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Healthy
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Combating Malnutrition in Africa Through Diversification of the Food System (HealthyDiets4Africa)

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Network maps of sustainable food value chains

Vegetables sold on a wheelbarrow © R. Asiimwe

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Introduction

A food environment comprises four types of food sources: wild-harvested foods, own production, market-based food sources, and transfers such as gifts and donations (Turner et al. 2018). Based on this classification, food sources can be grouped into market-based or non-market-based sources. Market-based food sources are described as a built food environment, which includes both formal (e.g., supermarkets, hypermarkets, online vendors, restaurants) and informal markets (e.g., open-air markets such as farmers' markets, wet markets, street vendors, kiosks, mobile vendors) (Pingault et al. 2017; Downs et al. 2020). The built food environment is considered to be more critical in High-Income Countries compared to Low and Low-Middle-Income Countries, as in High-Income Countries, most consumers entirely depend on markets to access food (Downs et al. 2020). However, in Africa, about 80% of the food produced is distributed through formal food supply chains, with 60% consumed in urban areas. The built food environment is thus the primary source of food in urban and peri-urban areas in developing countries; for example, it accounts for about 80% of all food costs in Uganda (Dolislager et al. 2022). Non-market-based food sources, such as own production and wild-harvested foods, are grouped as natural food environments. Non-market-based food sources are essential when considering the food environment in Low- and Middle-Income Countries (LMICs), in particular in rural and rural-urban areas as well as in some urban food environments, for example, in the form of urban agriculture (Downs et al. 2020). In LMICS, the natural food environment plays a key role, especially in rural settings where food availability and accessibility are limited. Many people in these areas obtain at least some part of their food from their own production, wild-harvested foods, and in-kind transfers and gifts (Turner et al. 2020).

Food environments are partly an outcome of the dynamics of food supply chains, in which consumer demand shapes supply chains and vice versa. Improving access to healthy foods, therefore, requires not only understanding the dynamics within the food environment but also the supply chains involved. This would allow identification of value chain interventions that could improve upstream food environments.

The aim of this deliverable is thus to identify sustainability risks in food value chains of different food environments (Deliverable 2.1). The results are expected to contribute to identifying intervention points for designing sustainable and healthy food environments.

Objectives

This deliverable aims to generate context-specific propositions for achieving sustainable food environments. This study focuses on the sustainability of value chains supplying perishable and/or indigenous nutrient-dense foods in Kenya, Uganda, and Benin.

Methods

Data collection took place in three countries: (1) Kenya (Kisumu), (2) Uganda (Kampala), and (3) Benin (Cotonou and Natitingou). Data on wild edible foods from Cotonou, the capital city of

Figure 1: Map of Africa indicating countries where food environment mapping was conducted (deliverable 2.1, red dots). Value chain assessments focused on Benin, Kenya and Uganda blue circle. © map: dmaps.com

Benin, and fish were collected in June 2024. The datasets complemented the first round of data collection in Kenya (fish) and Uganda (indigenous green leafy vegetables), conducted in 2023 (Figure 1).

In **Kenya,** the study focused on the fish value chain, with the starting point in Kisumu, the county capital of Kisumu County, situated along the shores of Lake Victoria in Western Kenya. The data was assessed within the Healthy Food Africa Project (HFA) in 2022 and amended within the Healthy Diet for Africa (HD4A) Project in 2024. The value chain assessment started in different informal settlements within Kisumu. Fish consumption in these areas is affected by the growing export-oriented fish industry, reducing the affordability and availability of fish for low-income consumers in Kisumu. The study encompassed all participants involved in the fish value chain, including producers, retailers, wholesalers, and processors. Both qualitative and quantitative data were used, gathered through a mixed-methods approach. Data collection research tools were then developed, including key informant interviews and focus group discussions, to target the different actors in the value chains: producers, retailers, wholesalers, and distributors. Structured questionnaires were formulated to gather information on demographics, business characteristics, fish types, characteristics (including costs, outputs, and losses), and main constraints in production and marketing. At the same time, open-ended questions and observations were used to identify barriers and opportunities in the overall value chain study. Additionally, a structured questionnaire was administered to characterize actors, including their demographics, vegetable production and sales patterns, and the effects of the pandemic and associated measures on the welfare of producers. A multistage sampling approach was used, starting with fishers in randomly selected wards across Kisumu, with a focus on fish-producing sub-counties. In the selected areas, actors were randomly selected to participate in the study voluntarily. In total, 100 fish producers, 58 wholesalers, 46 distributors, 65 fish retailers, and 54 fish processors were included in the study. The subsequent qualitative data collection (in 2024) followed up on the sustainability aspects identified in the quantitative data collection. Interview guidelines were used among key informants in the fishing, trading, and processing stages of the value chain. Questions related to environmental, economic, and social sustainability dimensions were included in the guide to facilitate the sustainability assessment of the fish value chain.

In **Uganda**, the study focused on green leafy vegetables, following up on the food environment assessment conducted in November 2023 at Mildmay Hospital. “Mildmay Uganda” is a nongovernmental organization established in 1998 with headquarters in Uganda's capital city, Kampala, that specializes in providing comprehensive HIV and AIDS prevention and care.

The research employed a multi-criteria assessment process to evaluate the sustainability of these value chains, analysing economic, social, and environmental dimensions (Gelli et al. 2015; Padulosi et al. 2013; Hawkes and Ruel 2020). The framework integrated traditional value chain analysis with a structured sustainability assessment, operationalized through agroecological principles (Hawkes and Ruel 2020; Peña and Garrett 2018a; 2018b). The study included all value chain actors and processes involved in production or delivery that have a significant impact on sustainability (Scialabba and FAO 2014). For these quantitative surveys of value chain actors, 296 farmers, 32 traders, and 320 consumers were interviewed. However, to describe the system, it was necessary to prioritize which indigenous green leafy vegetables to consider, given their diversity in Uganda. Based on existing literature, the most consumed leafy green vegetables with economic potential were selected for value chain analysis.

A two-step approach was followed, consisting of prioritization and mapping of the value chain actors to facilitate system description. The methods used for data collection included focus group discussions, semi-quantitative interviews, and observations. Three FGDs with producers and four KIIs with an input dealer, a market leader, and two transporters were conducted.

The assessment of the sustainability of green leafy vegetables value chains was structured into four main steps (Deytieux et al. 2016; Havardi-Burger et al. 2021):

1. Defining the system, which involved prioritizing key traditional vegetables (*Amaranthus* spp., *Solanum aethiopicum*, *Cleome gynandra*, and *Vigna unguiculata*) and mapping all relevant actors from input supply to consumption.
2. Describing the system by characterizing actor functions, linkages, and product flows to identify bottlenecks and inefficiencies.
3. Selecting assessment criteria and indicators. A set of 14 measurable indicators was adopted to quantify sustainability (Table 1):
    - Economic sustainability was assessed through indicators of profitability, income diversification, and access to credit (liquidity).
    - Social sustainability was evaluated using indicators such as gender and youth participation, involvement in knowledge-sharing platforms, land rights awareness, and the existence of fair systems and record-keeping.

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- Environmental sustainability was analysed using indicators reflective of a Life Cycle Assessment (LCA) approach, focusing on on-farm practices. These included soil fertility management (organic vs. inorganic), pest and disease management practices (ranging from heavy reliance on pesticides to integrated or no-chemical use), and crop residue management.

4. Performing the final assessment by calculating a composite sustainability index and sub-indices for each dimension, allowing for a comparative analysis of the value chains' alignment with agroecological and sustainability principles.)

Table 1: Indicators for assessment of farm-level sustainability of traditional green leafy vegetables

	Indicators	Scale
	Environmental indicators	
1	Crop residue management	0. Burn crop residues 1. Leaves the residues to decompose in the garden 2. Used as mulch or compost materials 3. Fed to livestock or sold
2	Type of soil fertility management practices adopted	0. None 1. Inorganic fertilizers only 2. Cultural practices* only 3. Both cultural practices and inorganic fertilizers
3	Type of pests and disease management practices adopted	0. No action is taken 1. Use chemical pesticides for all vegetables 2. Use chemical pesticides for specific vegetables 3. Use integrated pest management practices 4. No chemical pesticides are used
4	Adherence to pre-harvest interval	1 equals Yes; 0 otherwise
	Social indicators	
5	Proportion of joint male and female participation	1 if both male and female, 0 otherwise
6	Proportion of joint youth and non-youth participation**	1 if both youth and non-youth, 0 otherwise
7	Participation in knowledge-sharing platforms	1 equals Yes; 0 otherwise
8	Existence of actor groups: producers	1 equals Yes; 0 otherwise
9	Land rights awareness	1 equals Yes; 0 otherwise
10	Existence of a fair system	1 equals Yes; 0 otherwise
11	Record keeping by the farmer	1 equals Yes, 0 otherwise
	Economic indicators	
12	Profitability	1 if positive, 0 if otherwise
13	Diversified income: Number of different sources of income	0. One income source 1. 2-3 income sources 2. 4 or more income sources
14	Liquidity: Access to credit	1 if available, 0 otherwise

In **Benin**, three value chains were assessed: two neglected and underutilized species (NUS)—the Irvingia gabonensis and Vitex doniana value chains—and a fish value chain.

