Training kit for innovative food product and process development

Deliverable 6.2 | HealthyFoodAfrica

Healthy FoodAfrica

Summary

Task 6.2 consists in building capacity in developing innovative food products, processes and agri-business models. With specific regards to Deliverable 6.2, it aims to build a training kit to enhance capacity in developing innovative food products, processes, and agri-business models. It also identifies product innovations and provides technical information to facilitate their reproducibility. This report represents a Training Kit that is addressed to local producers and entrepreneurs, but also future stakeholders of local food systems (e.g. academic students). Through a pedagogical approach, it illustrates main themes related to sustainability and sustainable development goals, sustainable food systems (including a specific focus on drivers such as, political and economic factors, biophysical trends, demographics and socio-cultural challenges), Life Cycle Assessment (LCA), Social Life Cycle Assessment (SLCA), Life Cycle Costing (LCC), sustainable innovation and innovative and sustainable business models. Each section is complemented with the illustration of training exercises related to each analysed topic. In the end, the report provides practical information on how to build a business model of novel products as a case study.

Deliverable title: Training kit for innovative food product and process development
Deliverable number: 6.2

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Info list

-The role of the training kit as a part of training and engagement of entrepreneurs in summer schools is added in the introduction session called 'targeted audience of the T-Kit'. It mentions the targeted audience of the summer school, and how the T-Kit will be used during and possibly after.

- Introductions as transitions was added at the beginning of the chapter: sustainability, sustainable food systems, life cycle thinking for sustainable products, novel product: fruity soy pancake, and business model innovation. The last one mentioning it is a practical tool of Business Models Canvas (BMC) as a case study for training purposes.

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ACRONYMS:

WP – Work Package
NGO – Non-Governmental Organization
T-Kit – Training Kit
SME – Small and medium enterprise
VET – Vocational Education and Training
LCA – Life Cycle Assessment
LCSA – Life Cycle Sustainability Assessment
LCC – Life Cycle Costing
LCI – Life Cycle Inventory
LCIA – Life Cycle impact Assessment
ISO – International Organization for Standardization
BM – Business Model
BMC – Business Model Canvas
MAA –Multi Actor Approach
FSL – Food System Lab
HFA – HealthyFoodAfrica
SFS – Sustainable Food System
SDG – Sustainable Development Goal
HLPE – High level Panel of Expert
FSN – Food Security and Nutrition
LMIC – Low Middle Income County
BFA – Biodiversity for Food and Agriculture
ASF – Animal-Sourced Food
ICT – Information Communication Technology
GDP – Gross Domestic Product
FBDG – Food-Based Dietary Guidelines
NCD – Non-Communicable Diseases
FAO – Food and Agriculture Organization
WFP – World Food Program
WHO – World Health Organization
IPBES – The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
AGRA – Alliance for a Green Revolution in Africa
TEEB – The Economics of Ecosystems and Biodiversity

Executive Summary

Nowadays worldwide food systems are not sustainable. Production techniques fail to respect ecological needs by drying up and depleting water supplies, impoverishing and degrading soil, eroding biodiversity and strongly contributing to greenhouse gas emission. Meanwhile, the production value along the agri-food chain is not fairly and transparently redistributed and inequalities are constantly increasing. In addition, business-as-usual practices create massive food waste and losses and, therefore, unnecessary environmental impact. Furthermore, the demand for food constantly increases due to a growing global population, urbanisation as well as the increase in consumption driven by unsustainable economic models.

The overall goal of HealthyFoodAfrica (HFA) is to make food systems in 10 African cities in six countries across three African macro-regions more sustainable, equitable and resilient by reconnecting food production and food consumption in effective ways. To achieve this, the project engages farmers, food processors, retailers, civil society organizations, policymakers and local experts, and helps them create and test innovative technologies, practices and governance arrangements that will contribute to a more sustainable, resilient and healthy food system for all.

The present work was realised through an intense collaboration among project partners, namely The University of Pisa (UNIPI), The Mediterranean Agronomic Institute of Montpellier (CIHEAM-IAMM), the Council for Scientific and Industrial Research (CSIR), Böna Factory, Luke Research Institute (LUKE), The University of Helsinki (UH), with the support of comments from The Alliance of Bioversity International and CIAT (Bioversity), Northern Region Farmers Association (NRFA), Mentes Visíveis (MV) as well as the representatives of the HealthyFoodAfrica food system labs (FSL) in Accra (Ghana), Kisumu (Kenya), and Tamale (Ghana).

Work Package 6 (WP6) within the HealthyFoodAfrica project will focus specifically on the role of innovation in developing novel food products, tools and processes to support innovative agri-business models. WP6 is mainly responsible for the novel products & process challenge. The overall objective is to foster innovation in novel, sustainable and nutritious food products and test associated tools and processes, including the use of local under-utilised agro-biodiversity.

The present task 6.2 aims to build a training kit to enhance capacity in developing innovative food products, processes, and agri-business models through training in FSLs, and two

summer schools. It will also identify product innovations and provide technical information to facilitate their reproducibility. The Deliverable 6.2 is the central content of this document. Four main themes are discussed: general aspects of sustainability and life cycle assessment, sustainability of food systems (including agri-food value chains), innovation of business models, and the technical aspects of innovation for 3 specific food products. Deliverable 6.2 consists of a training kit (T-Kit) which serves as a guide to implement the HealthyFoodAfrica summer school sessions in 2022 and 2023 (second part of task 6.2) and for the collection, dissemination, and development of agri-food business innovations. The T-kit will offer a range of targeted training materials on general aspects of sustainability, sustainable food systems, business models and innovative food products and processes. The expected outcome is boosting the innovation capacity of project partners, food entrepreneurs, small and medium-sized enterprises (SMEs) and actors involved in food systems in developing novel products and business models for nutritious and healthy foods. The objective of the T-kit is to illustrate the potential of innovative, nutritious, and locally based products, explore methodological skills for assessment and strategy development, and enhance capacity in food innovations.

The T-kit is composed of:

- An open-source handbook for different kinds of vocational education and training (VET) providers and intended for trainees at different educational levels in the sub-Saharan context;
- The scientific framework for the organisation of the in-presence and online summer school (2022-2023)

The contents of the T-Kit are structured into 4 main themes moving from fundamental tenets and reflections on sustainability to a concrete analysis of innovative food products and business models.

- In the first section a comprehensive and operational definition of sustainability and sustainable development goals is provided to help in the understanding of the following chapters.
- The second section seeks to define “sustainable food systems”, including the main elements composing the system and its interrelations, and it explores sustainability issues with a specific focus on drivers such as, political and economic factors, biophysical trends, demographics and socio-cultural challenges. A practical activity on the use and construction of indicators on the sustainability of food and nutrition security is provided.

- The third section describe the importance of considering the entire supply chain to achieve long-term sustainability discussing the basics of Life Cycle Assessment (LCA), Social Life Cycle Assessment (SLCA) and Life Cycle Costing (LCC). The chapter is supplemented with guidelines for applying LCA.
- The fourth section gathers different aspects of innovative and sustainable business models (BM). The chapter aims to define "sustainable innovation", analyses the steps for the construction of the Business Models Canvas (BMC) and shows the opportunities that result from innovative and sustainable BM. The unit will present an exercise based on a case study to develop a BMC.
- The last section provides information on novel products describing the steps to produce a fruity soy pancake mix and its characteristics as a case study.

The multi-actor approach (MAA) has been central to the design of the training kit. This approach aims at focusing on concrete problems or opportunities that local producers and primary beneficiaries (end-users) are facing. The participation in bilateral meetings of all stakeholders was key to identify critical issues in the local food systems and to facilitate a brainstorming activity that triggered the exchange of ideas and inputs from various disciplines and sectors to co-create knowledge between practitioners, scientists, advisers, entrepreneurs, and researchers. The FSLs and the beneficiary groups/communities/up-takers represent the potential "end-users" or final beneficiaries in the future use of the T-Kit.

1. Introduction

Today, the majority of the food systems worldwide are not sustainable. Production techniques fail to respect ecological needs by drying up and depleting water supplies, impoverishing and degrading soil, eroding biodiversity and strongly contributing to greenhouse gas emission. Meanwhile, the production value along the agri-food chain is not fairly and transparently redistributed and inequalities are constantly increasing. In addition, business-as-usual practices create massive food waste and losses and, therefore, unnecessary environmental impact. Furthermore, the demand for food constantly increases due to a growing global population, urbanisation as well as the increase in consumption driven by unsustainable economic models.

To address these issues, we need to look at the functioning of agri-food business models and value chains in a systematic way. Innovative food products stemming from sustainable and new business models can help create more sustainable food systems: in fact, they can promote responsible use of raw materials, create value within and throughout the value chains, support social inclusion, reduce inequalities, and promote easy-to-use highly nutritious products.

Work Package 6 (WP6) within the HealthyFoodAfrica project will focus specifically on the role of innovation in developing novel food products, tools and processes to support innovative agri-business models.

HealthyFoodAfrica project founds its approach on five main pillars:

- Ten localised and context-specific Food System Labs for experimentation and innovation in regions with diverse production systems and challenges (Benin, Ethiopia, Ghana, Kenya, Uganda & Zambia).
- Ten work packages (WP) for holistically addressing food system challenges (nutrition & consumption; sustainable production; post-harvest; food safety; value chain governance; novel products & processes).
- Participatory, multi-actor, adaptive co-management approaches engaging farmers, food processors/packagers, retailers, consumers, non-governmental organizations (NGOs), scientists, decision and policy makers.
- The application of a Theory of Change framework for achieving transformational impact.
- Cross-cutting dissemination and capacity-building, to boost understanding, and wider and lasting impact.

WP6 is mainly responsible for the novel products & process challenge. The overall objective is to foster innovation in novel, sustainable and nutritious food products and test associated tools and processes, including the use of local under-utilised agro-biodiversity. WP6 aims at the realisation of 5 tasks:

The first task (6.1) seeks to analyse the current trends of food systems in Ghana and Kenya to identify the opportunities in food products, processes, and agri-business models.

The task 6.2 aims to build a training kit to enhance capacity in developing innovative food products, processes, and agri-business models through training in FSLs, and two summer schools. It will also identify product innovations and provide technical information to facilitate their reproducibility.

Task 6.3 aims to pilot the most promising innovations identified in T6.2 in the other FSLs to develop, launch and learn from novel, sustainable and nutritious food products. It will also represent the possibility to test associated tools and processes.

Task 6.4 purpose will be to provide technical fiches for 3 new food products and processes to understand the potential of new products, processes and business models, taking care to minimise the associated sustainability impacts throughout their life cycle.

The last task of the WP6, T6.5, will be to disseminate the lessons learnt from the piloting process through relevant platforms and networks. To also analyse the market accessibility, and potential business growth for start-ups.

The Deliverable 6.2 will be the central content of this document. Four main themes will be discussed: general aspects of sustainability and life cycle assessment, sustainability of food systems (including agri-food value chains), innovation of business models, and the technical aspects of innovation for 3 specific food products.

2. The Training kit

Deliverable 6.2 consists of a training kit (T-Kit) which serves as a framework and guide to implement the HealthyFoodAfrica summer school sessions in 2022 and 2023 (second part of task 6.2) and for the collection, dissemination, and development of agri-food business innovations. The T-kit will offer a range of targeted training materials on general aspects of sustainability, sustainable food systems, business models and innovative food products and processes. The expected outcome is boosting the innovation capacity of project partners, food entrepreneurs, small and medium-sized enterprises (SMEs) and actors involved in food systems in developing novel products and business models for nutritious and healthy foods.

