in the last ten years have highly stimulated F&V production. The Benin government has organized the primary production system so that F&V production is erected as a priority activity, especially in two Agricultural Production Zones (PDA 1 et 7). Moreover, public authorities' engagement helps obtain the Geographic Indication (GI) of the Kona sugarloaf pineapple, which opens the Chinese market to Beninese farmers. However, for this engagement to get sustainable results and keep the interest of end-users:

- Specialists of F&V should be engaged to advise and provide guidance to the farmers,
- Rules and regulations for safe F&V production need to be in place and endorsed, and
- More nutritious and climate-resilient varieties should be developed and promoted.

Given several improvements and developments, the supply of fruits and vegetables was perceived to have increased. Increased investments in vegetable value chains were perceived by some participants to be mainly focused on high market value crops (e.g.: tomatoes and onions) and not always on the most nutritious ones. Another key driver in terms of supply has been better access to inputs such as quality and improved seeds, fertilizers, and pesticides that promote better yields. In recent years, the supply of fruits and vegetables has also been driven by increased market demand, including small enterprises and those working to process and market fruit and vegetable products.

Markets are a driving force in the role of fruits and vegetables in Benin's food systems. Given the increased interconnectedness of markets through trade liberalization, the role of regional markets in neighboring countries such as Nigeria, Ghana, Togo, Niger and Burkina Faso influence the production, trade, and demand for fruits and

vegetables in Benin. Furthermore, increased urbanization also influences how consumers in Benin procure and consume fruits and vegetables. To a degree, there is increased demand for fruits and vegetables in urban areas in Benin. However, there is also increased demand for convenience foods in urban markets, influencing diets and what consumers are purchasing.

The prioritization of nutrition, through projects and policy, has contributed to people's increased awareness of the importance of F&V to nutrition. These changes and socio-cultural elements have influenced Benin's consumption of fruit and vegetables. Workshop participants also noted, however, that there is insufficient data and evidence on nutrition, diets, and the consumption of F&V in Benin.

2.6 Change agents of food system transformation

Food systems comprise many types of actors who directly influence or are influenced by the system. These actors, whether individuals, groups, or institutions, have the potential to drive, enable, or even inhibit changes in the transformation of the food system. This ability to influence change within the food system makes these actors change agents. Change agents can promote or inhibit the policies, actions, and investments needed to achieve food system transformations.

In Benin, the change agents for transformational change within the food system are diverse. Identified change agents include government institutions, civil society organizations, development partners, and traditional leaders in the country for their role in strengthening institutions, policies, laws, and regulations, providing needed resources for change, and organizing sections of the population.

Key change agents, including the country's President and his office, are identified at the government level. The President drives policy priorities, and this office can spearhead the government's interest in and investment in food systems. In addition to the President's office, two other government bodies were identified as key change agents, notably the Permanent Secretariat of the Food Council and Nutrition (Secretariat Permanent du Conseil National de l'Alimentation et de la Nutrition- SP/CAN) and the National Agriculture Development Fund (Fonds National de Développement Agricole- FNDA). The SP-CAN is a multisectoral institution designed to coordinate actors across sectors working on food and nutrition and, therefore, can significantly influence food systems. More recently, the government of Benin has also established a new agency for food and nutrition (Agence Nationale de l'Alimentation et de la Nutrition-ANAN) that will replace the SP-CAN. The National Agriculture Development Fund under the Ministry of Agriculture focuses on access to financial and non-financial services such as funding for agricultural projects, funds for agricultural research, capacity strengthening, and market certification services. The primary beneficiaries of these funds are the private sector actors such as cooperative societies, women's associations, farmers' organizations, etc.

Civil society actors, such as member-based organizations, were also identified as potential drivers of change in Benin's food system. These organizations include agricultural producer organizations such as the Plateforme Nationale des Organisations Paysannes et de Producteurs Agricoles (PNOPPA), the Plateforme des Acteurs de la Société Civile du Bénin (Network of Civil Society Actors; PASCIB), the Society for the Development of Cotton (Société de Développement du Coton; SODECO), the women organizations (ANaFEA-BENIN) and the Fédération Nationale des Organisations de Maraîchers (National Federation of Gardener Organizations; FeNOMa).

Development partners also play a crucial role as change agents within the food system through their technical and financial support to the country. Organizations such as the UN's Food and Agriculture Organization (FAO) were highlighted as key change agents for providing technical and financial support to address food systems.

Lastly, traditional and religious leaders play a crucial role in Benin society. Specifically, Vodou priests and local traditional leaders or kings ("Têtes couronnées") were identified as change agents because they could influence consumers to eat healthy diets, including fruits and vegetables.

3. Visioning the future of fruits and vegetables

3.1 Projected trends towards 2060

The two workshops identified five key trends, which can be extrapolated in time to continue impacting in one way or another on the functioning of Benin's food system and its outcomes. The trends presented here are identified as influencing the role of fruit and vegetables in Benin's food system. Extrapolation of these trends is based on the assumption that 'nothing else changes', such as policies or stakeholder actions that are taken to redirect a trend.

The first trend is the **increased consumer demand** in absolute terms for fruit and vegetables due to population growth, income growth by the middle class, and urbanization. This is different from changes in consumer patterns, which could result in a higher per capita consumption of fruit and vegetables, which is not yet a trend that is generally observed in Benin. A similar growth in consumer demand due to population growth and urbanization is observed in neighboring countries, notably in Nigeria, where also the processing capacity of fruit and vegetables is increasing, resulting in increased regional demand for fruit and vegetables from Benin.

The second trend is **climate change, reflected in changing rainfall patterns resulting in more frequent dry spells or floods** and increased temperatures reducing the favorable seasons for the production window of heat-sensitive crops. These changing weather conditions will increasingly constrain the production of fruits and vegetables. Note that there may well be more changing weather impacts than mentioned here.

The third trend is the continued **non-rational use of chemical inputs**, notably pesticides, in the production of fruit and vegetables, which are harmful to the environment and humans.