Irvingia gabonensis, locally called ‘wild apple’ or ‘bush mango’, is a multipurpose tree species that is widely distributed throughout Africa. Different parts of the tree are used for food and medicinal purposes and sold in markets. The fruits and seeds (fruit kernels) are consumed (Osseni et al. 2018). The fruits (even non-matured) are gathered for consumption and sold (Vihotogbe 2012). In southern Benin, I. gabonensis (wild apple) is consumed by people regardless of gender or socioeconomic status. The fruit kernels, also called almonds, are often used in African culinary preparations and have anti-diabetic properties and fight obesity due to their high fibre content. They contain up to 8.71% protein, 19.20% carbohydrates, 70.11% oil, and a significant amount of minerals (Koumba Ibinga et al. 2022; Ladele et al. 2016). Seed cake, which is the leftover after oil extraction, is used in sauce preparation; it has a high nitrogen, phosphorus, potassium, magnesium, and total protein content (20%) (Dahouenon-Ahoussi et al. 2012). Almonds are a popular condiment in Benin, especially in the south. They can also be used as substitutes for okra and peanuts, which are used as condiments in traditional cooking in Benin (Dahouenon-Ahoussi et al. 2012). The oil extracted from almonds contains high levels of saturated fatty acids, as well as a minority of unsaturated fatty acids, such as oleic and linoleic acids. It has proven antioxidant activity and may be used in the margarine production, thereby avoiding the chemical hydrogenation of unsaturated fatty acids (Ladele et al. 2016; Koumba Ibinga et al. 2022).

The fruits and leaves of the *Vitex doniana* tree are the most commonly consumed parts as food (Guindé et al. 2023). The leaves are used to make herbal tea for the treatment of multiple ailments, and the vegetables are consumed. In Nigeria, a study evaluated the nutritional composition of *V. doniana* leaves, where the results reveal that these leaves are particularly rich in fibre (14.7g to 35.4 g/100 g) and protein (15.5 to 37.3g/100 g), but contain little fat (0.8g to 1.9g) and carbohydrates (4.0g to 9.7 g) (Ifeanacho and Ogunwa 2021). When available, this species can offer up to 80 USD per rural actor.(Ashande et al. 2022; Soulémane et al. 2024).

The data collection took place in June 2024. The geographic focus was on South Benin, based on information from respondents living in the Cotonou Commune. Using the snowball sampling method, the study was extended to the departments of Atlantique, Plateau, Zou, Mono, and Couffo (Figure 2).

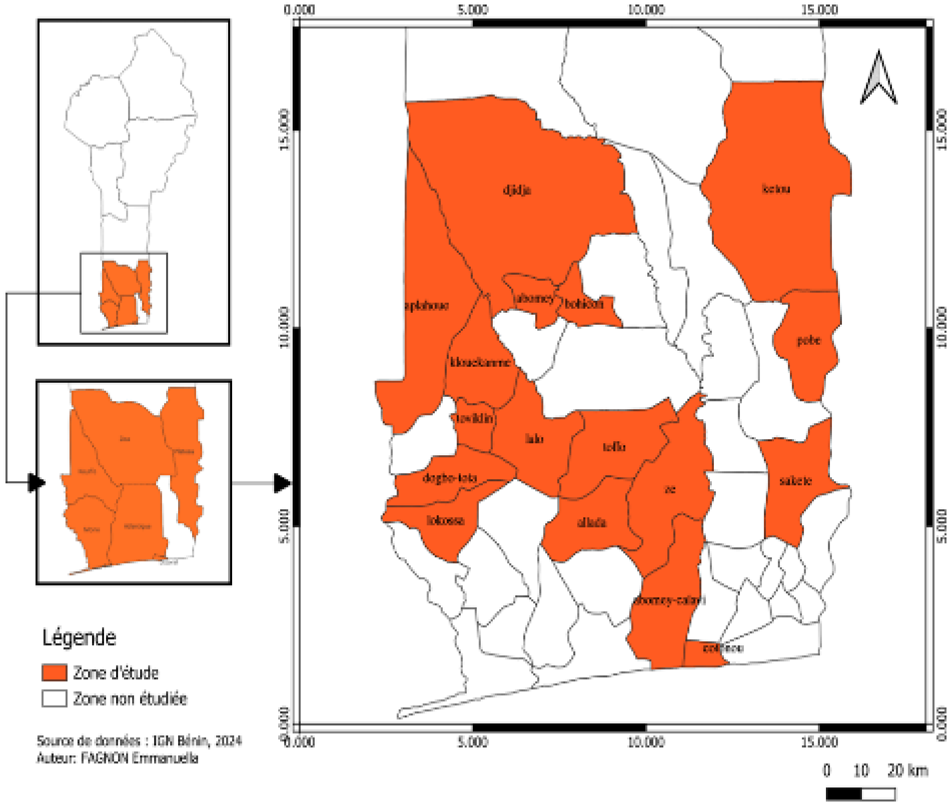

Figure 2: Study area of Irvingia gabonensis value chain in Southern Benin (HD4A, funded by EU)

In total, 290 stakeholders were involved in the study, including 82 wild apple collectors, 51 traders, and 157 consumers. The consumer population was identified by route sampling. Of the 20 markets offering bush mango products, 14 were selected for the assessment. In each of the 14 markets, one trader was surveyed to provide information on the origin of the bush mango products they had for sale. The most cited locations were used to identify collectors. Based on findings assessed via a structured questionnaire and following up on the Sustainable Food Value Chain methodology described by FAO and UNIDO, a functional analysis was done (FAO and UNIDO 2024). The approach used the Framework for Assessing the Sustainability of Food and Agriculture Systems (SAFA). SAFA covers 21 themes, each described by 116 indicators, and their performance is measured on a scale of 1-5.

The value chain study on Vitex *doniana* leaves was also implemented in the South of Benin, kicking off with traders due to their central role between the various other actors in this value chain. All functional markets (total = 20) were visited to identify sellers and verify the availability of *V. doniana* leaves. Its presence was confirmed in 12 markets, one supermarket, and two processors. Consumers were identified in the neighbourhood of the markets that offered the leaves. In total, 167 consumers were interviewed. Traders were asked to provide information about where they source the leaves, what they know about the buyers and processors, and, if possible, contacts. Subsequently, 22 supermarkets and 34 restaurants were included in the study. In addition, an online consultation of restaurant menus was conducted. Traders and consumers provided information on potential collectors, who were contacted in selected municipalities. A total of 135 collectors were surveyed (Table 2).

Table 2: Distribution of collectors surveyed by location

Actors	Departments	Municipalities	Districts	Numbers surveyed
Traders/ Consumers	Coastline	Cotonou	Aidjèdo, Fifadji, Vèdokô, Menontin, Zogbo, Sainte Rita, Dantokpa, Adjaha, Dégakon, Gbégamè, Wologuèdè, St Michel	167/ 12
Collectors	Atlantic	Ouidah	Savi	8
			Assôgbenoudaho	8
			Zounkowhé	7
	Mono	Come	Gadomè	15
			Sossikpè	1
	Zou	Zogbodomè	Kpokissa	4
		Djidja	Yes	17
		Ouinhi	Tohoue	18
			Mafougbon	16
		Agbangnizoun	Tanve	16
	Ouémé	Sèmè-kpodji	Krake	3
Total				**135**

The functional analysis of the *V. doniana* value chain was established as described by Fabre et al. (2021). For this NUS, the selection of indicators for assessing sustainability was based on several previous studies. A binary logistic regression model was developed to identify the factors influencing the consumption of *V. doniana* leaves.

A summary of the collected information is presented in Table 3.