2.1 Purpose and Application

The T-kit is an easy-to-use handbook for training and study sessions. It can be considered as a tool that everyone interested can use. More specifically, it is addressed to trainers, project designers, and future agri-food business innovators such as University students, offering them theoretical and practical tools to work on food sustainability and innovation.

The objective of the T-kit is to illustrate the potential of innovative, nutritious, and locally based products, explore methodological skills for assessment and strategy development, and enhance capacity in food innovations.

The T-kit will be composed of:

- An open-source handbook for different kinds of vocational education and training (VET) providers and intended for trainees at different educational levels in the sub-Saharan context

- The scientific and practical framework for the organisation of the in-presence and online summer school (2022-2023)

2.2 Contents Overview

The contents of the T-Kit are structured into 4 main chapters moving from fundamental tenets and reflections on sustainability to a concrete analysis of innovative food products and business models.

The first section gives a comprehensive and operational definition of sustainability and sustainable development goals to help in the understanding of the following chapters.

The second section seeks to define "sustainable food systems", including the main elements composing the system and its interrelations, and it explores sustainability issues with a specific focus on drivers such as, political and economic factors, biophysical trends, demographics and socio-cultural challenges. A practical activity on the use and construction of indicators on the sustainability of food and nutrition security is provided.

The third section describe the importance of considering the entire supply chain to achieve long-term sustainability discussing the basics of Life Cycle Assessment (LCA), Social Life Cycle Assessment (SLCA) and Life Cycle Costing (LCC). The chapter is supplemented with guidelines for applying LCA.

The fourth section gathers different aspects of innovative and sustainable business models (BM). The chapter aims to define "sustainable innovation", analyses the steps for the construction of the Business Models Canvas (BMC) and shows the opportunities that result from innovative and sustainable BM. The unit will present an exercise based on a case study to develop a BMC.

The last section provides information on novel products describing the steps to produce a fruity soy pancake mix and its characteristics as a case study.

Before starting to explore the contents of this T-Kit, the following part will be dedicated to the understanding of the approach and methodology used to collect the information and develop the T-Kit.

2.3 Approach and Methodology

The multi-actor approach (MAA) has been central to the design of the training kit. This approach aims at focusing on concrete problems or opportunities that local producers and primary beneficiaries (end-users) are facing. It also means that partners with complementary types of knowledge (scientific, practical, etc.) must join forces for developing the T-Kit in the task. As a result, an MAA approach enables the development of innovative solutions, ready to be applied in practice and covering operational needs.

The present work was realised through an intense collaboration among project partners, namely The University of Pisa (UNIPI), The Mediterranean Agronomic Institute of Montpellier (CIHEAM-IAMM), the Council for Scientific and Industrial Research (CSIR), Böna Factory, Luke Research Institute (LUKE), The University of Helsinki (UH), with the support of comments from The Alliance of Bioversity International and CIAT (Bioversity), Northern Region Farmers Association (NRFA), Mentes Visíveis (MV) as well as the representatives of the HealthyFoodAfrica food system labs (FSL) in Accra (Ghana), Kisumu (Kenya), and Tamale (Ghana).

The participation in bilateral meetings of all stakeholders was key to identify critical issues in the local food systems and to facilitate a brainstorming activity that triggered the exchange of ideas and inputs from various disciplines and sectors to co-create knowledge between practitioners, scientists, advisers, entrepreneurs, and researchers. To encourage and structure participation, plenary group meetings were organised for participant involvement and brainstorming, and then semi-structured bilateral meetings were held with key informants of the area of intervention for gathering in-depth knowledge and data.

The brainstorming process has been crucial to define the main objectives and the guideline for the contents to be included. For instance, the first challenge was to define the scope of a training kit, the contents and to understand the strategies to engage students and local entrepreneurs in the development of innovative products. Bilateral meetings represented the key method to foster open participation and to enable a deeper understanding on the need for training youth (students and young entrepreneurs) about sustainable food systems as well as on the needs of the FSLs and the commitment of the partners. It should be noted that the FSLs and the beneficiary groups/communities/up-takers represent the potential "end-users" or final beneficiaries in the future use of the T-Kit. Indeed, through a multi stakeholders' platforms, FSLs keep track of real needs and opportunities of local communities and allow the capillary dissemination of information and innovations.

Each meeting was structured according to the topics discussed during the brainstorming. Several issues have been addressed such as the strategies to boost innovations, the most suitable facilities to be used as case studies and the base learning approach of the T-kit. For each theme, participants' ideas and perspectives were collected with the aim to create a comprehensive and shared outcome. A report was produced from each meeting to keep track of and collect all the topics discussed, updates and proposals.

The T-Kit is mainly divided into two parts: the first part provides users with theoretical information on sustainability and the functioning of sustainable food systems to ensure a comprehensive and detailed background in line with the scientific community. The second part presents individual or group exercises and tools to encourage co-participation, co-learning and sharing to trigger critical thinking and foster the development of innovations.

2.4 Targeted audience of the T-Kit

The T-Kit represents the instructional framework for the implementation of the in presence and online summer schools foreseen by the project in 2022 and 2023 as well as a unique document for the trained beneficiaries or anyone interested in replicating the training. To ensure the T-kit replicability over time, it will be shared as a public deliverable of the HFA project website.

The targeted audience of the T-Kit are; first, the participants of the summer schools who are expectedly agri-food entrepreneurs (including SMEs) and academic students with food science and technology, food processing, food systems, and any other food related topics experience, who are interested in food products' innovations from Ghana, Kenya and Food System Lab partners; and second, anyone who is interested in replicating the tools and cases from T-Kit regardless of the participation of the summer school.

Participants of the summer schools will not only use the theoretical content, cases studies and tools embedded in the T-Kit to create or boost their business, but could be used as a tool to share and disseminate knowledge in:

- Sustainability and its assessment with technical tools such as life cycle assessment.
- Food system dynamics from the drivers, supply chains, consumer behaviors, and diets that are related to food security and nutrition, and assesses it thought indicators.
- Co-develop the capacity to design new and sustainable business models for innovative products and have training on the implementation on an actual innovative product.

3. Sustainability

This chapter Is an introductory section on sustainability and on sustainable development goals. This section aims to establish the definition of sustainability and to explain and recall the need of sustainability assessment through acknowledged indicators such as those that compose the Sustainable Development Goals.

At the end of this section, you will be able to:

- List and discuss key aspects and principles related to the sustainability in food systems and the food and agriculture nexus
- Have an understanding and the use of the United Nation's Sustainable Development Goals (SDGs)
- Understand the importance of target and indicators to measure the progress towards a goal
- Understand the sustainability principles underneath the main trends of agricultural policies and market strategies in food systems.

3.1 Definition and Principles for Sustainability in Food and Agriculture

In 1987, the United Nations Brundtland Commission defined sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." FAO has defined sustainable agricultural development as "the management and conservation of the natural resource base, and the orientation of technological change in such a manner as to ensure the attainment of continued satisfaction of human needs for present and future generations. Sustainable agriculture conserves land, water, and plant and animal genetic resources, and is environmentally non-degrading, technically appropriate, economically viable and socially acceptable" (FAO, 1988).

Sustainability entails far more than maintaining the protection of the natural resource base. Sustainable development requires an integrated approach that takes into consideration environmental concerns along with economic development. Sustainability also ensuring that everyone has access to the entire range of human rights in a way that does not

jeopardize future human rights. Social and economic, civic and political, cultural, and the right to a suitable and clean environment. To put it another way, sustainability requires a high quality of life for everyone that serves not only physical but also social and cultural needs and is distributed fairly.

Therefore, sustainability in agriculture must meet the demands of current and future generations for its goods and services while maintaining profitability, environmental health, and social and economic equality in order to be sustainable. Over time, sustainable agriculture would contribute to the later described six pillars of food security – availability, access, use, agency, sustainability, and stability – in an environmentally, economically, and socially responsible manner.

Sustainability is studied holistically in the establishment of a sustainable food system. To be sustainable, the food system's development must provide positive value in three dimensions at the same time: economic, social, and environmental.

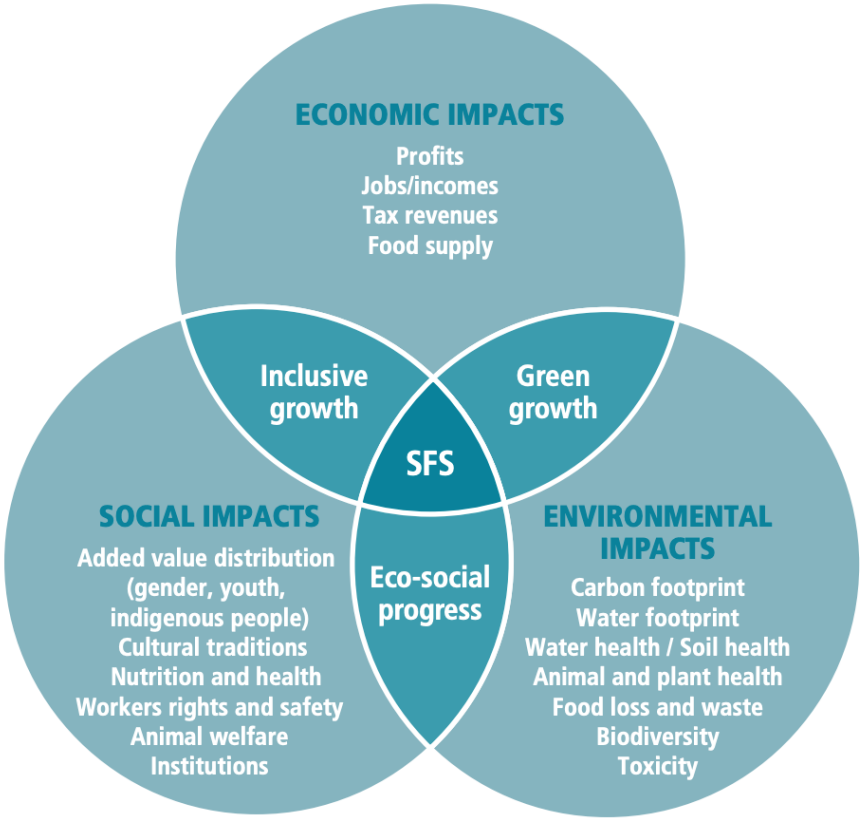


Figure 1, Three dimensions of Sustainability, Source: Adapted from FAO, 2014.

On the economic dimension, a food system is deemed sustainable if the actions carried out by each food system actor or support service provider are commercially or fiscally viable. Benefits, or economic value-added, should be generated for all stakeholders: wages for labour, taxes for governments, profits for businesses, and improved food supply for consumers.

On the social level, a food system is deemed sustainable when the economic value added is distributed fairly, taking into account possible vulnerabilities such as gender, age, ethnicity, and so on. Food system operations must contribute to the promotion of vital socio-cultural outcomes such as nutrition and health, traditions, labour conditions, and animal welfare, among other things.

On the environmental dimension, sustainability is defined as ensuring that food system activities have a neutral or positive impact on the surrounding natural environment, considering biodiversity, water, soil, animal and plant health, greenhouse gas emissions, food loss and waste, and pollution.

3.2 Sustainable Development Goals (SDG's)

Agenda 2030 and the Sustainable Development Goals (SDGs), were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity. In total, the 17 SDGs are interlinked global goals that individual governments and the world as a whole are striving to meet through concrete action. They recognize that action in one area will affect outcomes in others, and that development must promote social, economic and environmental sustainability. The SDGs aim to end poverty, hunger, AIDS, and discrimination against women and girls, among others goals.