The fourth trend is the continued **informal nature of the fruit and vegetable sectors**, also associated with a low processing capacity and the absence of more formal and larger corporate businesses. Most fruits and vegetables in Benin are traded through non-registered small and medium sized enterprises (SMEs), whereas the export of pineapple is the sole exception to the rule. SMEs have their own modes of organization and governance and are capable of trading fruit and vegetables over long distances to urban consumers, but meeting product standards, reducing transaction costs and reducing food loss will remain great challenges in the near future.

Finally, the fifth trend is the **low yield of fruit and vegetables** due to the declining soil fertility, absence or inaccessibility of improved seeds, and other production constraints such as weather risks and the generally low adoption of new technologies by Beninese fruit and vegetable producers.

3.2 Critical uncertainties towards 2060

Contrary to trends, uncertainties are less predictable but can also have a significant impact, positively or negatively, on food systems. Uncertainties lead to future shocks or unexpected impacts on the food system. The two workshops identified four categories of critical uncertainties that can alter the direction and nature of Benin's food system. Each category contains several uncertainties.

Uncertain changes in F&V supply chains: The first category of uncertainties relates to what can occur within the F&V supply chains in the country due to various contributors. The availability, accessibility, and quality of inputs are uncertainties that could influence the total yields and supply of F&Vs in the country. In addition to inputs, it is uncertain how the development and adoption of high-performance technologies will be taken up in the country and at what scale. Lastly, as demographics change, rural employment and labor participation in the production of F&V is another uncertainty that can affect the production and availability of F&Vs.

Uncertain changes in consumption behavior: The second category of uncertainties identified by workshop participants was related to changes in consumption patterns and consumer behavior. For example, workshop participants were highly concerned about the nutrition transition, the shift in dietary behavior away from traditional foods toward highly processed foods rich in energy, sugar, salt, and fat, and poor in nutrition. Participants noted that most people in Benin are not much concerned about this, but it is a change that could influence the food

system and should not be neglected. Consumer habits and perceptions of F&V, including local and indigenous F&V behavior, or more processed foods, can also have a significant impact on population diets.

Uncertain changes in national, regional, and international politics and relations: The third category of uncertainties relates to local, regional, and international politics and institutions which can influence the economy, production, and consumption. The specific uncertainties mentioned by participants include the leadership and party in power in Benin, the diplomatic relations with neighboring countries, and the overall security in the West Africa region. These uncertainties can influence regional and international geopolitics which can in turn affect the overall security in Benin, including people and the economy. Another key uncertainty is the monetary stability of the CFA currency in West Africa and the implications it would have on local and regional economies.

Uncertain responses by producers to climate change effects: A critical uncertainty that could affect the food system, especially F&V, in Benin by 2060 is how producers are capable of responding to climate change effects. Often, the positive effects of climate change are outweighed by much larger negative effects. Uncertainties around climate change and how value chain actors such as farmers, transporters, retailers, and vendors will respond to it is a critical uncertainty for F&Vs in the food system (Table 2). The effects of climate change may also potentially affect issues such as pandemics, increased and new pests and diseases which could negatively affect the production and availability of quality, nutritious, and safe F&V.

Table 2. Uncertainties towards 2060

Fruit & vegetable supply chains	<ul style="list-style-type: none"> ○ Integration of GMO seeds ○ Availability, accessibility and quality/safety of fruits and vegetables ○ Availability, accessibility and quality of inputs ○ Development and adoption of high-performance technologies ○ Rural employment and labor availability
Consumption and consumer behavior	<ul style="list-style-type: none"> ○ The direction of the nutritional transition ○ Consumer habits, behavior and perceptions of fruits and vegetables ○ Integration of indigenous fruits and vegetables and notably healthy species including green leafy vegetables into diets
National, regional, and international politics and relations	<ul style="list-style-type: none"> ○ Political regime in Benin ○ Reorganization of agricultural development agencies affecting fruit and vegetable production ○ Regional & international geopolitics and economic dynamics ○ Diplomatic relations with neighboring countries ○ Overall security (people, property) ○ Monetary stability in Benin and in the subregion
Climate change effects	<ul style="list-style-type: none"> ○ Climate change effects on fruit and vegetable production and quality and how producers will respond ○ Epidemics/Pandemics ○ Pests and diseases

3.3 Three plausible future scenarios

Following the stepwise approach to foresight analysis, the identified key trends and critical uncertainties were cross tabulated to identify the combinations with the most significant impacts on the food system and the role of fruit and vegetables (Figure 3). Four combinations of trends x uncertainties were selected, and their plausible impacts on the food system were evaluated by applying extreme situations to each of them (**Table 3**). By doing so, three plausible future scenarios emerged as likely food system responses to these combined trends and uncertainties:

Table 3. Exploring scenarios for future food systems and the role of fruits and vegetables by 2060

Major trends	Uncertainties	Extreme X	Scenario A	Scenario B	Scenario C	Extreme Y
Domestic and regional demand for fruits and vegetables	Direction of the nutritional transition and consumer preferences	High consumption of healthy and safe fruits and vegetables	Consumption of the recommended level of healthy and safe fruits and vegetables	Consumption of the recommended level of fruits and vegetables	Stagnation in fruit and vegetable consumption	Decrease in fruit and vegetable consumption
Current, persistent predominance of informality in fruit and vegetable value chains	Future levels of formalization and industrialization of fruit & vegetable value chains	High level of formalization and industrialization	Disappearance of small businesses to conglomerates	Predominance of small and medium-sized enterprises	Predominance of small and medium-sized enterprises	Predominance of the informal sector and stagnation of industrialization
Effects of climate change on fruit and vegetable production	Available technology, adoption rates and producers' responses	Producers are able to meet demand and challenges through access and adoption of technologies	High proportion of professional healthy and safe fruit and vegetable growers	High proportion of professional producers	Producers are not able to meet demand and challenges	Producers are not able to meet demand and challenges
Benin's future political regime and current regional instability	Capacity of the State to regulate Dynamics of regional and international geopolitics	Business climate conducive to the development of safe fruit and vegetable value chains	Incentives, regulation and effective enforcement for the development of healthy and safe fruit and vegetable value chains	Incentives for the development of fruit and vegetable value chains	Lack of incentives and non-enforcement of fruit and vegetable value chains	Further deterioration of the business climate for fruit and vegetable value chains

Towards 2060, two extreme situations guide the identification of future food system scenarios. The first extreme, called X, postulates that in the future, high consumption of safe fruits and vegetables will increase the formalization and industrialization of manufactories or enterprises. Farmers respond to the demand by innovating, investing and adopting technologies for the safe production of fruits and vegetables. The government provides an enabling environment for this food system transformation and regulates food safety.