Table 3: Overview of the different data collected from each actor type

Actors	Data Types	Data
Relating to the three main actors (traders, consumers and collectors)	Socio-characteristics demographics	• Age, Gender, Level of education • Number of years in the commercialization of *V. doniana* leaves • Marital status of the interviewee as well as household size and income-generating activities were collected.
Consumers	Consumption data	• Consumption of *V. doniana* leaves in the last 30 days, forms of consumption, • The place of obtaining • The quantity purchased in the last thirty (30) days and finally the other vegetables consumed by consumers.
	Perceptions related to the consumption of *V. doniana* leaves	• Perceived advantages, disadvantages and obstacles. • Beliefs related to the consumption of *V. doniana* leaves and other vegetables,
Traders	The place of obtaining	• The type of interaction between the trader and suppliers, • The type of suppliers, • The place of supply, • Shares and prices; • Quantities related to the marketing of *V. doniana*.
Collectors	Data related to processing and marketing	• The activities of the collection, • Handling and use after collection, • Farm to home processing and storage • Tthe primary sources of income. • Cooking temperatures • Cooking time

The **fishing sector** in Benin constitutes an essential part of the national economy and plays a crucial role in the country's food security. Apart from wild capture fishing, fish from aquaculture are also a source of protein for the Beninese population and constitute an essential alternative activity to promote regenerating fish stocks from wild capture fishing and to cope with population growth. Many actors are also involved in the aquaculture sector, and the synergy of their efforts ensures that fish are available to the country's consumers. Cotonou has the third-largest port in West Africa after Lagos, Nigeria, and Abidjan, Côte d'Ivoire. According to recent data, fish is among the most consumed meat products in Benin and is accessible to all economic classes (FAO 2025). Unlike the fish value chain in Kenya, which was located at Lake Victoria, a large lake serving different East African Countries, the fish value chain in Benin started in Cotonou, on the Gulf of Guinea, and in Abomey-Calavi, located at Lake Nokoué, which is connected to the Gulf of Guinea. Actors involved in production up to consumption were included in the assessment. Snowball sampling was used to select input suppliers. The contact details for input suppliers were obtained from the fisherfolk and fish farmers randomly selected in each of the two communes, Abomey-Calavi and Cotonou, from a list of members of the National Association of Fishmongers (ANM). The large fish markets and fish outlets in the two municipalities were the areas considered for the investigation of the traders. Consumers were identified in the neighborhood of fish-selling points and in areas 3-5km from the market, as they do not have easy access to fish. In each area, a central point —market or school — was used as a starting point for systematically sampling households.

Work Done

In **Kenya**, secondary data from the Healthy Food Africa Project, an EU funded project, was used to identify sustainability risk factors in the fish value chain in Kisumu (informal settlement). In **Uganda**, HealthyDiets4Africa mapped the food environment at Mildmay Hospital in November 2023. The Hospital was thus used as the starting point for the value chain assessment of four purposively selected green leafy vegetables (Table 4). Three vegetables, namely leaf amaranth, spider plant, and scarlet eggplant, were initially chosen for consideration because they are among the most commonly consumed vegetables (Mottaleb et al. 2021). Amaranthus was also selected due to its high nutritional value compared to other green leafy vegetables (Sarker et al. 2020). Cowpeas grown for their leaves were added to represent a leafy vegetable value chain, particularly suited to drier climates. Kales (Sukuma wiki) are non-indigenous, are traded very frequently and in larger quantities, and were therefore chosen as a comparison with indigenous leafy green value chains.

Table 4: Underutilized vegetables in focus of the value chain study in Kampala, Uganda (2023)

No.	Scientific name	English name
1	*Amaranthus spp.*	Leaf amaranth
2	*Gynandropsis (Cleome) gynandra*	Spider plant
3	*Solanum aethiopicum*	Scarlet eggplant
4	*Vigna unguiculata*	Cowpeas

Based on findings from the Cotonou food environment assessment (deliverable 2.1) and following up on the identification of important NUS with a market potential to improve diets, data were collected in 2024 and 2025 on *I. gabonensis, V. doniana*, and fish in Benin.

Kenya – Fish value chain

The fish value chain analysis identified various sources of fish traded in and around Kisumu, including direct capture from the lake, aquaculture, and even imports. Despite Kisumu's location next to Lake Victoria, one of the African Great Lakes and the world's largest tropical lake, exporting fish to the global fish market (Figure 3). This indicates that the fish produced in Kisumu is prioritized for export and/or too expensive for local consumers.

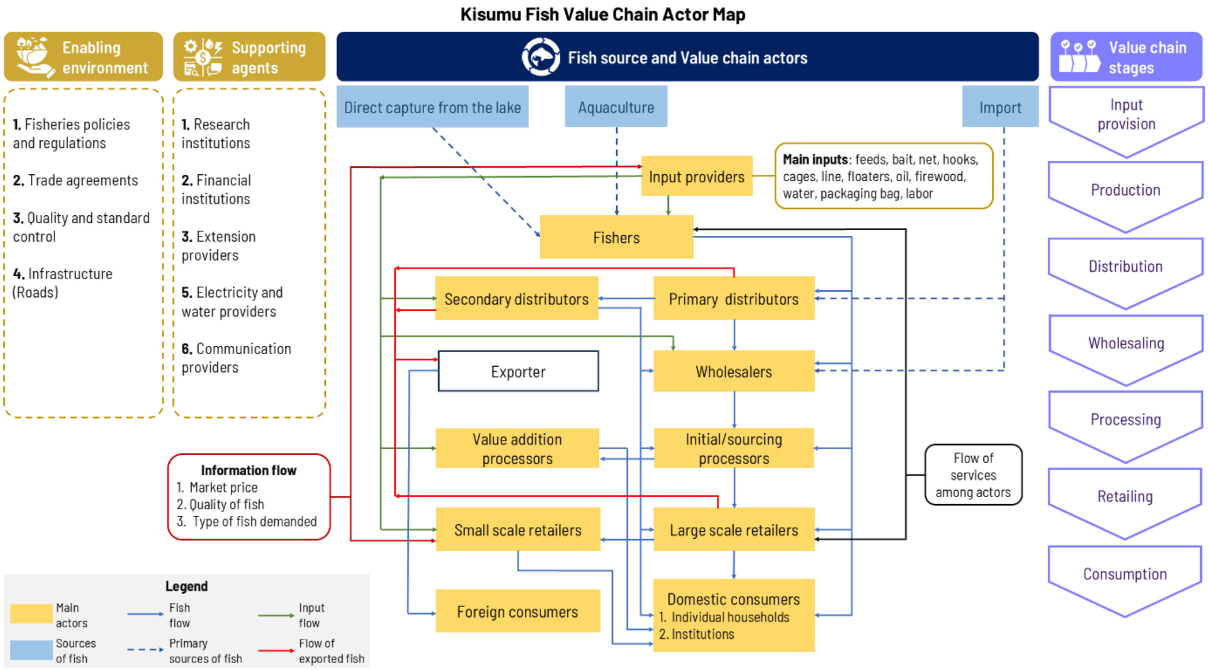

Figure 3: Value Chain Actors Map of fish in Kisumu, Kenya (secondary data analysis, HFA project, 2022), compiled by E. Mado and edited by C. Polo & E. Mosquera Echeverry (Alliance Bioversity-CIAT)

Fishers are often few compared to other actors in the network. They are the primary fish producers because they directly capture fish from the lake. After capturing fish, they operate in a geographically limited space and mainly sell their fish to distributors or wholesalers along the shore, interacting with fewer actors than other value chain actors. Fishers do not engage in many value-addition or fish preservation activities such as smoking, sun drying, deep frying, and salting. They sell their raw fish to “customers” such as households and retailers, who mainly buy from the shores and are not involved in vast storage, logistics, and transportation of fish. The data shows that fishmen may have limited access to information compared to other actors.

Wholesalers typically take fewer steps, which affects the speed at which information propagates and flows from them to other actors. They primarily act as intermediaries between fishers and retailers, playing a key role in connecting fishers to the available market (Figure 4, right). Overall, the actors in the fish value chain exhibit moderate connectivity and clustering in the network. About 39% of the actors in the chain may pair with up to three of their neighbours in the network. Consequently, the actor network is rather heterogeneous and not uniformly connected. It has a subset of actors —such as fishers —with strong internal connectivity. This signifies the different roles played by various actors in the fish value chain.