Figure 2, SDG's according to United Nations

The SDG's are also used as a planning tool and monitoring tool on action and progress at a national and local level, as countries committed to prioritize progress for those who are furthest behind. It is a long-term approach that support countries through formulation of public policies and budget, monitoring and evaluation instruments towards inclusive and environmentally friendly development.

Each of the 17 SDG's has a list of 8-12 targets, with a total of 169 SDG Targets, and with 1-4 indicators for each target to measure the progress: in total 232 indicators are measured (or 242 as some indicators repeat in different goals). These include both statistical and policy

goals. some are fully developed indicators and others are still being developed. Targets are often outcomes (circumstances to be attained) or "means of implementation" targets. The achievement of the SDG's is done through the SDG Tracker that presents the data for all the available indicators, using official statistics from the UN and other organizations. It is a free, open-access system that tracks global progress towards the SDGs and allows people around the world to hold their governments accountable to achieving the agreed goals (the SDG Tracker is available through this link).

In the 2030 agenda of the SDG's 3 core universal values are envision based in international human rights standards These 3 universal values are: leave no one behind, human rights-based approach, and gender equality and woman's empowerment, which are intended to place the person and his or her inherent dignity at the centre of the SDG's. Its goal is to combat discrimination and other forms of inequality that are at the roots of poverty and conflict. Integrating universal principles into the implementation of the SDGs also helps countries meet their international obligations.

An example of the specific targets to be achieved by 2030 by a goal and its respective indicators is the following:

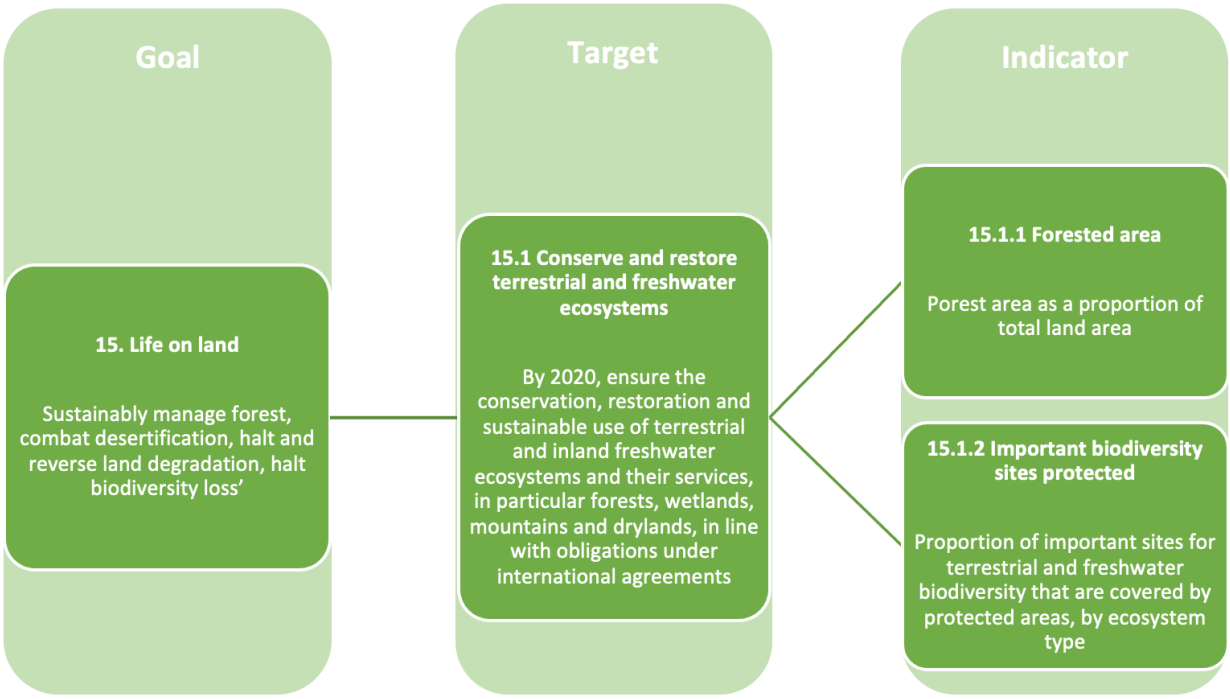


Figure 3 Source: Adapted from United Nations, 2020

Box 1. The Sustainable Development Goals tracking

The Sustainable Development Goals Report 2020 brings together the latest data to show that, before the COVID-19 pandemic, progress remained uneven and results were not on track to meet the Goals by 2030. Some progress was visible: the percentage of children and youth who were not in school had decreased; the frequency of numerous infectious diseases had decreased; access to safe drinking water had improved; and women's representation in leadership roles had increased. At the same time, food insecurity was on the rise, the natural environment was deteriorating at an alarming pace, and high levels of inequality persisted in all regions. For the first time in over 20 years, the worldwide extreme poverty rate increased in 2020. Hundreds of millions of people fell into poverty and chronic hunger. To achieve the SDG's for 2030, leadership and collective action among nation is needed, as well as the involvement of the civil society. For more detail on the report check this link.

4. Sustainable Food System

This section builds on the sustainability tenets and tools that compose the previous section and deals with the classification and description of the functioning dynamics of sustainable food systems, including the related multiple drivers of change, the main outcomes of food security and the different steps within agri-food value chains. The aim of this section is to develop and trigger knowledge on the factors that are responsible for change in food systems, on the outcomes that are expected from a sustainable food system and on the practice dynamics that characterize the functioning of value chains. This chapter provides a broad overview of sustainable food system's dynamics and contribute to the understanding on the global economic and social environment in which the agri-food activities are carried out.

At the end of this section, you will be able to:

- Understand the six dimensions of food security
- Explore the sustainable food system framework
- Recognize major trends that affects food systems
- Know how to map a food supply chain
- Recognize how consumer behaviours change and the importance of healthier foods and diets

4.1 Introduction

The High Level Panel of Experts on Food Security and Nutrition defines a food system as a system "that gathers all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relates to the production, processing, distribution, preparation and consumption of food, and the output of these activities, including socio-economic and environmental outcomes" (HLPE 12, 2017). According to FAO (2018), food systems are sustainable when they "deliver food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised."

In the first half of the 20th century, a series of innovations triggered a radical change in agricultural productivity. The Haber-Bosch process of converting atmospheric nitrogen into nitrogen compounds led to the production of low-cost fertilisers. Seed hybridisation has favoured high-yielding crops. Fossil fuels have enabled the mechanisation of agriculture, and water pumping systems have facilitated the extraction of ground waters. Finally, the

promotion of pesticides has facilitated the suppression of insects and weeds. The combination of these technologies launched the so-called "Green Revolution", leading to the industrialisation of agriculture and a general increase in food crop productivity over the last 50 years, helping much of the developing world to overcome its chronic food deficits (although sub-Saharan Africa continues to be the exception to the global trend).

On the other hand, the "Green revolution" participated in the establishment of a system that is vulnerable in the long term (dependence on monocultures, chemical fertilisers and pesticides, nitrogen pollution, the use of fossil fuels, and efficient but unsustainable transport, storage, and distribution systems).

Industrial Agriculture which depletes natural resources without regenerating them, creates a large amount of waste at all stages of production and threatens current and future generations' food security (FAO,2019).

In 2020, between 720 and 811 million people in the world faced hunger (FAO, 2020) and about 1.9 billion people were overweight (WHO, 2021), with strong health and environmental costs. It has been calculated that for every dollar spent for food production, society pays two dollars in health, environmental and economic damages (Elle MacArthur foundation, 2017). The scale of production through industrial agriculture is estimated to increase by 60% by 2050, requiring an additional 120% of water, 42% of cultivated land and a 77% increase in greenhouse gases (Laybourn-Langton, et al. IPPR, 2019).

However, of the world's population is fed by small producers. Indeed, with 560 million farms worldwide, 90% are run by an individual or a family and produce 80% of the world's food (FAO, F. Harvey, 2019). Notably, farms smaller than 2 hectares produce about 30 percent of most food commodities in sub-Saharan Africa, Southeast Asia, and South Asia (FAO, 2019).

	Industrialised agriculture	Small producers
% Farmland used	75%	25%
% Fossil fuels used	90%	10%
% Water used by agriculture	80%	20%
cultivated plant varieties	0,1 million	2,1 million
Breeds of animals raised	100 species	8.774 species

Table 1 Industrial farming in comparison with small farmers, Ellen MacArthur Foundation, Food and the Circular Economy,

As it is Illustrated in the table above, smallholder farming practices, which are closer to the rules imposed by the Ecosystem, present better performance in terms of overall sustainability of food systems (at least for absolute data). Nevertheless, small-scale producers are often also the most vulnerable. In fact, FAO as reported in the F. Harvey article ("Can we ditch intensive farming – and still feed the world?" 2019) considers investments to support this type of production "as the most urgent and secure and promising means of combating hunger and malnutrition, while minimising the ecological impact of agriculture".

Therefore, it is essential to reconsider the food system by relocating it within the Ecosystem, looking for sustainable solutions and innovations that can guarantee a definitive achievement of food security. The sustainable food system framework, whose every aspect will be further analysed, recognises the interrelatedness of food systems with other systems, and in turn appreciates the complex interaction of all the SDGs (Waage et al., 2015). It stresses the need to move beyond food policies that focus exclusively on agricultural supply and demographic change to instead implement policies that support fundamental changes to food systems in order to meet SDG 2 (End hunger, achieve food security and improved nutrition and promote sustainable agriculture) and support all the SDGs in an integrated way (Willet et al., 2019).

4.1 Six Dimensions of Food Security

Sustainable Development Goals are illustrated in the "Sustainability" chapter. Now we will seek to provide a definition of food security using the figure (Figure 3) provided by HLPE in 2021, which outlines 6 dimensions of food security within the definition itself.

"Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life" (World Food Summit, 1996). This definition remains the most authoritative and widely used definition of the concept today and, according to the most recent HLPE/FAO reports, features six dimensions: availability, access, utilisation, stability, agency, and sustainability.

Figure 4 Identify the six dimensions of Food Security in its current definition, HLPE, 2021

1. Availability: Having a quantity and quality of food sufficient to satisfy the dietary needs of individuals, free from adverse substances and acceptable within a given culture, supplied through domestic production or imports.

2. Access (economic, social, and physical): Having personal or household financial means to acquire food for an adequate diet at a level to ensure that satisfaction of other basic needs are not threatened or compromised; and that adequate food is accessible to everyone, including vulnerable individuals and groups.

3. Utilisation: Having an adequate diet, clean water, sanitation, and health care to reach a state of nutritional well-being where all physiological needs are met.

4. Stability: Refers to the continuity over time of the three previous dimensions despite crises, sudden shocks, or critical events.

5. Agency: Individuals or groups capacity act independently to make choices about what they eat, the foods they produce, how that food is produced, processed, and distributed, and to engage in policy processes that shape food systems.

6. Sustainability: Considering the long-term regeneration of natural, social, and economic systems, ensuring the food needs of the present generations are met without compromising the food needs of future generations.

Global food and nutrition insecurity is a highly differentiated problem. Although food availability is a crucial issue in the fight against malnutrition and hunger, it has become clear that we need a more complex set of approaches to address all dimensions of food security and ensure solutions that look at the system as a whole.