To the other extreme, called Y, the food system and the role of fruits and vegetables deteriorate due to a change in consumer behavior towards less healthy diets, stagnation in the coordination and development of fruit and vegetable supply chains, climate change effects, producers' incapacity to respond, and deterioration of the business climate for the fruit and vegetable sector.

Based on these two extremes, three distinct scenarios for future food systems may develop. Scenario A forecasts a food system in which consumption of recommended levels of safe fruit and vegetables in Benin will cause the disappearance of informal SMEs in favor of formal business conglomerates and increase professional farmers specialized in safe fruit and vegetable production. The food system operates in an incentive environment in which the state is successfully able to regulate the supply of safe fruit and vegetables to consumers. This scenario could be possible if the government is able to implement and enforce regulations, stimulate the formalization of businesses and motivate the companies and conglomerates to invest in safe fruit and vegetable supply chains. In this scenario, civil society contributes to raising consumer awareness of the importance of eating fruit and vegetables. This scenario requires agroecological practices and agroecological inputs (bio-fertilizers and organic pesticides) to be promoted and adopted by farmers to increase safe fruit and vegetable availability and accessibility in the food system. Informality will decrease, and the business conglomerates will emerge for fruit and vegetable processing.

In scenario B consumers will increase the portion of fruit and vegetables in their daily diets, which will result in increased market demand. Farmers will gradually professionalize their production practices, even when climate change affects their production environments, but not be able to meet the requirements for food safety. SMEs will dominate the supply chains which remain predominantly informal, stagnating the evolution of larger processing industries. In view of this, the government may provide certain incentives but will have continued difficulties enforcing food safety regulations.

Scenario C describes a situation in which farmers and other supply chain actors are not capable of meeting consumer demand in Benin due to climate change effects, commodity exports, and a lack of government incentives. Due to the unavailability of fruit and vegetables, their unsafety, and their unaffordability, consumers reduce their consumption while increasing their consumption of less healthy food options.

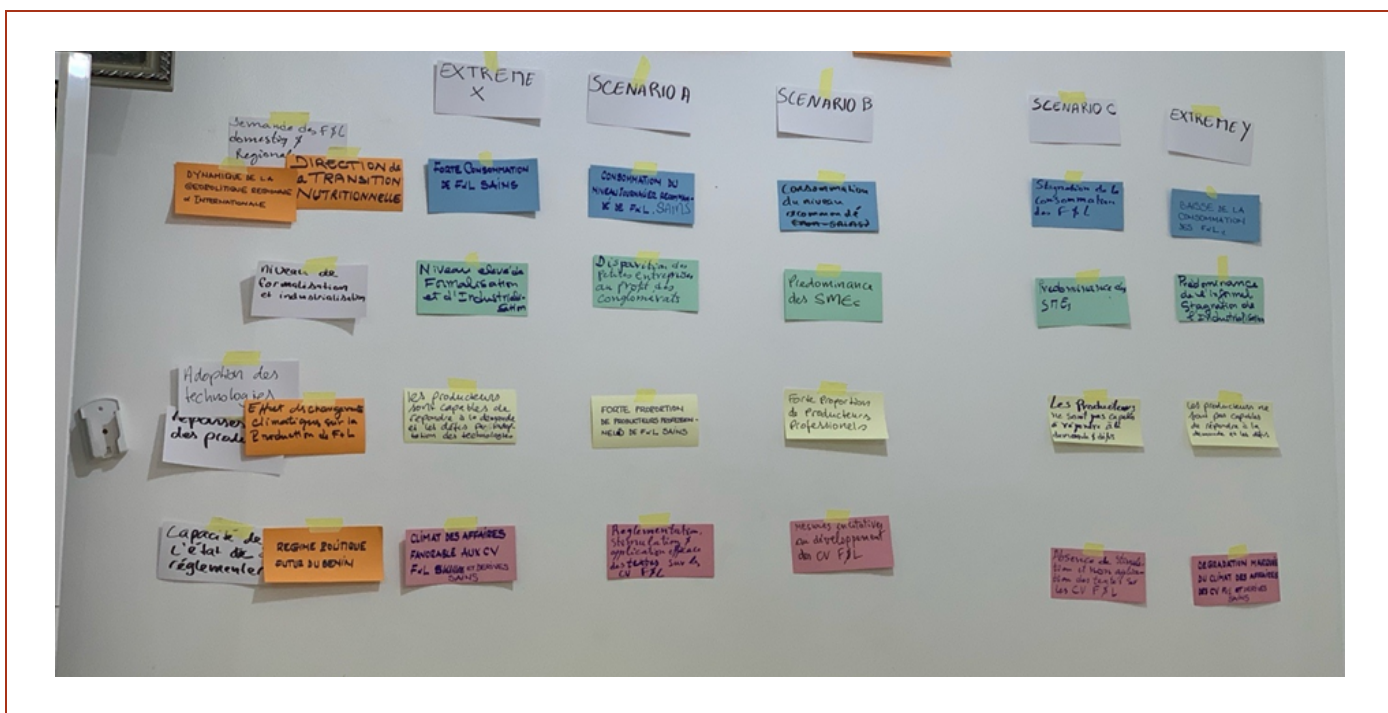


Figure 3. Scenario analysis by stakeholders using a whiteboard and sticky notes

3.4 Back-casting: anticipatory policy and stakeholder actions

After identifying the different types of scenarios, workshop participants identified actions that should or should not be taken to achieve the intended scenarios - a process called back-casting. These actions represent the pathways that lead to each scenario. Five guiding questions were used to guide the development of the pathways to the three identified scenarios:

1. What are the implications and results on the food system
2. What are the possible drivers of the change?
3. Who are the critical key actors in making this change happen?
4. What actions need to be initiated?
5. What will be the synergies and trade-offs to manage?