Figure 4: Fish skeletons from fish factory and processed to fish balls (left) and fresh fish sold at the fish market organized by a market organization (right) © I.Jordan

The fish value chain has seven main stages, from input provisions for fish production to consumption (Figure 3). There are three categories of fish consumers at the global level: domestic, institutional, and “foreign.” The failure to meet sustainability standards tends to affect all of them. These consumers are especially affected if food safety standards are not adhered to at all levels. This starts with the lake's water quality, fish handling at various stages, and, in the end, final processing at the consumer level. Although there are many regulations to follow, the limited communication between actors and their access to information can hinder their ability to act accordingly. Economic constraints may hamper the implementation of sustainability measures among vulnerable and least informed actors, especially if contracts are oral and environmental and infrastructural measures are beyond the scope of the individual actors. Table 5 provides a detailed overview of issues to be addressed in the current fish value chain, including other sustainability factors for which no data are currently available.

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Table 5: Sustainability issues in the fish value chain stages based on data collected in HFA project in Kisumu, Kenya in 2022; compiled by E. Mado

Value chain actor	Sustainability issue
Fishers/ producers	1. Improper fish handling, which increases post-harvest losses 2. Limited awareness of sustainability regulation reduces compliance levels 3. Uncontrolled harvesting of preferred fish varieties, especially Nile perch and Tilapia, will drive the species to extinction 4. Commercial and industrial fish capture in the lake presents an opportunity for the use of unsustainable fishing methods 5. Inadequate training on fish production and harvesting to encourage the adoption and use of sustainable fishing practices 6. Inadequate access to financial services for fish farming, harvest, or capture 7. The presence of brokers in fish trading is reducing the overall gross revenue 8. Seasonal fluctuations in fish availability leading to increased fishing efforts
Distributors	1. Inadequate specialized vehicles for fish transport increase post-harvest losses and food safety risks 2. Modes of transport for fish (motorcycle and vehicles) increase carbon emissions, hence affecting environmental sustainability
Processors	1. Limited awareness of food safety and quality regulations leading to non-compliance with quality control standards 2. Inefficient processing facilities, hence minimal engagement in secondary processing 3. Lack of proper storage and fresh fish holding facilities 4. Minimal technological advancement to promote uptake of new processing technologies
Traders	1. Lack of traceability and transparency in fish sourcing, with few traders keeping records of fish suppliers 2. Poor management of wastes generated from the open-air markets, which increases pollution levels 3. Trading relationship is majorly based on informal contracts, leading to the exploitation of smaller suppliers with less bargaining power 4. Inadequate ownership of a trading license creates unfair trading grounds for other licensed actors. 5. Inadequate incentives or benefits to promote trade in sustainably sourced fish 6. Price fluctuations disrupting fish supplies, hence the inability to meet consumers' demand for fish

Thematic analysis guided by an inductive coding approach of the qualitative data resulted in various indicators categorized into three major themes representing the three sustainability principles: environmental, social, and economic sustainability. The analysis of the Kenyan fish value chain reveals a combination of sustainability strengths and weaknesses across these three dimensions. Environmentally, the chain faces significant pressure from unsustainable fishing practices, such as the use of seine and cast nets in breeding areas, alongside declining species diversity and ecosystem degradation. Although most actors demonstrate awareness of conservation principles, there is a trade-off between economic and environmental sustainability, as individuals' economic necessity overrides their sustainable behaviour. Waste management remains informal mainly, relying on unsustainable methods such as burning, while cold chain limitations and frequent power outages contribute to post-harvest losses and resource inefficiency. Despite ongoing adoption of ice-based preservation, inadequacy of modern storage infrastructure and weak enforcement of environmental regulations persist.

Economically, Kenya's value chain is primarily domestic-oriented, supplying both local and regional markets with minimal export activity. High customer demand sustains trade, but unstable prices, limited access to affordable credit, and a lack of government support undermine profitability. Most actors operate informally with modest returns, and the adoption of value-addition practices, such as frying or drying, remains limited due to financial and technical barriers. Socially, the chain provides substantial employment opportunities, particularly for women who dominate the fish processing and trading sectors. However, the absence of job security, poor working conditions, and minimal occupational safety presents social sustainability risks. Despite uneven institutional effectiveness, governance structures such as beach management units foster participation and informal enforcement. Training by NGOs has improved awareness, but gaps in continuous support and product certification persist.

Benin – Fish value chain

The actor map of the fish value chain from Cotonou and Abomey-Calavi is presented in Figure 5. Consumers represent the last link and are also the driving force of the fish value chain. They consume a wide range of species, fresh as well as processed, which they either purchase directly from markets or street vendors, from fishmongers, from fisherfolk or fish farmers, or from supermarkets, or consume ready-to-eat in restaurants. Their criteria for selecting fish include freshness, size, texture, price, hygiene at the point of sale, and the fish's origin (local or imported). This diversity of expectations and behaviours among the consumers directly shapes commercial, processing, conservation, and even production practices throughout the chain, making consumers key players in shaping the fish supply. Figure 5 shows the options consumers have for purchasing fish. While restaurants are a stable outlet to commercially promote consumption of fish, they are targeting the wealthier population.

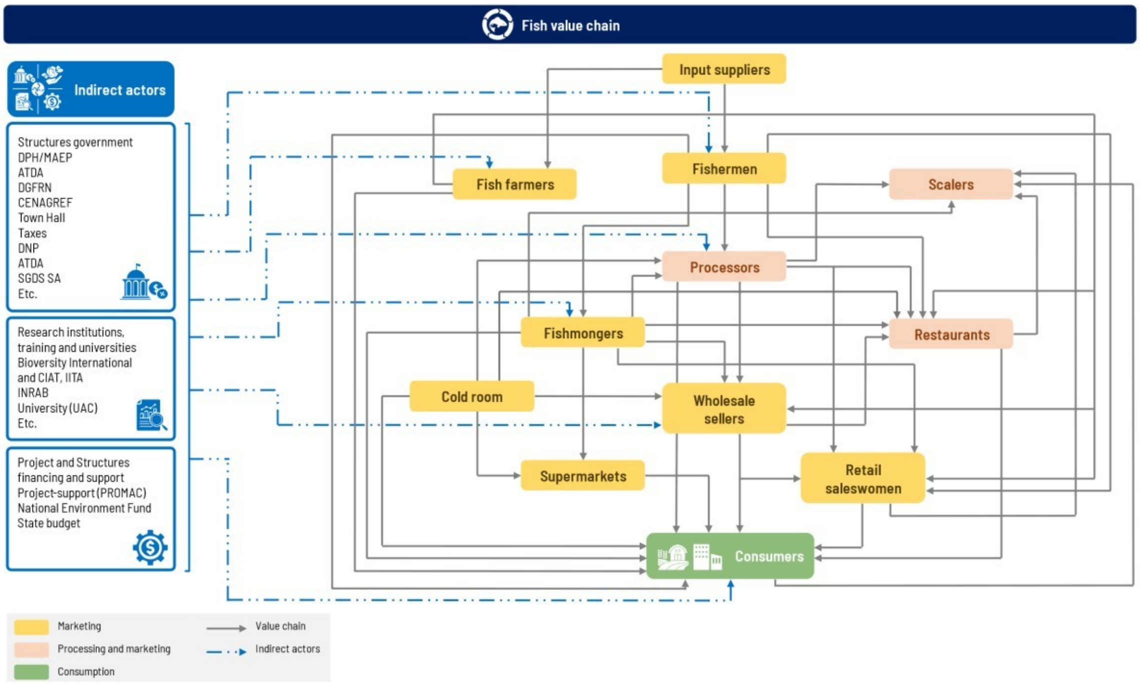

Figure 5: Fish value chain actor map from Abomey-Calavi and Cotonou, Benin (HD4A, funded by EU)

Fishmongers (mareyeuses and poisonneries) serve as intermediaries between importers and local stakeholders such as traders, restaurants, processors, and consumers. In general fishmongers refer to a business specializing in the sale of seafood products, primarily imported frozen fish (horse mackerel, mackerel) and sometimes locally caught fish or fish from fish farms. These establishments are key players in the protein supply chain and are often equipped with cold storage rooms for storage. Mareyueses focus on artisanal and inland fisheries. They buy fresh fish in bulk from fishermen, arrange for its transport, and manage its marketing or processing (smoking, drying) and ensure the link between production and consumption. Poissoneries stocks come mainly from imports, and their choice of suppliers is based solely on the quality of the fish, i.e., including traceability documents and a visual inspection. Despite their crucial roles, they face challenges due to fluctuating prices, which threaten the sustainability of their business.