4.2 Functioning of Food Systems

When we analyse systems (such as ecosystems, economic systems, social-cultural systems, energy systems and health systems), it is important to first consider how systems thinking works. Systems thinking is a holistic approach for analysis that focuses on the way that a system's constituent parts interrelate and how systems work overtime and within the context of larger systems. This approach contrasts with traditional analysis, which studies systems by breaking them down into their separate elements. Analogously a food systems approach is a way of thinking that considers the food system in its totality, considering all the elements, their relationships, and related effects.

A food system encompasses the complexity of relationships across sub-systems such as food production, food supply chains, food environments, the behaviours of individual consumers, diets, and nutritional and wider outcomes that feed back into the system. Including the stability and ability to reproduce over time without harming the social, economic and environmental spheres, we can aspire to a sustainable food system (SFS).

Sustainable food systems should be productive and prosperous, to ensure the availability of sufficient food. Equitable and inclusive, to ensure access for all people to food and to livelihoods within that system. Respectful and empowering, to ensure agency for all people and groups to make choices and exercise voice in shaping that system. Resilient, to ensure stability in the face of shocks and crises. Regenerative, to ensure sustainability in all its dimensions and healthy and nutritious, to ensure nutrient uptake and utilization.

HLPE 12 "nutrition and food systems" and HLPE 15 "Food security and nutrition" have been two essential reports for inspiring the development of this T-kit, allowing a deeper understanding of the complexities of food systems and to provide a common background in line with the scientific community. To ensure a full explanation of what a food system is, we use the framework proposed by the HLPE "conceptual framework of food systems for diets and nutrition" which will be described in the following section.

The enhancement of Food security together with the achievement of the Sustainable Development Goals, represents the final objective of the food system framework.

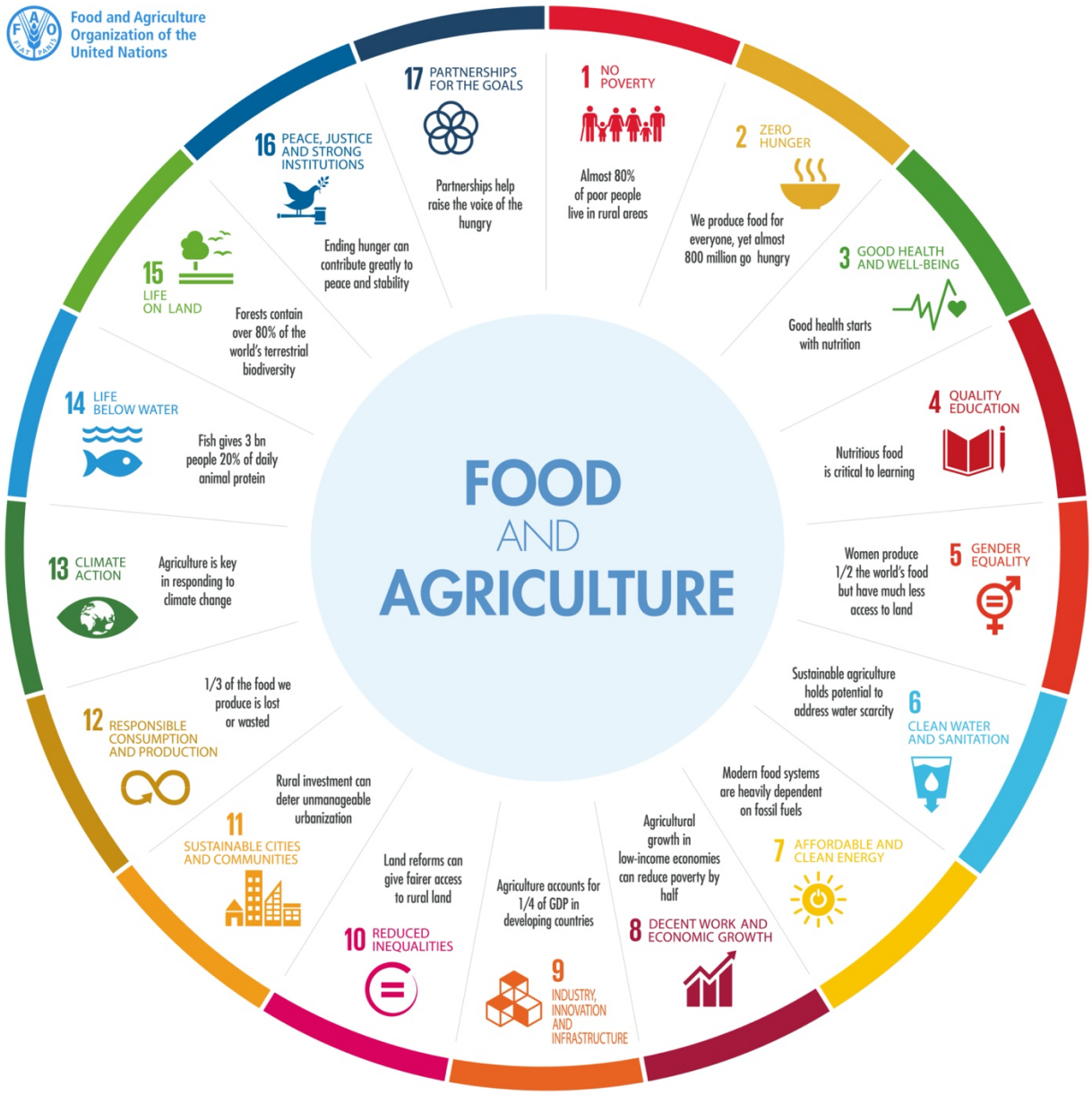


Figure 5 FAO (2015), SDG Wheel. The impact of Food and Agriculture on SDG's

4.3 Sustainable Food Systems Framework

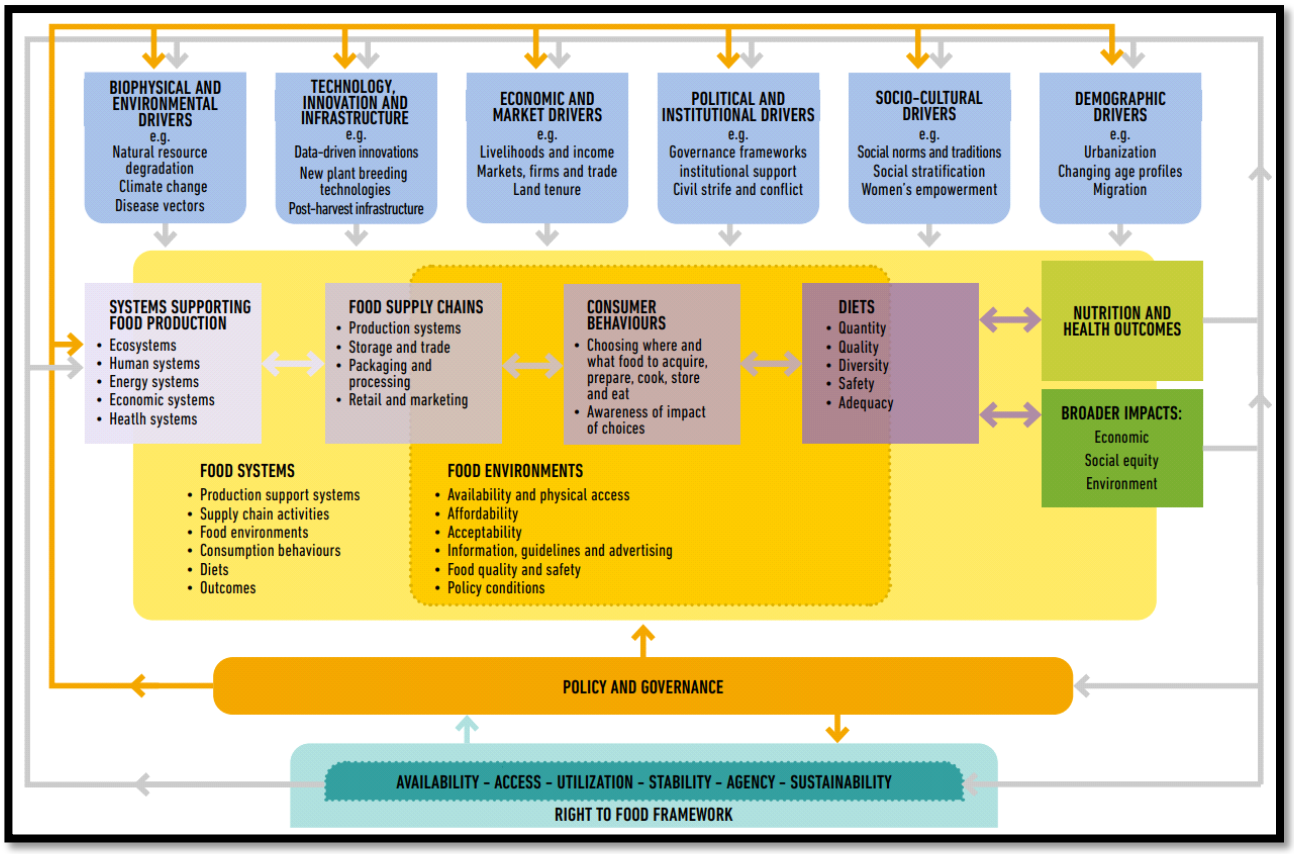


Figure 6 Sustainable Food System Framework, HLPE 2020

As it is illustrated in the diagram above, the final objective of the framework is to achieve Sustainable Development Goals and to enhance food security and nutrition (FSN) improving food access, availability, utilisation, and stability but also agency and sustainability. To achieve these objectives, three main elements operate and interact within the food system: food supply chain, food environment, and consumer behaviour. These three elements shape diets and determine the final nutrition, health, economic and social outcomes of food systems.

The main system components are influenced and affected by five main drivers of food system changes: biophysical and environmental; innovation, technology, and infrastructure; political and economic; socio-cultural; and demographic drivers. In addition, the framework emphasises the importance of the systems supporting food production, such as Ecosystems, Human systems, Energy systems, Economic systems, and Health systems.

4.4 Drivers of Food System Change

The drivers of food system change are factors that influence food systems in complex ways and alter food system activities and outcomes occurring consistently over periods of time (Béné et al., 2019). Drivers may be endogenous, but some others are independent and exogenous in the way they affect the food system. Also, the drivers influence every component of the food system, from the supply chain, food environments to the consumer behaviours.

4.4.1 Biophysical and Environmental Drivers

As food system is heavily dependent on ecosystems and biodiversity, these drivers refer to the natural resources dynamics that influence the food system functioning. They include land, water, nutrients, soil, sunlight, energy, and biodiversity, all of which are critical inputs needed to produce food. They also comprise the ecosystem services provided by the natural environments and that have multiple benefits for society and the environment. Climate change is an important driver that affects productivity and shapes the landscapes to produce food, in which case it has direct and indirect outcomes for nutrition and health in food systems.

Box 2. Climate change as driver for food insecurity in the Kenyan food system

Kenya has presented meaningful variations in annual rain precipitation and increase of mean temperature. According to data calculated from FAOSTAT (2021), from 1961 to 2021 Kenya presented trends of increasing rainfalls. According to the same data from FAOSTAT, there has been a rainfall variation +/-20% for Kenya from its long-term average, and the temperature has increased from 0,6 °C on average from 1961 to 2020. Nonetheless, since 2016 Kenya has shown more variation comparing to previous years, having as consequence severe drought which forced the government to declare a national drought disaster. As an example of the negative effect on the food system, pastoralists have sold surviving animals during the drought causing a glut in the market that triggered price crash in some areas where most of livelihood rely on livestock. This phenomenon caused a reduction on the availability of milk protein, worsening nutritional levels, particularly among children.