Pathways to Scenario A

Scenarios A and B reflect desirable futures in terms of increased consumer demand for fruit and vegetables and the ability of supply chains to deliver these. However, there are some distinct differences between the two scenarios. Scenario A presents a future where there is a focus on not just the availability and consumption of healthy F&Vs but also safe and healthy F&Vs. In this scenario, the supply of sufficient and notably safe F&Vs is

associated with a process of formalization and professionalization of value chain actors, including the replacement of small businesses with larger companies or even conglomerates. At the policy level, Scenario A represents a future where the enabling environment endorses and effectively enforces laws and regulations that are implemented by value chain actors for the development of healthy and safe F&V value chains.

Implications and results for food systems under Scenario A

Under Scenario A, the production of F&V would be more resilient and less harmful to the environment and improve the livelihoods of actors working in the F&V sector. There would be increased consumption of healthy and safe F&V and improvements in the overall nutritional status of the population. These improvements in food and nutrition security would lead to improvements in human health and stronger human capital in the country and increased productivity. Overall, these improvements would lead to increased productivity, economic growth, poverty reduction, and an environment conducive to better human and animal life.

Drivers and actions needed to achieve Scenario A

Workshop participants identified important drivers and actions that could lead to the desired changes in scenario A. These drivers include factors related to consumption, technology, investments, resources and markets, and policy-level interventions. In regard to consumption, there would need to be increased awareness of the importance of F&V to nutrition and health and increased awareness of food safety risks. This increased awareness of the importance of eating F&Vs could be promoted through actions such as Social Behavior Change Communication (SBCC) (campaigns to increase consumers' awareness of the importance of F&V, encouraging F&V supply in school canteens, and integrating nutrition in school curricula. In regard to the safety of F&Vs, workshop participants recommended equipping citizens with the ability to monitor F&V safety. Lastly, improving the consumption of healthy and safe F&Vs could be attained by supporting existing consumer association networks in the country to address issues on healthy diets and health and nutritional outcomes.

Another key driver to achieving Scenario A will be the increased availability and accessibility of technologies and innovations that address the different value chains of the food system such as seed, production, processing, and transport systems. For example, in terms of inputs, participants highlighted that Benin would need to invest in increasing farmers' access to seed varieties to promote safe and healthy production (i.e., resistance to pests and diseases, use nutrients more efficiently, and thrive under climate change challenges). Production systems would need to be more mechanized and would promote the use of organic manure and biopesticides, strengthen agricultural advisory and extension services to strengthen producers' capacity to use rational amounts of chemicals when needed and adopt GAP to produce safe and healthy F&Vs. There would also need to be investments and technology improvements in processing and industrialization processes which would be driven by the increased presence of larger or conglomerate businesses. Participants also identified key actions needed to improve the infrastructure and introduce transformative technologies. Investments in processing, packaging, storage and conservation tools and practices would be necessary. This would include addressing F&V transport logistics, in terms of post-harvest management technologies and logistical organizations, to allow for the transportation of F&Vs across different regions of the country while being mindful of the potential to lose a lot of products on the way due to packaging and weather/temperature conditions.

Achieving and scaling these technological innovations will not be possible without increased investments in research and development (R&D). Participants specifically highlighted that the country would need to prioritize holistic R&D on F&Vs. They identified holistic R&D to explain that there should be more funding for the whole food system, and funding for nutrition given the gaps in research and data on nutrition, diets, and the consumption of F&Vs in the country. In addition to increasing investments toward R&D across the food system, strengthening human capital is essential across primary, secondary, and tertiary levels.

Policy is the last key driver of the food system in Benin that is needed to achieve Scenario A. The main drivers identified are that Benin's policy environment would need to reflect a strong sense of political will to promote F&Vs for improved diets. This political will would also need to be translated into policies, regulations, and incentives that are applied optimally to develop and support innovations across the different value chains of the food system. These would address the key areas identified in the other drivers of change towards Scenario A such as infrastructure development, logistics, agricultural practices, and programs to promote healthy diets through the increased consumption of F&V. The policy environment would also need to increase access to energy at

affordable prices to support the mechanization and industrialization of processing. Policies and regulations would also need to be developed and implemented addressing the topic of food safety when it comes to F&Vs. Strengthening the policy environment on food safety could be supported through actions such as developing quality standards for F&V, strengthening the quality certification system, and supporting the quality control of processed and unprocessed F&V products through sufficient funding.

Stronger public-private partnerships could lead to increased investments in the different domains of the food systems. Government incentives, such as the taxation of imported F&Vs and subsidies and the exemption of taxes on agricultural inputs and equipment imported into the country, could provide relief to local producers and food system actors.

Critical actors to make these changes happen

Achieving Scenario A by 2060 will require the support of key actors across government, academia, civil society, and professional organizations.

In **government**, various institutions across different ministries and departments will be needed to create an enabling environment, deliver services, etc. **Universities and research centers** will also play a key role in conducting the research and development needed to provide evidence, create innovations, and identify optimal ways to scale innovations. **Civil society organizations** along with **professional organizations** for the actors who work across the food system will also be critical to moving things forward in the food system. The experiences of these actors will be important in order to address challenges and constraints they face in their work, in developing their sectors, and adapting new ways. **Technical and financial partners** of Benin will be needed to provide financial support.

Importantly, consumers themselves will be critical to achieving Scenario A. As the consumers of F&Vs, it will be essential to reach these actors with messaging and consumer-to-consumer influencing. Middle-income consumers will be an important group in this scenario in case there is a rise of conglomerates and the disappearance of small businesses. Consumers in rural areas and low-income consumers in urban areas will also be a key group of consumers to reach and target in order to increase the overall consumption of globally recommended levels of safe F&Vs.

Despite these different actors being critical to achieving the intended situation in Scenario A, it is important to identify who would be key supporters and those who could be potential resistors to the situation. **Key supporters** of this scenario include (a) producers of organic inputs, (b) processing investors, (c) large companies of F&Vs and supermarkets, and (d) territorial agricultural development agencies (ATD) in charge of the promotion of F&Vs. **Potential resistance** for this scenario could come from small-scale producers and small-scale and medium enterprises as this scenario favors large businesses and conglomerates. Producers, importers, and distributors of chemical inputs could also be key resistors of this scenario as these products would be less used to promote the production and transportation of safe F&Vs.