Supermarkets act as a modern distribution point primarily aimed at urban consumers looking for standard, affordable products which meet conservation and hygiene requirements. In the observed value chain, exclusively women traders are the foundation of the distribution of fish products. They market both fresh and processed (smoked or dried) fish, depending on market demand. Their clientele is diverse, including individual consumers, restaurants, street vendors, and even health facilities such as hospitals. However, despite their importance in the supply system, the women face numerous challenges. These include health problems related to working conditions, insufficient funding, the unavailability or high cost of fish, periods of poor sales, cases of theft, and the lack of appropriate storage infrastructure to maintain product quality. Despite these challenges, no formal structure or association appears to bring together women traders in their communities, limiting the possibility of mutual assistance, collective advocacy, or easier access to technical or financial support. Similarly, the sellers, also exclusively women, who ensure the primary preparation of fish before processing or marketing, face several challenges. They carry out their activity in generally inadequate locations, with a glaring lack of suitable equipment, which makes their work even more difficult. Despite this, they meet diverse and regular demand from several categories of stakeholders: individual consumers, processors, fishmongers, market and street vendors, and restaurants. This wide range of customers testifies to their essential role in the fluidity and quality of the fish distribution chain. Unlike the traders, they seem to be aware of their challenges, and many have joined together in local scaling associations, which allow them to exchange information, help each other, and better organize their activity, even if these structures are still poorly equipped.

The situation for the fisherfolk is different. First of all, the group consists exclusively of men who hold a strategic position as suppliers of fish from natural environments such as lakes, rivers, and oceans. The exercise is conditioned on holding an official permit or having an official authorization to allow fish production. Fish preservation is usually done using ice and/or water to limit early deterioration. Their main challenges are: limited access to financing, dwindling stocks, disappearance of particular species, equipment theft or lack, water pollution, and price instability. To cope with a lack of financial resources, fishermen often borrow money from fishmongers and repay them in fish, depending on the loan's value. Although most communities have fishing associations, these structures offer few benefits, such as disseminating regulatory information.

Most processors aim to process all the fish purchased on the same day. In case of surplus, they use freezers or refrigerators for temporary storage. The equipment used includes stoves, traditional ovens, salting and fermentation tanks, grills, and basins. However, access to modern technology remains limited, making it difficult to improve the quality and sustainability of processed products. Their main customers are street and market traders, restaurants, and end consumers. They are organized mainly into associations, which allows them to exchange market information, coordinate their production, and benefit from a system of mutual aid among members.

“Scaly”—or rather, “scalers”—describe the group of people whose job involves removing the scales and cleaning fish after they have been purchased. A few years ago, fish were cleaned exclusively in the home, and fish cleaning was not yet considered a profession or even an income-generating activity. It was seen more as a domestic cooking task, as housewives would buy fish at the market and clean it at home. Today, fish cleaning has moved beyond the home to become a profitable trade practiced at markets. Fish scalers charge for their services to save time for many housewives, who can then prepare their family meals sooner.

The majority of consumers (70%) believe that their relatives or influential people encourage them to buy (70%) and consume (74%) more fish each week. A similar proportion believes that their peers also consume it regularly. In terms of self-efficacy, most reported that it is up to them to decide whether to buy (80%) or consume (82%) more fish, and claim to be confident in their ability to do so, even though around 15% consider purchasing or consuming it more difficult. Fish is widely perceived as accessible and appreciated: 84% find it easy to find, more than 70% prefer it to other protein sources, and 80% believe its image is valued in their social circles. Table 6 provides an overview of the different fish types sold and consumed in South Benin. Entry points for sustainability, as well as sustainability risk factors at each stage of the fish value chain, are summarized in Table 7.

Table 6: Typology of fish sold and consumed in South of Benin (HD4A, funded by EU)

Scientific names	Local/common names	Statutes	Habitats / origins	Average heights/weights	Consumption/trans-formation methods	Availability / seasonality
Clarias gariepinus	Catfish	Local species, breeding and capture	Fresh water (lake, pond)	30-50 cm, 0.5-2 kg	Fresh, smoked, fried	All year round (abundant in rainy season)
Oreochromis niloticus	Tilapia	Introduced species, especially breeding	Fresh water (pond, river, lake)	20-40 cm, 0.3-1 kg	Fresh, grilled, fried	All year round
Brama brama	Large castagnole/ brama	Capture	Sea water	30-60 cm, 1-2 kg	Smoked, Grilled	All year round
Esox lucius	Northern pike	Capture	Fresh water	30-150cm, 2-10kg	Fresh, smoked, fried	Dry season
Phoxinus phoxinus	Minnow	Capture	Fresh water	2-10cm	fried	Rainy season
Dicentrarchus labrax	Common sea bass/sea bass	Breeding and capture	Brackish water	50cm-1m, 1-4kg	Fresh, grilled	All year round
Polydactylus quadrifilis	Captain Fish	Capture	-	50-100 cm, 3-6 kg	Smoked, braised	Dry season
Cyprinus carpio	Carp	Breeding and capture	Freshwater (Lakes and ponds)	30-70 cm, 1-4 kg	Smoked, braised, fried	All year round
Hypophthalmichthys molitrix	Silver carp	Breeding and capture	Fresh water, brackish water	40-80 cm, 2-5 kg	Smoked, braised, fried	All year round
Carassius auratus	Red carp	Breeding and capture	Fresh water	25-40 cm	Smoked, braised, fried	All year round
Trichiurus lepturus	Common scabbardfish	Capture	tropical Sea water	60-150 cm, 2-6 kg	Smoked, braised	-
Sardinella aurita	Sardinella	Capture	Sea water	20-30cm	Smoked, grilled	-
Sparus aurata	Royal sea bream	Breeding and capture Capture	Brackish water	30-50cm	Fresh, grilled	All year round
Dentex dentex	The tooth		Sea water	50 cm-1 m	Smoked, braised, fried	-
Xiphias gladius	Swordfish	Capture	Sea water	455 cm, 50-200 kg	Smoked, braised, fried	-

Table 7: Entry points to mitigate risk factors that threaten the sustainability of the fish value chain in South Benin (HD4A, funded by EU)

Actors	Durability issue
Fish farmers	• Employment relationships are based mainly on verbal agreements, without respect for national standards in terms of labor rights and social security. • Reduced access to financing, limiting the ability to cope with cashflow crises or to invest. • Misuse of natural waters in livestock farming, which can lead to environmental impacts. • Frequent fish losses due to insufficient disease control.
Fishermen	• Activity requiring intense physical effort, leading to fatigue and work overload. • Unstable incomes, exacerbated by climatic variations influencing the availability of species and price fluctuations on the market. • Low diversification of commercial outlets, leading to dependence on a limited number of buyers. • Weak initiatives for the prevention of water pollution.
Fishmongers (Mareyeuses)	• Informal employer-employee relations, without social protection mechanisms; primarily women. • Fish losses due to the use of unsuitable preservation methods. • Insufficient training on health and safety at work. • Limited controls regarding product safety
Scaly (scalers)	• Limited access to adequate infrastructure and equipment to carry out the activity under good conditions. • Limited access to financing, restricting the ability to strengthen or develop the business. • Poor management of wastewater obtained after use, leading to environmental pollution.
Transformers	• Insufficient access to modern equipment and infrastructure, hindering the efficiency of operations. • Limited control of the food safety of processed products that may cause harm when consumed. • Lack of training on occupational safety and health. • Strong dependence on wood energy, promoting deforestation and contributing to atmospheric degradation.
Shopkeepers	• The absence of formal agreements between traders, suppliers and buyers often puts suppliers and buyers in a weak position during negotiations. • During periods of abundance, supply far exceeds demand, leading to significant losses of fish due to its high perishability, which contributes to food waste. • Fluctuations in fish prices cause income instability for the actors involved.

Actors	Durability issue
Fishmongers (Poissonneries)	• Low presence of local species, often replaced by imported products. • Limited access to financing, reducing investment and adaptation capacity; primarily women) • Dependence on non-renewable energy for conservation, causing environmental impacts.
Restaurants	• Lack of training in hygiene, food safety and management. • Insufficient occupational safety and health conditions. • Frequent use of non-biodegradable materials and packaging, generating polluting waste.