The relationship between food systems and ecosystems is highly complex, because environmental changes are both drivers and outcomes of food systems (Fanzo et al., 2021).

Agriculture relies directly on the use of natural resources, if there is not enough water or there is a lack of nutrients for production, crop yield and animal production is optimized and not enough food produce for the population demand, and therefore food security, dietary quality and human health is jeopardized.

Food security, diets, and nutrition all strongly depend on biodiversity (DeClerck et al., 2011), much of which can be found in wild landscapes, such as forests and waterways, as well as farms. As agriculture systems around the world becomes more similar by the consumption and use of major crops, such as wheat, rice, sugar, palm oil, maize, and soy, preservation of biodiversity including indigenous products becomes relevant to keep pool of diets with important nutritious intakes.

4.4.2 Sociocultural Drivers

Traditions and norms have a great role on food choices and often reflect sense of identity and culture. Cultural tradition and gender norms are major drivers of food environments and diets. The types of foods we consume, the way we prepare and eat them, the people with whom we share food, and the places where we eat are repositories of tradition (Fanzo et al., 2021).

Box 3. Gender disparities in agricultural participation in Ghana and Kenya

A big proportion of women participate in agriculture as workers and labourers as in some regions, rising migration and changing livelihoods have led women to become increasingly responsible for agricultural production. Women also have an important role in shaping food system and diets as in most of the world women prepare the food for their entire households. Despite their important role, often in some societies women have the responsibility for unpaid household and childcare labour, in which many cases effects on the possibility to participate in other paid labour activities in the food systems. Even as women take on more work, their access to agricultural inputs, tools, information and extension services, land, and other resources remains limited (Fanzo et al., 2021). In Ghana, for example, men are more likely to be members than women in farmers' groups. 32% of men are members of agricultural groups, compared to 17% of women (Yokying and Lambrecht, 2019). Moreover, in rural areas, men are five times more likely to take part in wage-employment than women. On the contrary, rural women are more likely to be engaged in unpaid family work and non-agricultural self-employment activities than rural men (FAO, 2012).

4.4.1 Political and Economic Drivers

Policies on agricultural, trade and health issues shape the political landscape that affects the functionality of the food systems. Trade and subsidies affect food security in a country through availability and affordability of food-by-food commodities. Food based dietary guidelines also shape and promote healthy diets by imposing taxes on unhealthy food for example.

Globalisation and trade exert a force that integrate the global markets and foreign investment. These drivers affect the type, quantity, quality, cost, and desirability of foods that are available to consumers (Hawkes, 2006). In low-income countries, trade has incentivised the production of energy dense foods, led to higher prices for more nutritious foods, and contributed to the increased popularity of "Westernised" diets (Fanzo et al., 2021).

Food insecurity can also contribute to conflict through rising food prices, price volatility, and food shortages (Brück et al., 2019). Crises also act as drivers of food insecurity and malnutrition. Conflict and humanitarian crisis can disrupt the food systems and increase level of poverty and food insecurity and nutrition. Harm to infrastructure could affect negatively processing, distribution, and access to food, and disruption in production, crops, livestock, and water may also impact the availability of food.

4.4.1 Demographic Drivers

Urbanisation, migration, and population growth shape food systems worldwide. These drivers are significant in Low and Middle Income Countries (LMICs) where often there is rapid population dynamics and migration to cities which affects food consumption and demand and often food insecurity is intensified by climate change and conflict.

By 2050, the global population is projected to grow to 9.8 billion people. Some regions, such as Africa, will experience a growing population of young people, while others, like Europe and Asia, will face a significant ageing population. The increase of population creates pressure on the use of natural resources and land use specially if the demand for certain resource-intensive foods continues to increase. Higher yields will be needed to sustain the food demands and assure availability of food, and therefore the increase of use in pesticides and fertilisers along with its negative environmental impact. As the global population

grows, changes to dietary patterns and food demand will be necessary to ensure the sustainable production of sufficient nutritious food for all (Fanzo et al., 2021).

By 2050, more than 6 billion people, or approximately two-thirds of the world's population, will live in urban areas. The growth of urban sector is related by an increase of population rates and migration to cities is leading to a transformation of the food systems. This raises concerns, particularly in sub-Saharan Africa where urban growth and the economic sectors are not able to cope with such a rapid transition and offer employment to rural dwellers as has occurred historically in other continents (Neufeld et al., 2021). Urbanisation is often related with the change of diets towards a more energy-dense diets and greater demand for ASF, fats and oils, refined grains, and fruits and vegetables. Many urban dwellers prefer processed and prepared foods, which can be less healthy than fresh foods but more convenient (HLPE, 2017). Urbanisation shapes the food environments by the increase of number of supermarkets, however low-income populations may not have physical or economic access to healthy, fresh foods from these retailers (Fanzo et al., 2021), leading poorer households to get food from informal retailers. Also, food in urban areas require longer food chains and more processing, packaging, and refrigeration when food is transported from rural areas.

4.4.2 Innovation, Technology, and Infrastructure

The industrial revolution and green revolution brought mechanisation of the agri-food production practices and technologies through fertilisers, pesticides, technologies in processing and preservation, that shaped how food is produce, stored, and consumed. Modern innovations in agricultural technology, product development, processing, packaging, and logistics can stimulate change at other stages of the food supply chain (Fanzo et al., 2021). Innovations and technology often shape diets and nutrition in positive ways by increasing productivity, efficiency, and agricultural intensification, and by providing off-farm jobs to women and youth (Reardon et al., 2019). Access to communication technologies can reduce the cost by shortening the supply chain thanks to mobile applications (e.g., farm to fork initiatives), affecting nutrition by lowering food costs and making seasonal foods more widely available. Time-saving technologies have positively altered women's responsibilities, allowing them more time to engage in the labour market, education, or childcare. But technological innovations could also have negative effects on the food systems if farm technologies are not accessed by all producers, such as in cases where there are more processed and packaged foods into the food supply that are

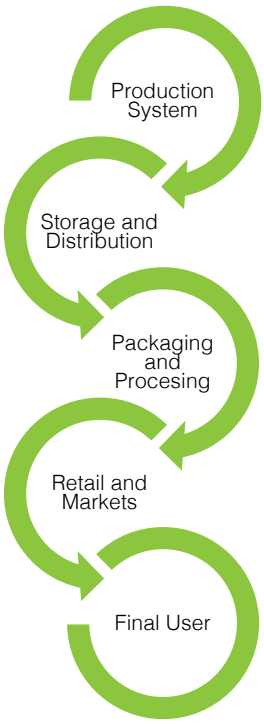
unhealthy, and when long supply chains are more exposed and vulnerable to climate shocks, food safety risks, diseases, conflict and unrest, and energy costs.

Given the fact that the world is becoming more urbanised, specifically in the case of LMICs, infrastructures play a major role as links between rural and urban area in the transportation of food. Food environments are also affected by infrastructure as food often needs to be transported over long distances, for examples in areas where there are food shortages and food security is lacking. Good infrastructure in transportation reduces food waste and food-borne diseases, ensuring quality and availability of food.

Biophysical and environmental drivers include natural resource and ecosystem services, and climate change. Political and economic drivers include leadership, globalisation, foreign investment and trade, food policies, land tenure, food prices and volatility, conflicts, and humanitarian crises. Socio-cultural drivers include culture, religion, rituals, social traditions, and women's empowerment. Finally, demographic drivers include population growth, changing age distribution, urbanisation, migration and forced displacement. The relative impact of each driver will depend on the type of food system in question, the type of actors involved, and the type of actions and policies that are decided upon (Nesheim et al., 2015).

The system components that are led by the drivers of food system change cause social, economic, and environmental impacts that can affect political actions, programmes, and institutions. Indeed, understanding the complexities of the system can lead to the development of coherent and coordinated policies to turn at best intentions into actions.

We will now take a closer look at the components of the proposed framework and how they interact. The analysis of the supply chain, the food environment and consumer behaviour will be supported by a description of the main problems arising from the current economic model of the food system. Furthermore, possible solutions will be provided to guide the reader (students, practitioners, entrepreneurs, decision makers etc.) towards more conscious and sustainable choices.



4.5 Food Supply Chain

"The food supply chain consists of the activities and actors that create and manage agriculture and food products from primary production to final consumption, until the disposal of the related waste" (Hawkes and Ruel, 2012). The sub-components of food supply chains include production; storage and distribution; processing and packaging; retail and markets.

Every sub-component involves different actors, both public and private, which are influenced by drivers of food system (Porter and Millar, 1985). The decisions made by one group of actors at one stage of the chain have implications for the others. These decisions influence the way food is produced and processed along the supply chain (Downs and Fanzo, 2016) and impact the six dimensions of FSN as well as the nutritional value of the food produced and processed.

Box 4. Food loss throughout the food chain

One of the main problems affecting the whole supply chain is food waste. 30 % of agricultural production is lost for various reasons between the field and our mouths (WFP, 2021). In Sub-Saharan Africa, food loss is mainly caused by limitations in cultivation, harvesting and preservation techniques or by the lack of adequate storage and transport infrastructures, as well as problems related to organic/inorganic contaminants and standards imposed by large retailers. Losses also result in the unprofitable use of agricultural land, fertilisers, and pesticides.

Well-planned and creative management of by-products can turn these into highly valued products, thus avoiding potential waste. The most important tip for managing by-products is to "never stop innovating".

How to manage waste efficiently (FAO and INRAE. 2020. *Enabling sustainable food systems: Innovators' handbook.* Rome. https://doi.org/10.4060/ca9917en , pp 138)

1. Recycling organic materials through animals**.** Different types of organic waste can constitute a valuable feed for chickens, goats, pigs, fish or earthworms. Likewise, many organic wastes that cannot be eaten by animals can be used as substrate for fungi.

2. Recycling organic materials through composting. This type of waste can be used as simple compost (open compost) or composted in a biogas digester. Composted materials can be used in agricultural production as a natural fertiliser to combat soil degradation. Alternatively, they can be sold directly to potential users, offering an innovative business.

3. Recycling non-compostable materials (paper, glass bottles, plastic bags, etc.) with public garbage services where possible**.** A further business opportunity could be to invest in plastic or glass recycling machines in order to offer these services to local businesses and/or the government.

4.5.1 Primary Production System

The primary production system embraces all actors and activities involved in the production of staple food. Depending on the food chain, we can distinguish different components interacting within the system, such as farmers, agriculture, and agribusiness, but also livestock and fisheries, or people producing food for their own livelihood, such as indigenous peoples.

Food production, including its accessibility, is threatened from many aspects. At this stage of the supply chain, biophysical and environmental drivers exert major influence. According to the Intergovernmental Science-policy Platform on Biodiversity and Ecosystem Services (IPBES 2018), the rapid expansion and unsustainable management of cultivated land and grassland is the main driver for soil degradation. As a result, climate change is intensifying, damaging crop productivity, and jeopardising the ability to feed a growing world population.

It is acknowledged that soil degradation is mainly caused by intensive agriculture (FAO, 2018), pushed by large amounts of industrial fertilisers and pesticides spread on crops and consequently absorbed by the soil. Intensive livestock farming creates large effluents containing hormones and antibiotics, pathogens and heavy metals that are deposited in groundwater as well as in the soil. Urban centres and industries participate in soil degradation through pollutants, heavy metals, and micro-plastics as well as persistent organic pollutants, polycyclic aromatic hydrocarbons, and radionuclides. In addition, intensive labour of the soil also produces soil erosion and degradation (IPBES, 2018)

The combination of soil degradation and climate change has led to desertification and drought, resulting in the loss of 120 million hectares of land, an area equivalent to 2 times the size of Kenya (TEEB, 2018). At this rate it is expected a reduction in crop yields by an average of 10% and up to 50% in India, China, and sub-Saharan Africa with negative impacts on the well-being of at least 3.2 billion people (IPBES, 2019).