Trade-offs to manage

Achieving the situation in Scenario A by 2060 will involve the management of potential trade-offs. A distinct characteristic of Scenario A is the disappearance of the majority of small, informal businesses to the rise of formalized, larger enterprises and conglomerates. While the rise of these types of businesses may mean the industrialization of sectors and technological and efficient advances across the food system, it will have negative effects on many of the excluded informal SMEs - which represent a large portion of enterprises in Benin's society currently. The exclusion of SMEs could lead to loss of employment and deliberate policies and actions would need to be taken on how to integrate people into the jobs available within larger enterprises or how to capture these workers in other industries.

While implications on the environment in Scenario A are expected to be largely positive - given the decreased use of biochemicals in production, other types of pollution may arise. The rise of large businesses and conglomerates can have negative implications on the environment. There can be risks of increased industrial pollution from these companies. Preemptively preparing for such cases can help the country address these challenges and mitigate any adverse environmental outcomes.

Lastly, the availability of healthy and safe F&Vs to local consumers should not be assumed because of large businesses and conglomerates that can supply these food products. Having few and large producers and retailers of F&V through so-called 'super marketization' can limit the diversity of F&Vs available to consumers. The cost of healthy and safe F&Vs may also be a challenge and can lead to low consumption if the costs are not affordable to consumers. There is also the risk of conglomerates and large enterprises exporting their production to international markets to the detriment of local consumption as is already experienced in some domains in Benin today. Such practices would decrease the availability of F&Vs in the country and negatively impact affordability and the amount available to consumers. Lastly, the existence of large businesses and conglomerates does not exclude these companies from selling products outside of F&Vs. These companies could also increase the availability of unhealthy and ultra-processed foods in the country which can contribute to the nutrition transition and to less nutritious diets.

Pathways to Scenario B

In scenario B, consumers increase their awareness of the need for fruit and vegetables for their health, resulting in increased market demand that can be met by farmers, SMEs, and other businesses. Formalization does not seem to be a condition for their professionalization. Meeting the increased demand for fruit and vegetables seems to go at the expense of food safety, which is not prioritized by the government in this scenario.

Implications and results for food systems under Scenario B

The overall food system in Scenario B shares many similarities with Scenario A. Food and nutrition security outcomes are similar as the population consumes more F&Vs leading to improved nutritional and health status. Improvements in human capital and increased productivity are also observed leading to a stronger economy that is reflected in poverty reduction and job creation. The main difference with Scenario A is that Scenario B has continued use of chemical inputs in the production value chain and the F&Vs that are available in sufficient supply in the country are unsafe due to unsafe production practices. This continued use and misuse of chemical inputs also has adverse environmental effects.

Drivers and actions needed to achieve Scenario B

Increased consumption is a key driver, stimulated by the increased awareness of the importance of F&Vs through social marketing, regulation, and advocacy by consumer organizations and others. The difference in consumption drivers in Scenario B is that there is less consumer awareness of food safety risks associated with F&Vs due to a lack of campaigns and programs supporting this component.

The supply-side value chains in this scenario are dominated by SMEs which are able to meet the demand for F&Vs but are not strongly formalized. This lack of formalization means that although inputs for production are available and accessible, production systems are not mechanized or updated. Infrastructure and transformative technologies are developed and adopted across value chains. Therefore, food processing, packaging and storage, conservation, logistics, and other technologies are adopted by value chain actors in Scenario B.

There is, however, less access to safe inputs because there is no focus on supplying green manure and biopesticides. Although attempts are made to strengthen producers' capacities for the rational use of chemicals, it does not reach many in the country. This results in low levels of awareness among producers on GAP to produce safe F&Vs.

At the enabling environment level, the application of policy and regulation texts on the development of F&V value chains is also sub-optimal, especially when it comes to food safety. For example, although quality standards for F&Vs are developed, the quality certification system is not developed or operational for processed and unprocessed F&Vs. The enabling environment also does not rise to the occasion of facilitating the formalization of SMEs

Critical actors to make these changes happen

Achieving Scenario B by 2060 will require the support of key actors across government, academia, civil society, and professional organizations. These actors are similar to those identified in Scenario A. Workshop participants identified only three main differences in the key actors that are essential for the above changes to happen. These

actors are DPV (Direction de la Production Végétale) in government, the Patronat and CIPB (Conseil des Investisseurs Privés du Bénin) as para-public structures.

Key supporters of Scenario B different from Scenario A are SMEs because large companies and conglomerates were more important in Scenario A. Actors who would not be supportive of Scenario B's food system are the producers and consumers who value food safety and the use of organic inputs in production and may feel this domain is not prioritized.

Trade-offs to manage

Achieving the situation in Scenario B by 2060 will also involve the management of potential trade-offs across the different food system domains. Although Scenario B would involve more and larger formal producers working with SMEs, there is a potential loss of revenue for the state in terms of tax revenue they could collect from more formal and larger enterprises. The other key trade-offs that workshop participants identified in Scenario B are the risk that unsafe F&Vs pose by being on the market and consumed by the population and the pollution risks that result from the misuse of chemical inputs by farmers during production.

Pathways to Scenario C

Scenario C depicts a less-than-ideal situation in which stakeholders do not take collective action, and the government and its agencies do not prioritize developing and investing in the F&V sector. Climate change effects, lack of consumer preferences for F&Vs, and economic interests will overshadow enhancing the food and nutrition outcomes of the food system.

Implications and results for food systems under Scenario C

The food system under Scenario C is not resilient as it faces low F&V production and high post-harvest losses given the lack of investment in technology, innovation, and infrastructure across value chains. It involves the high use of chemical inputs to try and increase yields leading to unsafe F&Vs.

The food system under this Scenario exhibits low food and nutrition security outcomes. These outcomes are due to the low consumption of F&Vs which lead to an increase in diet-related diseases and the continued prevalence of micronutrient deficiencies. At the environmental level, the system faces environmental challenges due to the high use of pesticides and biochemicals during production. Economically, Scenario C reflects a situation where the food system is led by SMEs that are not well supported and produce low profits for producers and other value chain actors and overall low productivity for the country.