Comparative Discussion of Sustainability Aspects in the Fish Value Chains of Kenya and Benin

The sustainability aspects across the fish value chains in Kenya and Benin reveal both shared and context-specific issues shaped by their ecological and institutional backgrounds. In both countries, environmental sustainability is strained by the overexploitation of natural resources and the limited adoption of technology. In Kenya, unsustainable fishing practices such as the use of non-selective gears, fishing in breeding areas, and limited adoption of modified gears threaten stock regeneration and ecosystem balance. In Benin, similar environmental pressures are observed, including dwindling fish stocks, the disappearance of particular species, water pollution, and poor wastewater management by processors. This is compounded by limited access to modern preservation methods and a strong reliance on wood energy in conservation, both of which contribute to deforestation. While Kenya benefits from stronger institutional mechanisms such as Beach Management Units (BMUs) and periodic training to enhance compliance and awareness, Benin's value chain relies more on informal structures, traditional fishing practices, and localized associations.

Socially, both value chains are characterized by gendered roles and limited labour protection. In Benin, men dominate fishing while women lead in processing, trading, and scaling. They often operate under poor working conditions, informal labour arrangements, and limited collective representation. Kenya exhibits similar gender divisions. Still, stronger social organization through BMUs, cooperatives, and training initiatives has enhanced participation and compliance. Economically, both countries experience price instability and high operating costs, which reduce the profits obtained from their operations. In Benin, informal financing through fishmongers remains common, while in Kenya, organized groups and emerging savings associations dominate. Post-harvest loss is common in both countries due to perishability, resulting from infrastructural challenges such as power shortages and a lack of specialized transport vehicles. Overall, the Kenyan value chain shows relative strength in institutional and regulatory support, while in Benin, fish processors work closely together at the local level, with a vibrant consumer market, but are hindered by informal labour and financial constraints.

Uganda – green leafy vegetables in Kampala

Scarlet plant was the most produced green leafy vegetable in the surveyed region, both in the last five years and in the most recent complete production cycle. The production cycle for indigenous green leafy vegetables (2.5 months) was shorter than the average agricultural season (5-6 months). On average, producers accessed 1.72 acres for production. Of this, only 0.71 acres were used for vegetable production. In this survey, half of the producers reported cultivating vegetables on less than 1 acre. Of those interviewed, half produced two complete vegetable cycles in the last six months, one-third produced one complete cycle, and about 11% had three or more full cycles. Over 85% of the land used for vegetable production is under secure land tenure systems, such as *mailo*[1], freehold, or leasehold. However, 56% of producers rented or leased their land, while 21% owned it. Sixty-one percent of the land was

Figure 6: A plot of scarlet plant, amaranthus and spiderplant on raised beds (left) and Cowpea plants growing on raised ridges (right) © R. Asiimwe

[1] Mailo is a specific land tenure system only prevalent in Uganda and similar to freehold (Satgé 2016).

perceived to be moderately fertile. Furthermore, 37% of production was on flat swamp land, while the rest was produced on gentle slopes or flat dry land (Figure 6).

Most traders interviewed were 36 years old, had some secondary education, and had an average of 6 years of experience trading vegetables. Women, who represented 86% of respondents, dominated the vegetable trading business. This is comparable to existing studies that have shown women constitute, on average, 70% of the vendors in fresh fruits and vegetables markets in Uganda, compared to 20% youth and 10% men (Kansiime et al. 2024). Nevertheless, this contrasts with broader observations of typical agricultural value chain setups in Uganda, where women typically remain involved primarily in production tasks, across various stages from planting to harvesting, and men take over dominance from post-harvest handling to processing and marketing (AVSI 2019). The production system is characterised as labour-intensive, with less than 2% of farmers primarily using tractors for land preparation and with smallholder farmers dominating. Sixty-one percent of farmers reported using chemicals on all vegetables indiscriminately, while 26% used chemicals on specific vegetables for pest and disease control. This evidence suggests that agrochemicals are intensively used in the study area for vegetable production, which can be detrimental to farmers' and consumers' health. Most (78%) farmers left residues to decompose in the garden, which is partly due to their harvesting practices. Typically, farmers harvest the entire plant and remove the flowers only after the plant has already flowered, resulting in minimal residue during production. Less than 15% of farmers were organized into groups, and even among those groups, only 2% engaged in marketing through their respective farmer organizations. On average, farmers were located within 5 km of markets for their produce.

The (indigenous) green leafy value chain (Figure 7) starts with input suppliers, including seed suppliers, fertilizer (both organic and inorganic), plant protection substance suppliers, and consumables. The chain then continues with the farmers, who are the leading actors given their central position. From a production perspective, the value chain has two dominant variants. The first type of value chain is the farmer-retailer-consumer value chain, in which retailers act as intermediaries between farmers and consumers. The retailers include table-top sellers, retail stall owners in markets, hawkers, and roadside sellers. The farmer-retailer-consumer value chain is the most dominant of the existing value chains. However, there are no specialized stores (e.g., organic stores and grocers) or supermarkets, or vegetable produce marketing cooperatives. The second type of chain is the farmer-wholesaler-retailer-consumer value chain. Some wholesalers may also act as retailers when they take their produce to the markets. Therefore, farmers may not clearly distinguish between wholesalers and retailers, as both groups are potential buyers of their produce. The third value chain is the farmer-consumer value chain, in which farmers sell their produce directly to consumers. This value chain is the least common because only a few farmers have access to trading space away from their gardens. Transporters are essential actors in the value chain. Vegetables are mainly grown in peri-urban areas near major consumption centres, with an average distance of less than 30 km between production and sales points. Motorcycles (*boda-boda*) and tricycles (*tukutuku*) are commonly used to transport vegetables. The reason is that smaller volumes are usually transported, and vegetables need to reach the market as soon as they are harvested to ensure freshness and high quality. Smaller capacity trucks are also sometimes used, but not as commonly as motorcycles and tricycles (Figure 6).

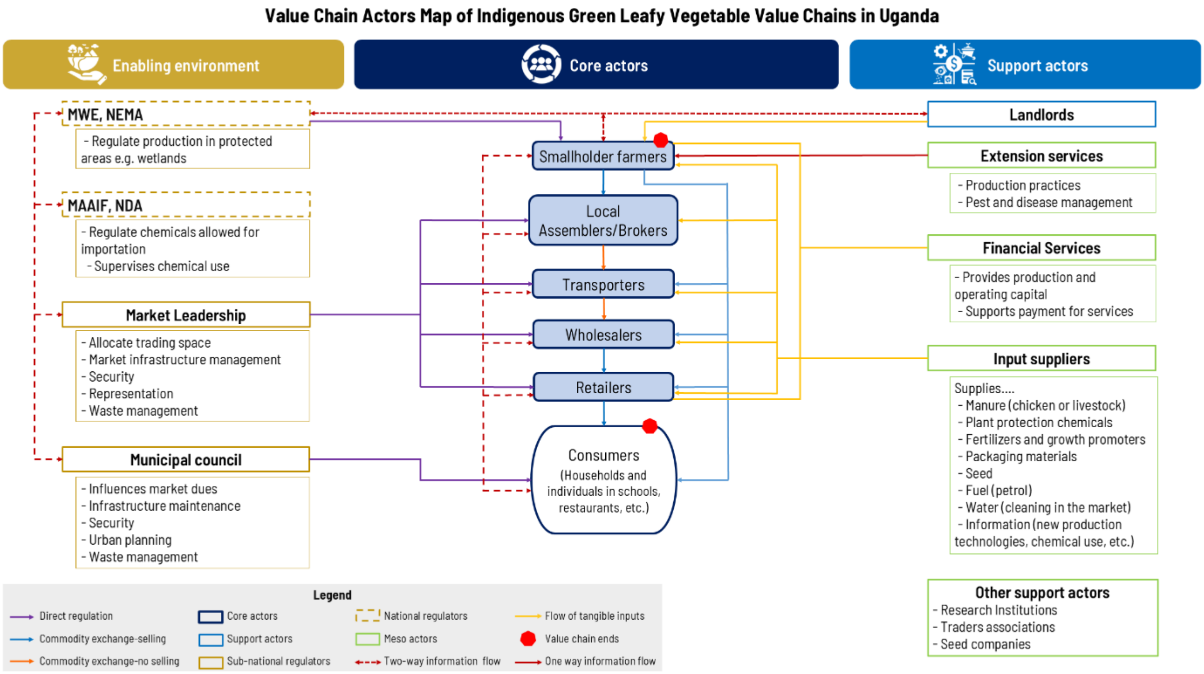

Figure 7: Value Chain Actors Map of four purposively selected dark green leafy vegetables in Kampala, Uganda (primary data analysis, HD4A, 2023), compiled by R. Assiimwe (JLU Giessen) and edited by C. Polo & E. Mosquera Echeverry (Alliance Bioversity-CIAT)

No certification or control bodies were observed along the entire value chain to certify the economic activity of all the actors involved. Trader associations existed, but there were no identified unions to protect producers or consumers (Figure 7). Another category of interested parties, weakly represented in the value chain, is state institutions that supervise and monitor the activities of the leading actors. These include the Ministry of Water and Environment (MWE) and the National Environment Management Authority (NEMA), which, among other duties, supervise and regulate agricultural production activities in protected areas such as wetlands. The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) is responsible for certifying seed, and together with the National Drugs Authority, they coordinate chemical use.