With regards to biodiversity, the agricultural industrial revolution altered the balance that ensured stability and resilience. According to FAO (2019), Biodiversity for Food and Agriculture (BFA) is essential to ensure food security, sustainable development, and vital ecosystem services. It helps to make production and livelihood systems more resilient to shocks and stresses. It contributes to livelihoods of those households that have limited access to external production inputs or live-in marginal areas with difficult environments.

Thus, the preservation of high level of biodiversity is essential, however the world livestock production relies on about 40 animal species and 75 % of the food produced in the world is generated by only 12 plants and 5 animal species (FAO, 2017).

Indeed, since 1900, around 75 % of the genetic diversity of cultivated plants has been lost to genetically uniform highly productive varieties (FAO, 2017). The data reported are highly alarming if we consider that lack of diversity causes vulnerability to climate change and pests. Cultivating a limited number of varieties makes agriculture more exposed to the risk of drastic drops in production.

Box 5. Agroecology

Agroecology can be an effective solution to reduce the impact of biophysical and environmental drivers on the supply chain by using ecological and regenerative practices. It is indeed necessary to increase the capacity of agricultural soils to absorb carbon, increase biodiversity in productive soils, reduce the flow of new chemical entities, reduce atmospheric aerosol emissions and make efficient use of water.

Agroecology is an integrated approach that simultaneously applies ecological and social concepts and principles to the design and management of food and agricultural systems. It seeks to optimize the interactions between plants, animals, humans, and the environment while taking into consideration the social aspects that need to be addressed for a sustainable and fair food system (FAO, 2018)

Agroecology strengthens socio-economic resilience placing a strong emphasis on human and social values, such as dignity, equity, inclusion, and justice all contributing to the improved livelihoods dimension of the SDGs. It addresses social inequalities by creating opportunities for women and youth, providing promising solution as a source of decent jobs.

1. Agroecological farming can result in higher yields in the long term, as compared to conventional farming approaches
2. Agroecological businesses can benefit from increased prices per unit produced and consequently improve the overall revenue of farmers
3. Can increase agricultural productivity by reducing external inputs
4. Foster resilience to external shocks, such as adverse climatic conditions or volatility in agricultural input prices

Strengths	Weaknesses
In the long-term, agroecology is more resilient to climatic shocks, extreme weather events, as well as pests and diseases.	Lack of capital at the outset may constrain agroecological business abilities to invest and grow.
Opportunities	**Threats**
An increasing demand for sustainable and healthy production is a key opportunity for agroecological business, yet the sustainability benefits of agroecology need to be clearly communicated.	The access of agroecological business to investment and credits may continue to be constrained if impact investments remain comparatively small, and access to credits is difficult in the absence of suitable collateral.

4.5.2 Storage and Distribution

Storage and distribution include all actors, inputs and activities involved in collecting, storing and transporting food from production sites to the place where food is sold or consumed (households or local, regional, national and global markets). To be successful, this process requires appropriate processing and post-harvest practices, efficient transport and appropriate knowledge and infrastructure for storage and conservation.

A critical challenge is food safety, especially in the conservation phase in which it is crucial to prevent contamination by bacteria, viruses, parasites, mycotoxins, chemical contaminants, heavy metals, and natural toxins. Many staple foods can be contaminated if not dried and stored properly, provoking serious health consequences such as acute or chronic illnesses.

Perishable foods such as fruits, vegetables, and animal-sourced foods (ASF) (e.g., meat, fish and shellfish, eggs and dairy) require cold-chain storage and transport unless consumed within a short space of time and very close to their place of origin. However, cold storage facilities are lacking or inaccessible to most smallholder farmers in sub-Saharan Africa. Highly perishable produce requires adequate storage facilities with well-maintained conditions, mainly temperature, relative humidity, and gas composition. If infrastructure for initial storage is lacking, perishable produce can spoil within hours (Rolle, 2006; Stuart, 2009).

Transport also plays a key role in ensuring the quality of the products and preventing losses. In developed countries, transportation of the perishable foods in refrigerated trucks is standard practice. Conversely, in developing countries, lack of proper transportation vehicles, poor state of the roads and inefficient logistical management hinder proper conservation of perishable commodities during transport (Rolle, 2006). Exacerbating the deterioration is the way products are packed/packaged for transport. The means frequently used are sacks, baskets, and polythene bags, or simply loading 'naked' products directly onto trucks, leading to compression damage during transport. in addition, the poor state of the roads, especially in rural areas where most production occurs, further aggravates losses during transport.

4.5.3 Processing and packaging

The quality of food is strongly influenced by how it is handled and can deteriorate very rapidly when mistreated. It could be reminded here that the quality of (processed) food is dependent on the initial quality of the ingredients. Food processing and packaging contribute to improved food security and nutrition by preventing food quality loss or waste by extending shelf-life of products, increasing the bioavailability of nutrients, and improving the sensory characteristics and functional properties of foods, destroying food-borne microbes and toxins, and improving food safety (Augustin, 2016).

Food preparation and processing can be defined as "any change that is made to a food to alter its eating quality or shelf life" (FAO, 2004). This means that processing covers all treatments made in food preparations both at household and industrial scale: washing, peeling, cutting, mixing, heating, cooling, cooking, and fermenting.

Processing food can provide several benefits to food availability; food production is frequently linked to the seasonality of products, which involves an alternation of harvest periods and periods of inactivity. Processing and preservation of food can ensure the regular supply of diversified and adequate nutrition in terms of quantity and quality during the whole year. Techniques for processing food are varied; the following table describes the process categories and examples feasible at small scale.

Process	Example
Heating to destroy enzymes and micro-organisms	Boiling, blanching, roasting, grilling, pasteurization, baking, smoking
Removing water from the food	Drying, concentrating by boiling, filtering, pressing
Removing heat from the food	Cooling, chilling, freezing
Increasing acidity of foods	Fermentation, preservation by adding citric acid or vinegar
Using chemicals to prevent enzyme and microbial activity	Salting, syruping, smoking, adding chemical preservatives such as sodium metabisulphite or sodium benzoate
Excluding air, light, moisture, micro-organisms and pests	Packaging

Table 2 FAO Diversification booklet 5, Processed foods for improved livelihoods, 2004.

In most developing countries, there is a general lack or inadequacy of processing facilities. The situation is aggravated by seasonality of some of the processed products. A good example is represented by mango production. In Kenya, processors are overwhelmed

during the high season (December to March) when there is an oversupply of mango fruits. However, since the processing facilities are not sufficiently equipped, high volumes of mangoes delivered to processors end up in landfills and thus wasted.

Packaging of food can be used as one tool of ensuring that the quality of unprocessed and processed food can be maintained for extended periods and food loss and food waste can be prevented. The two key levels of packaging for the sub-Saharan context are the primary packaging and secondary or transport packaging. The primary packaging refers to the packaging that is in direct contact with the food. The secondary packaging then enables delivering multiple products together. It may be good to understand that in some cases, especially regarding fresh produce the transport packaging may also be considered as the primary packaging.

The key functions of food packaging are to:

- Contain the food
- Protect the food from the environment and the environment from the food
- Enable handling
- Inform the consumer about the product.

The two last functions increase in importance as the production scale and the supply chain of food increase and commercialise. Food processing and packaging often cannot be separated from each other, since for example the beneficial effect of heat treatments such as pasteurisation will be rapidly lost, if it is not followed by the packaging process. Therefore, the materials used for food packaging should match the hygiene level of the food and the materials should not transfer any unwanted or harmful components to food. Some relatively simple packaging processes such as vacuum packaging, where all the air is removed from packaging before sealing, can increase the shelf life of food significantly, especially if applied together with food processing such as drying.

Metal and glass are used often in food packaging materials especially for long shelf-life foods, as they effectively block the transmission of oxygen, preventing oxidation, which is one of the key causes of food spoilage. This kind of packaging materials that are very permanent can also be effectively reused or recycled. The other materials commonly used as primary packaging materials are plastics and fibre-based packaging materials such as paper board or liquid board packaging (Tetrapak).

Wood is also a common packaging material, especially in transport packaging such as boxes, crates, and pallets. The selection of packaging material is very dependent on the type of food, how It has been processed, the expected storage conditions and the supply chain to the consumer.

THE USE OF PLASTIC FOR PACKAGING

Today the selection of packaging material also considers the end-of-life for the packaging materials, as we need to pay attention to the challenges posed by the rapidly exceeding climate change and environmental Issues such as marine/land litter. The use of plastics especially has been in the centre of this discussion as plastic is a very permanent material. The good characteristics of plastic in food protection (lightweight, good protection capability and durability) are weighed against the amount of plastic litter in the environment.

Biodegradable and compostable packaging materials have been developed over the last time to reduce the use of traditional plastic. Unfortunately, the availability of these is still limited and the prices tend to be high compared to conventional plastics, therefore effectively limiting their use. Moreover, bioplastics require a whole system to ensure their effective collection, disposal and reuse. Consequently, the use of bioplastics may be unhelpful if not integrated with other solutions.

Globally there has been progress to develop circular economy approaches, and general material efficiency, in which, also the packaging waste is seen as a material resource for new packaging or other products. Therefore, there are investments worldwide in improving the recycling and waste management practises and this kind of actions should also extend to developing countries.

Other solutions to the use of plastics for food packaging can be the choice of bulk purchasing, organising through a co-operative or citizen committee the purchase of goods in larger quantities at reduced prices. This would save a large amount of plastic normally used for smaller packaging. Similarly, in the case of grocery shops or food companies, it is possible to organise a collection system to recover the used packaging by offering consumers a discount on their next purchase. All recovered materials could then be recycled.

4.5.4 Retail and Markets

Retail and markets refer to any infrastructure that physically or contractually brings supply and demand together and this space shape the food environment in which consumers make purchasing decisions. Physical market infrastructure includes urban markets, storage units, consolidation areas, retailers, wholesale markets, supermarkets, and shippers.

In Africa, traditional markets, and small-format shops currently account for 80% to 90% of urban food retailing and in African cities food retailing currently accounts for about 20% of the total value of the agri-food value chain in sub- Saharan Africa (Reardon, 2019). As a result, markets are essential to ensure food security in urban and rural areas and to transmit demand signals from urban consumers upstream to farmers. Access to markets requires a range of actors and intermediaries such as assembly traders, wholesale markets, agro-processors or food retailers and vary depending on the type of food and the distance to markets.

Strengths	Weakness
Accessibility: Markets are easy to access and are usually widespread	Insufficient infrastructure to maintain sanitation and hygiene.
Product diversity: The lack of or limited specialisation means consumers have access to a wide range of fresh products, including indigenous and seasonal foods	Lack of storage facilities means foods have a short shelf life, leading to high food losses and waste.
Social interactions: Markets form part of local cultures provide a space for people to exchange goods and services but also serving as a social meeting place	Price volatility: Prices can vary depending on the season, post-harvest losses, as well as on the bargaining power between vendors and consumers.
Women-led: Markets have a strong female presence providing them with a source of employment and income.	Food safety issues: There are no standards or little to monitoring of food sold at markets.