Drivers and actions needed to achieve Scenario C

This scenario is driven by the lack of priority and collective action by the government, its agencies, and stakeholders within the food system. Although some actions may be taken to develop and disseminate technologies for production, processing, packaging, storage, and conservation, these innovations are not shared, taken up, or scaled widely given the lack of priority given to this sector and the role of F&Vs in food systems.

Critical actors in Scenario C

Even though Scenario C is marked by a lack of priority and progress for the F&V sector in Benin, workshop participants still identified actors who would be playing a role, albeit not an optimal role. These include **government actors** such as ABSSA (Agence Béninoise de la Sécurité Sanitaire des Aliments) and DDAEP (Direction Départementale de l'Agriculture, de l'Élevage et de la Pêche). It also includes **universities and research centers** in Benin that conduct research in the various domains of the food system. **Civil society and professional organizations** would also be critical actors. These actors would play a role in mitigating the reverse effects of this scenario. **Technical and financial partners** would also continue to play their role as key partners for sustainable development in Benin. However, without identified priorities, and coordinated actions towards the key drivers of food systems, the actions of these actors would not lead to transformative changes on F&Vs and the food system overall.

This scenario would not have any particular supporters and proponents. However, some actors could resist this type of situation such as small-scale producers and SMEs who would face economic hardships and low

productivity. Formal businesses may also be resisters. Lastly, producers and consumers who would be proponents of healthy and safe F&Vs may resist this scenario which would not be conducive to the availability of safe and nutritious F&Vs.

Trade-offs to manage

Some key trade-offs to manage in this Scenario include poor economic development outcomes due to low productivity, low profitability across value chains, and low revenue for the state. Another important trade-off to manage is the safety risk to producers and consumers from misusing hazardous inputs in the production of F&Vs.

3.5 Anticipatory policy and stakeholder actions

Stakeholder engagement centered on the promotion of F&V across the food system's value chains can foster capacity and knowledge exchange to find solutions on how to improve the availability, accessibility, affordability, and desirability of F&V. Intentional and collective action on F&Vs among stakeholders across the food system can help Benin move towards the Scenario the country would like to see in 2060. The implications and drivers identified from this foresight analysis can induce stakeholders' engagement towards the changes needed to promote sustainable healthy diets, and specifically the increased production and intake of F&V. It is important to engage the different stakeholders across the F&V food system in order to address the different domains of the food system. Stakeholder engagement consists of iterative actions and activities that enable dialogue between individuals, groups, and institutions to listen, inform, and collaborate toward a common goal or vision (O'Riordan and Fairbrass, 2014; Cundy et al., 2013; Kujala et al., 2022). It is for this reason that it was important to work with the National Platform of Actors in Vegetable Value Chains in Benin in this Foresight Analysis work. Their implication in the analysis of this work strengthened these results as they could contribute throughout the process based on the realities on the ground and their experience in the food system.

Consequently, the members of the National Platform of Actors in Vegetable Value Chains identified relevant actions they could begin to take toward reaching the ideal Scenario of A or B. In Table 4, the specific actions mentioned by actors are summarized by value chain and by type of actor. Some actions were identified as collective actions that should be taken by the Platform while others are actions specific stakeholders can take within their domain. The identified actions illustrate the engagement and support of the vegetable value chain actors to prioritize F&Vs in the food system and take action to move toward the desired scenario.

Table 4. Identified actions to be taken by the National Platform of Actors in Vegetable Value Chains

Food system component	Theme	Mentioned by				
		Govt	Civil Society	Private Sector	Academia	Multi-Stakeholder Platform(s)
Consumption	Raise consumer awareness on the importance of F&V consumption through SBCC and campaigns	✓	✓			
	Conduct research to better understand the intake of F&V and barriers to F&V consumption, including preferences		✓		✓	
	Encourage interventions, including home and school gardens	✓				

Food system component	Theme	Mentioned by				
		Govt	Civil Society	Private Sector	Academia	Multi-Stakeholder Platform(s)
Production	Produce certified F&V seeds			✓		
	Facilitate access to quality inputs	✓		✓		
	Support the capacity of manufacturers to produce biopesticides and biofertilizers			✓		
	Support producers to use biopesticides and biofertilizers	✓	✓			
	Promote agroecology and agroecological practices	✓	✓	✓		
	Support the capacity of farmers on good ag practices	✓				
	Mapping large F&V production areas according to the seasons			✓		
	Advocacy for subsidizing inputs for production		✓			
	Facilitate registration of F&V varieties in the Beninese catalog of varieties	✓				
	Facilitating approval of biopesticides	✓				
Develop catalogs of input suppliers in the country	✓	✓				
Post-harvest	Strengthen women entrepreneur's post-harvest management capacity		✓	✓		
	Advocacy for the installation of appropriate conservation infrastructure (cold room; refrigerated trucks)		✓	✓		
	Strengthen capacities of traders on the conservation and professional transport of F&V		✓	✓		
	Develop a catalog of the technologies available focused on the conservation and transformation of F&V	✓	✓			

Food system component	Theme	Mentioned by				
		Govt	Civil Society	Private Sector	Academia	Multi-Stakeholder Platform(s)
Processing	Conduct a study on the categorization of F&V processors			✓		
	Strengthen business links between producers, processors, and traders		✓	✓		
	Consider or integrate food safety and nutrition aspects in ag research (production, transformation, health soils, plant protection)	✓		✓		
Enabling environment	Dissemination of findings from research and studies		✓			
	Review of F&V policies	✓				
	Monitoring implementation of activities	✓				
	Support innovative platforms for F&V				✓	
	Multi-stakeholder collaboration	✓				✓
	Strengthen synergy of actions of different stakeholders	✓				
	Advocacy to bring foresight analysis report to decision-makers		✓	✓	✓	✓

4. Conclusion

The objective of this study was to develop, in collaboration with the national Platform of actors in Benin's fruit and vegetable sector, a common vision of the future role of fruit and vegetables in the country's food system. Using the foresight analysis approach, the study explored possible scenarios for integrating fruit and vegetables to make the food system healthier and more diversified by 2060. Three scenarios A, B and C were explored, the first two of which are desired, characterized by the consumption of ample quantities of fruit and vegetables (scenarios A and B) with particular attention to the sanitary quality of fruit and vegetables in Scenario A. In addition, the intense discussions during the two workshops made it possible to analyze the implications of each scenario for Benin's food system, to identify the drivers of the desired changes and the key actors needed to promote these changes. The analysis also identified the actions required to initiate these changes and possible trade-offs.