Figure 8: Vegetables loaded for transportation on motorcycle (left) and tricycles for larger harvests, (right) © R. Asiimwe

Sustainability Performance of Green Leafy Vegetable Value Chains: The application of the multi-criteria sustainability assessment framework yielded a clear, quantifiable profile of the value chains' performance. The results are summarized by the composite and dimensional sustainability index scores in Table 8. The mean composite sustainability index score across all farms was 7.71 out of a possible 22 points. When normalized, this equates to a 43% alignment with agroecological and sustainability principles, indicating a sub-optimal performance overall.

Table 8: Summary findings of the sustainability performance of green leafy vegetable value chains per sub-index (HD4A, funded by EU)

Sustainability Dimension	Mean Sub-Index Score (Potential range)	Key findings and interpretation
Environmental	2.99 (0 - 7)	This was the weakest performing dimension. The low score was driven by prevalent practices such as the indiscriminate use of chemical pesticides (reported by 66% of farmers on all vegetables) and a heavy reliance on inorganic fertilizers, often combined with manure.
Economic	2.59 (0 - 4)	Performance was moderate. A high proportion of farmers (77%) reported profitable production, and access to credit was widespread (87%). However, income diversity was a mixed picture, with most farmers relying on 2-3 sources.
Social	2.13 (0 - 7)	Social structures showed potential but were not fully realized. About half of the farmers were aware of land rights (49%) and perceived a fair system (52%), but participation in knowledge-sharing platforms was limited (36%).

Some sustainability issues, such as non-compliance among input suppliers regarding the quality and type of chemicals sold to farmers, and the absence of a system to monitor adherence to recommended practices, were identified. These sustainability issues need to be addressed critically, as they can affect the safety of the commodities sold in the market. Table 9 presents an overview of barriers and facilitators for sustainability that are likely applicable to other leafy vegetables and to other vegetables with shorter value chains that are highly perishable in areas with poor infrastructure, including poor electricity and cooling systems.

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Figure 9: Vegetables prepared for transportation on motorcycle (left) and tricycles for larger harvests, (right) © R. Asiimwe

Table 9: Sustainability issues and facilitators identified along the green leafy vegetable value chain, primary data collected in HD4A in Kampala, Uganda (2023)

Value chain actor	Identified sustainability issues (Barriers)
Input suppliers	1. Non-compliance by input suppliers on the quality of and type of chemicals sold to farmers
Farmers	2. Lack of specialized markets, e.g., organic markets and other markets that provide premium prices or reward efforts for environmentally-sound production 3. Absence of a system that regulates and monitors adherence to recommended and approved wetland use practices 4. The vegetable lands are mostly rented. Most farmers lack clear documentation of their lease agreements. In addition, the land near the wetlands has highly competitive alternatives, such as the construction of houses, since it is in the city's suburbs where the settlements are extending 5. Production in swamps presents a potential area of conflict with the National Environment Management Authority. Most wetland areas in the country are gazetted as protected areas and require NEMA approval for any activity. Farmers did not have this approval 6. Lack of strong and functional farmers' organizations of the green leafy vegetable producers 7. Excessive and non-judicious use of chemicals (especially plant protection) in the production process that would harm the wetland ecosystems and increase chemical residues in the vegetables produced
Retailers	1. Lack of proper waste management 2. Lack of proper storage facilities to extend shelf life

Value chain actor	Identified sustainability issues (Barriers)
Other actors	1. Low levels of consumption by the households 2. Absence of strong consumer protection unions and or bodies 3. The road infrastructure to the production sites limits the use of available improved fresh produce transport systems, such as cold trucks

	Identified sustainability issues (Facilitators/opportunities)
Input suppliers	1. Existence of a trader's union, the Uganda Agro-input Dealers Association, and the National Drug Authority
Farmers	1. Improvements in road infrastructure could make it equally profitable to produce in more distant places and still make it to the market in time 2. Existence of an all-year-round market, market-especially among the lower-income categories
Retailers	1. Increasing awareness of consumers about the benefits of vegetable consumption 2. The government's planned investment in city market infrastructure to provide for cold storage, vending space, water, and electricity in the markets
Other actors	1. Existence of a regulatory body within the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF)

Benin – *Vitex doniana* leaves value chains

The V. *doniana* (leaves) value chain in Benin is characterized by common actors such as processors, traders, and consumers. Still, unlike the leafy vegetable value chain in Uganda (above), it also includes "collectors". They are not farming; they are collecting leaves in their environment. Women are key throughout this value chain. The collectors are the first link in this value chain. They walk several kilometres to collect the leaves from trees and require a large number of trees to obtain a sufficient amount. On average, the women have 13.3 years of experience (± 9.6 years). About 93.3% do not own the land on which they collect and practice free exploitation.

Men, often paid daily or according to the number of trees covered, are asked to cut branches to facilitate leaf collection. In the overall opinion of the collectors:

> *"The distance travelled for collection is increasingly longer; and this is for various reasons, including the purchase of plots, deforestation, exploitation*

for firewood and charcoal, as well as excessive harvesting practices. These factors harm the growth of trees and their production of leaves and fruit."

Local markets are held every five days, and collectors begin harvesting new leaves the day after each market. The leaves are pre-cooked the day before the market. Transport to the markets is considered a challenge; a market in one's own village would be much appreciated. About half of the harvest is sold to wholesalers, while 26% is sold to retailers. Little is purchased directly from collectors. About a quarter (26%) is for own consumption, storage, and donations. The wholesalers, all of whom were women, have about 22 years of experience and often also market garden vegetables. Some women were wholesalers and retailers. Processors do not appreciate that the collectors do pre-cook the leaves before marketing. They responded that it is challenging to sell dried leaves and therefore abandoned the processing and marketing of *V. doniana*. The leaves are rarely offered at restaurants, but are potentially available on order. Seasonality may be a reason, but so may the effort involved in preparing the leaves. The actor map is presented in Figure 10.

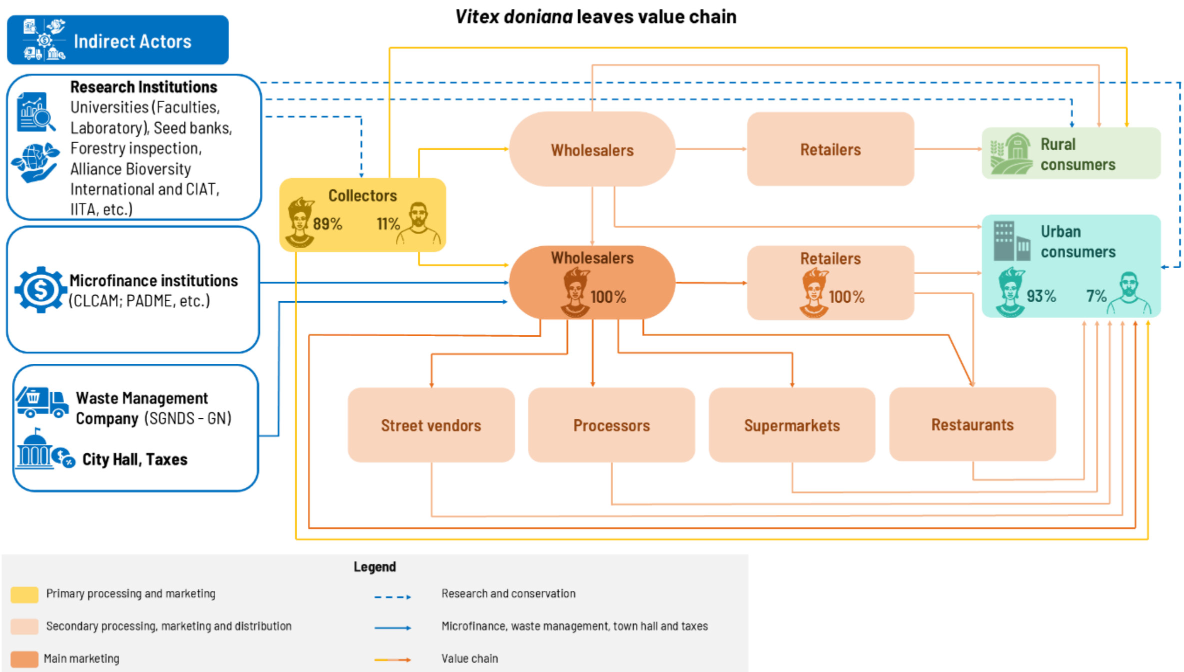

Figure 10: Value chain actor map of Vitex *doniana* leaves (HD4A, funded by EU)

Among the surveyed consumers, 30% reported having consumed the leaves in the month prior to the interview in a sauce. The main source was an open-air market (Figure 11).