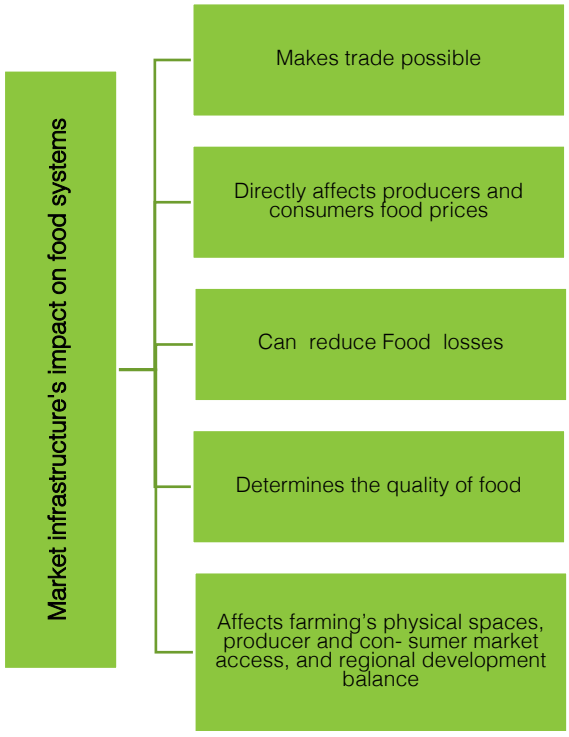
Table 3 Strengths and weakness in African markets

Wholesale and logistics are the "lifeblood" of the agri-food value chain in sub-Saharan Africa (AGRA, 2020). Traditional wholesale markets take a central role in most African food systems, and generally, local governments designate the locations and hours of market operations. Governments typically provide the basic market infrastructure, licenses traders and theoretically provide inspectors to monitor weights and measures, prices, and food safety (Battersby and Waterston, 2019). Traders' associations and local governments work

together to regulate markets, with governing boards made up of private and public officials determining operating norms and price systems that control market access.

However, the rapid expansion of African cities has placed extreme pressure on wholesale markets in many of these cities and, across most regions of Africa, the penetration of supermarkets has increased in recent decades affecting the current supply chain.

According to the Africa Agriculture Status report (2020), supermarket procurement systems require large-scale and timely deliveries of products that meet private quality standards. Small farmers are particularly challenged to meet the high requirements and standards and therefore risk to be excluded as direct suppliers of supermarkets. Data from Kenya's local supermarket chain in Uchumi, confirmed that small farms account for only 10% to 15% of total produce purchases, while medium and large farms account for 45% to 65% of supplies.



In places where large and efficient wholesale markets exist, supermarkets are inclined to work with them to source commodities, at least in the early stages of market penetration (Reardon, 2008). In other locations, where traditional markets are fragmented and poorly coordinated, the strategy of many supermarkets is to establish direct agreements with large wholesalers for food procurement, bypassing small farms.

Market infrastructure for food supply and distribution can serve as an important lever for improving food system sustainability whether a formalisation process takes place since institutional market infrastructure includes quality standards, ICT (information and communication technologies) and price information systems, contracts, purchasing processes, competition rules, and national and international regulations (World Bank, 2021).

Market infrastructure has an important impact on how food systems function and therefore on achieving the SDGs: improvements at this stage affect prices by reducing transport costs, improving logistics, increasing competition, regulating monopolies, and achieving

economies of scale (Quattri, 2012). Market infrastructure affects farming's physical spaces, producer and consumer market access, and regional development balance influencing where activities will be located and thus transport distances, spillover effects on farmland and regional development.

Market infrastructure determines the quality of food through storage facilities, logistics, cold chain maintenance or quality inspections, improving most vulnerable systems. Furthermore, market infrastructure improvements can reduce food losses. It must be considered that all forms of food losses represent about a third of production (FAO, 2017), or 150 kilograms per capita per year in Sub-Saharan Africa, and more than 200 kilograms per capita per year in North Africa (FAO, 2020). High losses at the retail stage occur in perishable commodities such as fruits and vegetables, fish and seafood, meat, dairy products, baked foods and cooked foods (HLPE, 2014). Losses are exacerbated in situations where measures such as protective packaging, temperature and humidity control, and proper display to minimise handling by buyers, are not in place.

According to the UN economic commission for Africa (2015), the informal sector is the major source of employment across Africa, accounting for 70 % of employment in Sub-Saharan Africa and 62 % in North Africa, mostly derived from the services and agriculture sectors. Thus, the informal sector creates employment and value addition contributing about 55 per cent of sub-Saharan Africa's GDP. In addition, the informal market mainly involves women and young people between the ages of 16 and 24 (9 out of 10 informal workers) rendering it crucial for vulnerable groups. However, the informal market leads to a lack of social protection, skills upgrading and productive income that often traps these groups in poverty and exclusion from economic growth and development.

Informal food vendors are particularly vulnerable as they face several problems including: illegibility which can lead to fines or closures by the police or government representatives; the pursuit of low prices can result in a reduction of quality control or health standards; poor access to capital can prevents investments in scale, technology, or equipment; and the small market size can inhibit gains that might be realised through economies of scale. However, a large proportion of consumers choose to buy their food from the informal market because of its proximity and affordability (Romanik, 2008).

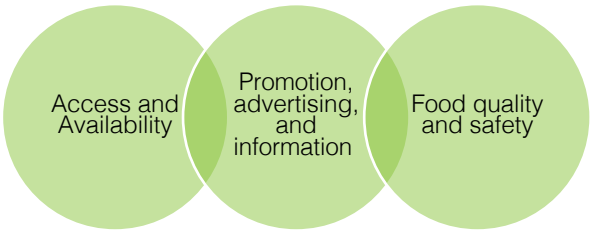
4.6 Food Environment

According to HLPE (2017), "*Food Environment refers to the physical, economic, political and socio-cultural context in which consumers engage with the food system to make their decisions about acquiring, preparing and consuming food*".

FAO defines Food environments as the 'interface' or 'link' between food systems and diets. Food environments typically overlap with food supply chains, consumer behaviours and diets. Consumer behaviours respond to food environments and are comprised of individual awareness and decisions on where and what foods to acquire, prepare and eat. Individual decisions ultimately shape diets in terms of quantity, quality, diversity, safety, and adequacy of food (Downs et al., 2020).

Healthy food environments enable consumers to make responsible choices towards nutritious and sustainable food products with the aim of improving their diets, local economies, reducing inequalities and combating malnutrition. However, food environments in many parts of world are considered "unhealthy" in that they promote unhealthy dietary choices for consumers through misleading marketing and advertising, unhealthy food product placements, pricing policies and packaging (HLPE, 2017).

The key elements of Food Environments are:



4.6.1 Access and Availability

"Food availability involves having a sufficient amount of high-quality food to satisfy a person's dietary needs. This food should be free of adverse substances and culturally acceptable" (HLPE 2020). The insufficient availability of nutritious food may increase the risk of malnutrition, as well as obesity and diet-related chronic non-communicable diseases (NCDs). The UN Committee on Economic, Social and Cultural Rights noted that hunger and malnutrition are often not caused by a lack of food availability but by the inability to access food which includes both physical and economic access.

Physical access to food depends firstly on the built environment. The built environment refers to the presence of vending machines, small kiosks, *bodegas*, corner stores, wet markets and supermarkets, restaurant foraging, production for self-consumption, urban gardens, food banks, formal and informal markets, schools, hospital and public canteens (Herforth and Ahmed, 2015) and adequate infrastructures to access them.

Physical access to food depends also on geographic or technical conditions such as natural or artificial physical environments. In low-middle income countries (LMICs) the lack of appropriate infrastructure can limit availability and access to foods, especially perishable foods. In addition, "food deserts" and "food swamps" can exacerbate this condition. Food deserts are geographic areas where access to food is restricted or non-existent due to the absence or low density of food entry points within a reasonable distance. Food swamps are areas where there is an overabundance of unhealthy foods but little access to healthy foods, especially fresh produce, and minimally processed foods (Fanzo, J. et al., 2021)

Economic access to food (food affordability) reflects the relative cost of food compared with a household's income and purchasing power (Powel et al., 2013). Food prices, food taxes and subsidies affect the affordability of food and influence consumption patterns as well as household purchasing power and welfare. A strategy to stimulate consumers to buy certain foods rather than others could be to reduce the cost of healthy, nutritious products. However, in most places in the world, this is not the case. Nutritious foods tend to be more expensive and less affordable than less nutritious, high-calorie foods, exacerbating malnutrition problems (HLPE, 2017).

The influence of food price mainly affects less developed countries where a larger proportion of the household budget is devoted to food. Nutritious food sold at high costs directly reduces affordability affecting consumers' well-being. At the same time, a drop in prices can reduce producers' welfare. As a result, changes in food prices and an inefficient system of subsidies and taxation create a vicious circle that weakens food systems, especially in the most vulnerable countries.

4.6.2 Promotion Advertising and Information

Retail outlets and markets can promote foods to consumers through advertising, branding and social marketing. Simple signage, product placement, billboards, radio, and television advertisements all serve to impact food acceptability, consumer preferences, purchasing behaviour and consumption patterns, both negatively and positively (Kelly et al., 2013).

Food education is certainly an effective method to increase consumers' awareness towards what they are eating and to help them make healthy and balanced food choices every day. Most countries have developed a graphic representation of *Food-Based Dietary Guidelines* (FBDG) to illustrate the proportions of different foods with similar characteristics that should be included in a balanced diet, although they may have a list of messages or tips as well. Graphic formats provide a consumer-friendly framework so that if foods from the main groups are eaten each day, an important first step is taken towards achieving a healthy diet, without specific knowledge of nutrients.

According to The Nutrition Source of the Harvard T.H. Chan School of Public Health a healthy diet is essentially a plant-based diet making most of our meal vegetables and fruits (1/2 of the plate), whole grain and by-products (1/4 of the plate), healthy proteins as beans, dry fruits, fish, and lean meats (1/4 of the plate). Further explanations on sustainable and balanced diets will be provided in the chapter "Diets".

Food labelling and the provision of declarations on food packaging, in food retail outlets and on menus, are other ways of informing consumers. Indeed, nutrition labels shape consumer preferences, and influence industry behaviour by encouraging product reformulations (Cairns et al., 2013). Easy-to-understand, front-of-the pack labelling and nutrition information on menus (i.e., calories or sodium content of foods) allow consumers to make more informed decisions about the foods they purchase and consume.

4.6.3 Food Quality and Safety

"Food quality describes the attributes of a food that influence its value and that make it acceptable or desirable for the consumer. This includes negative attributes such as spoilage, contamination with filth, discoloration, off-odours and positive attributes such as the origin, colour, flavour, texture and processing method of the food" (FAO/WHO, 2003).

Food safety describes the impact of food on human health, and refers to "all those hazards, whether chronic or acute, that may make food injurious to the health of the consumer" (FAO/WHO, 2003). It involves the various ways to prevent food-borne diseases, which are mainly caused by contaminants such as pathogens, chemical components, or physical components. Contaminations can occur during food production, processing, storage, transport, and distribution, or at household level where lack of knowledge exacerbates the risk. Food safety also refers to the regulations and controls that are in place to protect consumers from unsafe food (HLPE, 2017).

Consuming unsafe food or using contaminated water that has not been properly sterilised can lead to the emergence of diseases (such as diarrhoea) that result in malnutrition, particularly affecting the most vulnerable groups (children, the elderly and the sick) (WHO, 2015). In fact, more than 50% of all food-borne illness and 75% of related deaths occur in LMICs in Africa and Asia. Standards and controls, policies, interventions, and investments at the national or global level can significantly influence food safety outcomes (The World Bank, 2019).