To avoid Scenario C, it is critical that anticipatory policy and stakeholder actions are undertaken to facilitate farmers' responses to climate change and increased consumer demands. This will require public-private collaboration between government research and extension institutions, input suppliers, and civil society agencies with a strong reach among different segments of fruit and vegetable producers. Coordination between stakeholders in a national platform will be instrumental to tune intervention agendas and merge resources. The focus of these anticipatory policy and stakeholder actions should not be limited to economic value creation, but also to the provision of healthy, nutrient-rich fruits and vegetables to consumer markets and building resilience back into the food system.

Scenario B is plausible if producers find ways to respond to climate change effects and are able to professionalize their fruit and vegetable production. The key driver behind this scenario is increased, mainly urban, consumer demand for fruits and vegetables. This in turn will be the result of changes in consumer behavior and increased purchasing power, notably by the emerging urban middle class in Benin. Farmers will be responding because of more favorable market conditions, which are being developed by mid-stream value chain actors. These remain in this scenario predominantly small- and medium-sized and mixed in terms of their level of formalization. Processing industries may evolve but could still be constrained by a lack of value chain coordination and integration, and inadequate food safety regulation. The latter may continue to impact negatively on public health through the consumption of contaminated (microbial, chemical residues) fruits and vegetables.

Scenario A is only plausible if breakthroughs take place in terms of consumer behavior, imposing demands on the safety of fruits and vegetables, and government enforcement capacity of food safety standards. These must then be matched with farmers' responses to meet these requirements, the availability of alternative inputs such as biopesticides, and midstream actors to communicate and incentivize these changes in market demand- and supply. In this scenario, it is highly likely that the formalization of midstream companies will take place and result in the concentration of private corporations. Whereas many advantages can be associated with this scenario, trade-offs may also occur in terms of the exclusion of economic actors and negative effects on the accessibility of fruits and vegetables to low-income households, as consumer prices may increase.

No one can predict the future, but exploring different scenarios based on identified trends and plausible uncertainties shows that food systems are dynamic, being shaped by drivers that cannot be easily influenced, yet allowing for space to steer them into desirable directions. The latter can be done if we agree on what our food system should deliver to us, and how to balance its outcomes. Such a collective aspiration can only be achieved through dialogue between all stakeholders and based on an understanding of where we come from. Anticipatory policy and action are also only effective if collectively agreed upon and put into practice. With food systems approaches and foresight analyses being more and more mainstreamed and used for this purpose, we evolve from parallel development processes driven by single-actor interests, towards consolidated, multi-actor, and collective action.

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Annexes: result of workshop discussions on anticipatory policy and action

Q: What are the implications of the scenarios for the food system and its outcomes?

Note: The outcomes of the food system are: 1) socio-economic, 2) food and nutrition security, and 3) environment

General food system	Scenario A	Scenario B	Scenario C
More resilient food system	✓	✓	
Non-resilient food system			✓
High post-harvest losses			✓
Use of chemical inputs		✓	✓
Preservation of biodiversity	✓		
Significant improvement in the incomes of players in the fruit and vegetable sector	✓	✓	
Prevalence of unhealthy and unsafe fruits and vegetables for consumption		✓	✓
Food and Nutrition Security	Scenario A	Scenario B	Scenario C
Excellent nutritional status (micronutrients) of Beninese	✓	✓	
Strengthened human capital (better health, better productivity)	✓	✓	
Sustainable food system more supportive of human health	✓	✓	
High consumption of fruits and vegetables	✓	✓	
Low consumption of fruits and vegetables			✓
Increase in diet-related diseases			✓
High prevalence of micronutrient deficiency			✓
Economic development (macro and micro level)	Scenario A	Scenario B	Scenario C
Improved productivity	✓	✓	
Economic growth	✓	✓	
Increase in GDP	✓		
Poverty reduction	✓	✓	
Job creation	✓	✓	
Low income of SMEs			✓
Low productivity and profitability of farms			✓

Environment	Scenario A	Scenario B	Scenario C
Less pollution of the environment and more conducive environments to human and animal life	✓		
High levels of environmental pollution		✓	✓

Q: What are the possible drivers of the desired change in food system?

The demand for fruits and vegetables	Scenario A	Scenario B	Scenario C
Increased consumer awareness of the importance of fruits and vegetables	✓	✓	
Social marketing to boost fruit and vegetable consumption	✓	✓	
Consumer awareness of food safety risks associated with fruits and vegetables	✓		
Regulation and advocacy by the state	✓	✓	
Supply	Scenario A	Scenario B	Scenario C
Availability and accessibility of inputs (quality seed, specific fertilizers, quality phytosanitary products)	✓	✓	
Availability and accessibility of inputs needed to produce healthy and safe fruits and vegetables	✓		
Logistics & technologies (digitalization, full mechanization, e-agriculture)	✓		
Conglomeration, private investments in processing and industrialization	✓		
Research & development	Scenario A	Scenario B	Scenario C
Availability and accessibility of inputs (quality seed, specific fertilizers, quality phytosanitary products)	✓	✓	
Availability and accessibility of inputs needed to produce healthy and safe fruits and vegetables	✓	✓	
Logistics & technologies (digitalization, full mechanization, e-agriculture)	✓	✓	
Conglomeration, private investments in processing and industrialization	✓	✓	

Institutional support	Scenario A	Scenario B	Scenario C
Political will to promote fruit and vegetables	✓	✓	
Policy and regulation incentives for the development of fruit and vegetable value chains	✓	✓	
Application of texts	✓		
Investment & resources	Scenario A	Scenario B	Scenario C
Intensification of projects and programmes to promote fruit and vegetable sectors geared towards local consumption	✓	✓	
Improved investment in holistic fruit and vegetable R&D	✓	✓	
Strengthening public-private partnership	✓	✓	
Increasing accessibility to agricultural finance	✓	✓	
Support for innovation	✓	✓	
Access to quality energy at a lower cost	✓	✓	
Investment in R&D for nutritious fruits and vegetables	✓	✓	
Infrastructure development	✓	✓	

Q: Who are the key players that are essential for this change to happen?