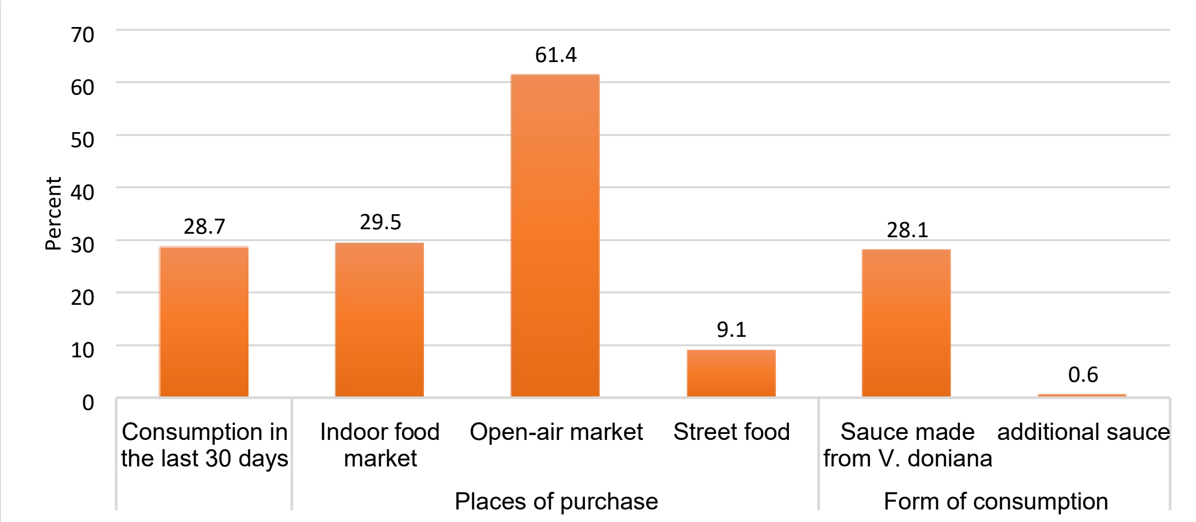

Figure 11: Eating, purchasing and preparation behaviour among consumers of Vitex *doniana* (HD4A, funded by EU)

The main barriers to the consumption of *V. doniana* leaves were: low availability of leaves in markets and near residential areas, poor quality of leaves and high purchase cost compared to other vegetables. At the same time, the main factors that were identified by consumers as facilitating the consumption of *V. doniana* leaves were: availability of leaves in local markets (66)%, good quality of leaves and being less expensive than other vegetables (52 %).

Benin – *Irvingia gabonensis* kernel leaves value chains

The general structure of the *I. gabonensis* kernel value chains is quite similar to the leaves of *V. doniana*. The value chain is dominated by women and low instruction actors. The main direct actors are: collectors, wholesalers, retailers, processors and consumers. There are also indirect actors such as research structures, microfinance institutions, waste management companies, etc. (Figure 12).

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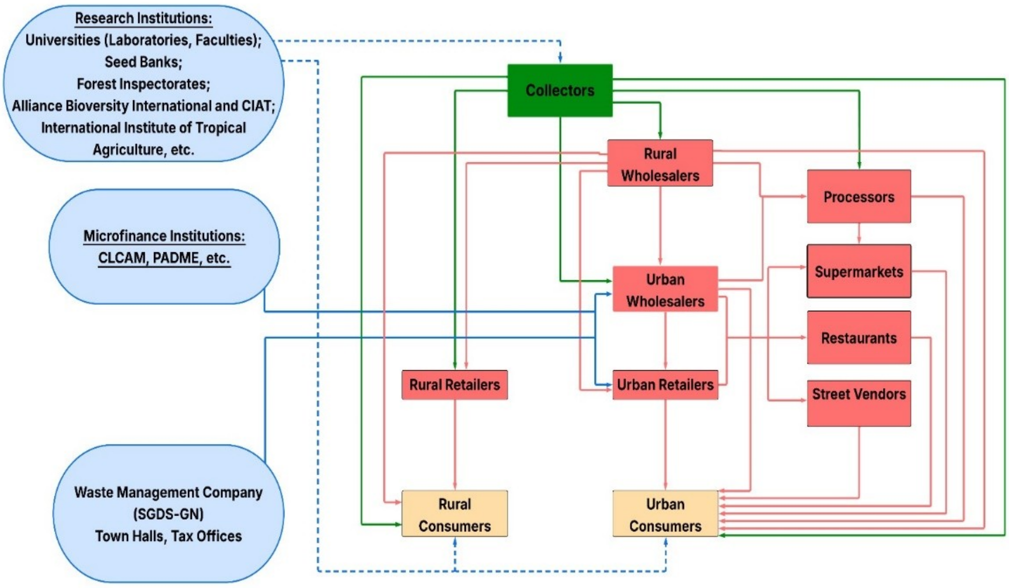

Figure 12: Value chain actor map of Vitex doniana kernels (HD4A, funded by EU)

The value chain has an interesting financial profitability for direct actors. However, it presents moderate, limited and unacceptable scores of sustainability vulnerabilities for the economic, the social and the environmental levels.

The main challenges among the value chain are: the fact that the chain is mainly informal and poorly organized, seasonal availability of the products, price fluctuations, low mechanisation of the processing and poor control over the quality of raw materials and processed products.

Conclusion

To ensure an efficient functioning of the fish value chain, collaboration between actors is necessary to facilitate effective communication, information flow, and fish flow. The network analysis indicates a sparsely connected network with low interaction among actors. Some actors have higher connectivity than others and largely form local clusters among themselves. This evidence indicates that there are disjoined nodes in the value chain, which may lead to inefficiency in communication and low levels of collaboration among the actors involved. Therefore, it is necessary to conduct further research into the supply chain's efficiency to identify areas for improvement. This will enhance coordination and collaboration among value chain actors. Additionally, Batool and Niazi (2014) highlighted that nodes with higher degree centrality also have higher eigenvector centrality and facilitate rapid diffusion of information in a network. Therefore, wholesalers need to be highly empowered as they play a critical role in facilitating information flow and effectively connecting other actors in the chain. The fish value chain in Kisumu has numerous entry points that affect sustainability like organized networks which ensure that information reaches the actors in an efficient way, maintain lake water quality as important resource for all actors, written agreements which can be used to claim rights and improve workspace conditions reducing dependencies. Although regulations may exist, limited surveillance capacity may hinder their effectiveness. Economic objectives and pressures may overrule sustainability aspects, which are crucial for ensuring sustainable fish production and safe consumption for all.

The sustainability of short vegetable value chains, particularly those involving indigenous green leafy vegetables (IGLVs), reveals several noteworthy aspects. Firstly, the production system for IGLVs is largely labour-intensive and predominantly operated by smallholder farmers, with minimal use of mechanization. Despite the small-scale nature of production, the majority of farmers access land through informal rental arrangements (unwritten agreements) which hinders secure access to land, i.e. the key production resource. With increasing urbanization, human settlement or other economic activities might be prioritized leading to reduced land for vegetable production which is close to (urban) consumers. There exists the potential conflict with environmental regulations, particularly in wetland areas, where a significant portion of production occurs. Unsustainable practices such as indiscriminate use of chemicals pose threats to both environmental integrity and human health. The dominance of informal retail outlets, coupled with limited presence of specialized stores or supermarkets, suggests a lack of market differentiation that could incentivize sustainable production practices due to access to premium markets. Moreover, the absence of strong farmers' organizations and consumer protection unions hinders collective action towards sustainability goals. Improvements in road infrastructure could potentially expand production areas and improve market access, while the existence of an all-year-round market, particularly among lower-income consumers, provides stability for producers. The presence of trader associations and regulatory bodies such as the Uganda Agro-input Dealers Association and National Drug Authority offers avenues for promoting better practices within the value chain although these are currently not being utilized.

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