Government	Scenario A	Scenario B	Scenario C
DANA	✓	✓	
DPV	✓		
ADPME		✓	
ANM	✓	✓	
ABSSA	✓	✓	✓
DDAEP	✓	✓	✓

Academia and research centers	Scenario A	Scenario B	Scenario C
NARS-Benin (Universities and Research Centres)	✓	✓	✓
Civil society and POs	Scenario A	Scenario B	Scenario C
Professional Agricultural Organisations (OPA)		✓	✓
PASCiB	✓	✓	
Fruit and Vegetable Value Chain Stakeholder Platform		✓	✓
FeNOMa- Benin	✓	✓	✓
FNCPRoMa	✓	✓	✓
FNOTProMa	✓	✓	✓
Para-public structures	Scenario A	Scenario B	Scenario C
CNAB	✓	✓	
Patronate	✓		
CIPB	✓		
CCIB	✓	✓	
APIEx	✓	✓	
Technical and financial partners	✓	✓	✓
Consumers	Scenario A	Scenario B	Scenario C
Middle-class consumers	✓	✓	
Consumers in rural areas	✓	✓	
Low-income consumers in urban areas	✓	✓	

Q: What actions need to be taken to achieve the desired changes?

Behavioral changes	Scenario A	Scenario B	Scenario C
Promoting the fruit and vegetable sector	✓	✓	
Encouraging the supply of fruit and vegetables in school canteens	✓	✓	
Promoting the greening of schools with the help of fruit species	✓	✓	
Integrating nutrition into training curricula	✓	✓	
Raising awareness/educating consumers on the consumption of fruits and vegetables	✓	✓	
Inputs	Scenario A	Scenario B	Scenario C
Development of varieties that do not require chemical inputs	✓	✓	
Promotion of green manure and biopesticides	✓		
Encourage the development of inputs and practices specific to healthy production	✓		
Production of healthy fruits and vegetables	Scenario A	Scenario B	Scenario C
Information and awareness-raising for target populations	✓	✓	
Strengthening support for specialised fruit and vegetable advice	✓	✓	
Strengthening agricultural advisory services	✓	✓	
Capacity building of key stakeholders	✓	✓	
Strengthening the professionalisation of SMEs	✓	✓	
Raise awareness among producers about the adoption of good cultural practices to produce healthy and safe fruits and vegetables	✓		
Strengthening producers' capacities for the rational use of chemicals	✓	✓	
Transformation	Scenario A	Scenario B	Scenario C
Improving infrastructure and transformative technologies	✓	✓	
Improvement of processing, packaging, storage and conservation processes	✓	✓	
Strengthening fruit and vegetable transport logistics	✓	✓	

Quality control	Scenario A	Scenario B	Scenario C
Developing quality standards for fruits and vegetables	✓	✓	
Developing, operationalizing, and strengthening the quality certification system	✓		
Improved quality control of healthy and processed products	✓		
Research & development	Scenario A	Scenario B	Scenario C
Prioritizing holistic R&D on nutritious fruits and vegetables	✓	✓	
Development and dissemination of technologies for production/processing/packaging, storage and preservation		✓	✓
Fruit and vegetable R&D funding	✓	✓	
Strengthening human capital in R&D	✓	✓	
Dynamization of CRA-Horticulture	✓	✓	
Business climate	Scenario A	Scenario B	Scenario C
Government incentives for import of agricultural inputs and equipment (subsidies, exemption)	✓	✓	
Easing the formalization requirements for SMEs	✓		
Private investment in fruit and vegetables	✓	✓	
Taxation of imported fruit and vegetable products	✓	✓	
Citizen monitoring	Scenario A	Scenario B	Scenario C
Strengthening citizen monitoring of fruit and vegetable quality	✓		
Campaigns and promotion of the consumption of healthy and safe fruits and vegetables	✓		
Boosting consumer associations	✓	✓	

Q: What can be the possible trade-offs associated with the changes?

Availability of fruits and vegetables	Scenario A	Scenario B	Scenario C
Unhealthy highly processed foods are more available with conglomerates	✓		
Low diversity of fruits and vegetables	✓		
Higher costs of safe fruits and vegetables	✓		
Risk of exporting all production to the detriment of local consumption	✓		
Risk of unhealthy and unsafe fruit and vegetables being put on the market & risk of eating unhealthy and unsafe fruit and vegetables		✓	✓
Economy	Scenario A	Scenario B	Scenario C
Negative effects on excluded SMEs and loss of employment	✓		
Loss of revenue for the state in terms of tax revenue		✓	✓
Environment	Scenario A	Scenario B	Scenario C
Risk of industrial pollution	✓		
Risk of pollution due to use of chemical inputs by farmers		✓	

Suggested citation

Mitchodigni-Houndolo, M. I., Iruhiriye, E., Egah, J., Herbert, O., Afe, I., Madode, Y. E., Ayenan, A. T., Salaou, A. M., Videgla, E., Schreinemachers, P., & de Steenhuijsen Piters, B. (2024). *The future of fruit and vegetables in Benin's food system: a visioning exercise*. CGIAR Research Initiative on Fruit and Vegetables for Sustainable Healthy Diets, Technical Report.

Cover photo

Stall of a fruit and vegetable seller at the Gandhi market in Cotonou, Benin. Sourced from the communication service of the World Vegetable Center Regional Office for West and Central Africa.

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The FRESH Initiative is being implemented by CGIAR researchers from IFPRI, CIMMYT, The Alliance of Bioversity International and CIAT, IWMI, and CIP in close partnership with World Vegetable Center, Applied Horticultural Research, the University of Sydney, the Institute of Development Studies, Wageningen University & Research, the University of California, Davis, Borlaug Institute of South Asia, Sokoine University of Agriculture, Wayamba University of Sri Lanka, the Philippines Department of Science and Technology-Food and Nutrition Research Institute and other partners.

We would like to thank all funders who support this research through their contributions to the CGIAR Trust Fund: www.cgiar.org/funders.

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