4.7 Consumer Behaviour

"*Consumer behaviour reflects all the choices and decisions made by consumers, at the household or individual level, on what food to acquire, store, prepare, cook and eat, and on the allocation of food within the household including gender repartition and feeding of children*" (HLPE, 2017).

The factors which influence the choice and consumption of certain foods rather than others are varied and may include cultures, geographical surroundings, type of community, family unit and of course personal choices. Consumer behaviour can also be influenced by culinary skills: for example, not all consumers have culinary skills to get the best nutritional results from the food available to them, even if its constituent elements are nutritious. In such cases convenience foods that require little or no preparation may be preferred, even though they may be much less nutritious than home-cooked food (HLPE, 2017).

The move towards sustainable food systems can be strongly stimulated by changes in consumer behaviour. Consumer behaviour can be changed through interventions aimed at the food environment known as "choice architecture" (Hollands et al., 2013) or through "agentic" interventions, such as incentives, education programmes or Food-based dietary guidelines (FBDGs), to provide more information to consumers.

Choice architecture is a term coined by Thaler and Sunstein (2008) and refers to the practice of influencing choice by "organising the environment in which people make decisions" (Thaler et al., 2013) specifically by altering small-scale physical and social environments, or micro-environments to cue healthier behaviour. Micro-environments are defined as settings in which people may gather for specific purposes and in which they may acquire or consume food, alcohol or be physically active. Altering a micro-environment could be changing the size of plates, bowls or glasses, or placing less healthy foods further away from customers in a food market/shop, may influence the amount and type of food selected and consumed (Rozin, 2011). Similarly, increasing the time taken for elevator doors to close may increase the likelihood of people using the stairs instead.

More specifically, changes can occur at the level of ambience, altering aesthetic or atmospheric aspect of the environment; Labelling, applying labelling or endorsement information on products; Presentation, changing sensory qualities or visual design of the product; Sizing, altering size or quantities of the product but also Proximity, making alteration easier (or harder) to engage with, requiring reduced (or increased) effort. Interventions of this kind typically require little conscious engagement on the part of the

individual to realise their intended effects, mainly working via automatic or non-conscious psychological processes (Hollands et al. 2013).

- *Choice architecture* is a tool already used by companies to increase sales but at the same time it can be a strategy to promote a nutritious and sustainable diet.
- *Agentic interventions* refer to interventions targeting one of the six dimensions of food safety, Agency. As mentioned before, Agency means the personal capacity of individuals or communities to make their own choices independently

Historically disadvantaged individuals and communities (including women, small-scale agricultural producers, indigenous peoples, pastoralists, fisherfolks, vulnerable food system workers, marginalised communities, and poor people in urban areas, for example) often lack agency with respect to food security and food systems, and often experience disproportionate levels of food insecurity. At the same time, other actors (such as donors and large corporations) may have disproportionate agency or power in shaping the way we think about food insecurity including defining the solutions and influencing the contours of food environments (HLPE, 2017). It is widely recognised that governments have an important role to play in strengthening both the individual and collective capacity of disempowered people to have a greater role in shaping their food systems, including creating political spaces for debate where power differentials are minimised and enhancing their food security outcomes by improving their nutritional capabilities (HLPE 14, 2019). "Agentic" interventions, promoting healthy eating have been shown to reduce social inequalities in diets in LMICs (Mayén et al., 2016).

Possible Agentic interventions often refer to improvements in education and communication. The HLPE 2017 highlights the need to strengthen nutrition education through the introduction of specific school programmes to generate autonomy, capacity for reflection and empowerment. Moreover, several studies suggest that nutrition education is often more effective when combined with other interventions such as nutrition support in the form of food supplements, micronutrient supplements or conditional cash transfers (Dewey, 2016). Social protection programmes such as cash transfers and school feeding programmes can contribute to the realization of the right to adequate food when implemented from a rights-based approach (Sepúlveda Carmona et al., 2012), including respecting the principle of equality and non-discrimination, transparency, participation, and accountability. The human rights-based approach is a conceptual framework for the process of human development that is normatively based on international human rights standards to promote and protect human rights. It seeks to analyse inequalities which lie at

the heart of development problems and redress discriminatory practices and unjust distributions of power that impede development progress (UNICEF, 2015).

Mass Media also play a key role in changing consumer behaviour through communication: in fact, mass media which includes newspapers and other printed material, radio, television, billboards, can communicate to a vast majority of the population. Multi-component, community-based media campaigns can be beneficial in promoting nutrition education (HLPE, 2017). Similarly, social and behavioural change communication can influence consumer choice by positively influencing knowledge, attitudes and social norms.

4.8 Healthy Diets

Diets comprise the individual foods that a person consumes, and dietary patterns are the quantities, proportions, and combinations of different foods and beverages in diets and the frequency of how they are habitually consumed (Hu, 2002). Dietary patterns interact with food systems, not only as an outcome of existing food systems but also as a driver of change for future food systems (HLPE, 2017).

Throughout the last century, the science of nutrition has tried to clarify what is the best diet for human health and today we face a new challenge: combine man and planet health. However, there is no universal right diet; in fact, it is necessary to find the best diet depending on the local context.

FAO defines sustainable diets as: "those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy, while optimising natural and human resources" (FAO, 2012). This agreed definition recognises the interconnections between food production and consumption and FSN and health. Reaffirming the fact that human health cannot be isolated from ecosystem health.

A healthy diet should promote growth and development and prevent malnutrition. In the global nutrition policy sphere, the term "malnutrition" no longer refers only to undernutrition, such as wasting, stunting, underweight, or deficiencies in vitamins or minerals. Malnutrition – in all its forms – is now understood to include obesity as well as dietary factors that increase the risk of non-communicable diseases (NCDs) such as heart disease, stroke, diabetes, and certain cancers. To address malnutrition, diets must improve.

However, the task is challenging, as drivers to changing diets are numerous: rising incomes and urbanisation in developing countries drive high diets in sugars, refined flours and fats, meat, and other animal by-products. In 2050 these dietary tendencies, if not controlled, could contribute up to 80% to the increase of greenhouse gas emissions.

According to WHO, healthy diets typically have the following characteristics:

- Quantity: Healthy diets contain adequate food energy to maintain life, support physical activity and achieve and maintain a healthy body weight; sufficient macro- and micronutrients to meet individual nutrition and health needs. They limit overconsumption, particularly of nutrient-poor foods high in energy, saturated and trans fats, added sugars and salt.
- Diversity: Healthy diets include a variety of nutrient-dense foods from basic food groupings including vegetables, fruits, whole grains and cereals, dairy foods and animal- and plant-based protein foods. Specific types and amounts of foods within these groups, especially staple foods, will vary depending on geographic location and cultural context.
- Quality: Healthy diets contain the needed macro- and micronutrients. Foods should not contain unspecified or unhealthy additives such as trans fats. Foods can also be processed to remove "anti-nutrients" or components within foods that interfere with the absorption of key nutrients
- Safety: Healthy diets contain foods and beverages that are safe to consume.

Healthy diets promote health and nutrition, economic, social, and environmental outcomes. Healthy diets are essential to prevent malnutrition in all its forms (undernutrition, micronutrient deficiencies, overweight and obesity) promoting food products which embody the four characteristics explained above.

Environmental outcomes result mainly from local food consumption, avoiding long transport distances and reducing emissions, consuming food with a low environmental impact and avoiding the excessive consumption of meat, which is the most unsustainable element in food systems.

Agriculture and food production provide income and employment for millions of people, particularly smallholders and poor people in rural areas (HLPE, 2013). Agriculture alone is estimated to provide employment to 1.3 billion people worldwide, 97 percent of them living in developing countries (IBRD/World Bank, 2007). Promoting sustainable diets can prevent direct losses due to poor physical condition; indirect losses due to poor cognitive function and educational deficits; and losses due to increased health care costs. (HLPE, 2014). From a social and equity perspective, a more equitably distributed food would improve health for the most vulnerable and, therefore, enhance social equity, which may positively impact vulnerable groups such as those living in poverty, women, children, and smallholders (HLPE, 2017).

4.9 Food security and Food System Sustainability assessment

According to the above-mentioned definition and dimensions that characterise and compose the concepts of food security and sustainable food systems, in this section we develop an operational exercise for the assessment of food security and food system sustainability performance at country level and based on available and measured indicators.

Assessment of food security conditions and food system sustainability is important to illustrate the state of the availability, accessibility, utilisation, stability, agency etc. of food, as well as to monitor the environmental, economic, and social sustainability of food systems. This static assessment, like the one that is proposed by the following exercise, can provide useful information to draw a view of the state of food security and food system sustainability for communication, decision and policy making, intervention planning for development, agriculture and nutrition, as well as for market strategies. The exercise provides a methodology of assessment at a country level. Similar analysis could be led, according to data availability, at different geographical or spatial scale, for instance at international level, but also at regional and city level. For this reason, this methodology is different from analysis that are done at a food product level (e.g. Life Cycle Assessment, etc.).

Before starting any assessment, it is important to clarify the following key aspects:

a) For whom the assessment is done (who are the users? E.g., policymakers, local stakeholders, decision-makers, researchers, development practitioners, industry, entrepreneurs, consumers, etc.);

b) What exactly will be measured (a conceptual framework is needed to orient the survey, to structure the information gathered and to justify the methodological approach on which the identification of indicators is achieved);

c) What is the aim of the assessment (why the information is needed and for what actions to be implemented? E.g., Assessing changes or improvements towards defined policy or development goals, supporting decision-making process and proposing new ways forward, etc.).

With particular regards to the conceptual framework needed (b) in this exercise we suggest to adopt the dimensions of food security that are illustrated in chapter 4.1 or the dimensions of sustainability of food systems illustrated in chapter 4.3 of this T-kit.

The exercise will be developed through the following key steps:

1) Choice of the countries for a comparative analysis.

2) Identification of the indicators and data retrieval.

3) Normalisation of the indicators.

4) Presentation of a Food security or Food System profile (suite of indicators)

5) Measurement of a Food security or Food System index (composite indicator).

1) Choice of the countries for the comparative analysis.

Countries to be compared through a food security or a food system assessment will be identified. The criteria of choice will need to be defined. Potential criteria could be represented by the geographical context, the economic trends, political dynamics, migrations and demographic conditions, availability of natural resources, commercial relationships, etc.

2) Identification of the indicators and data retrieval.

The indicators will need to be identified according to the criteria that justify the aim of the assessment, the final users of the results obtained, and the conceptual framework that is adopted. Indicators available from international and open access databases can be selected within the multiple dimensions of food security (chapter 4.1) or food system sustainability (chapter 4.3), building on the specific aim of the evaluation process. Indicators should be selected within reliable dashboards and databases that are open access. The "Compendium of indicators for food system assessment" available from CGIAR is an important tool to guide the selection of indicators and to provide reference on the related available and accessible databases.

Key databases for food security and food system assessment are also available from the World Bank database and the FAO STAT database.

Data will be retrieved from the above-mentioned open-access databases and will be organised in spreadsheets (example illustrated in fig. 1 and 2).

3) Normalisation of the indicators

Indicator scores will be normalised to enable the comparison of different dimensions of food security across countries. Normalisation rebases the raw indicator data to a common unit so that it can be aggregated.

The indicators for which a higher value indicates a more favourable environment for food security or food system sustainability – such as GDP per capita or average of food supply – are normalised on the basis of:

$$X = (x - \text{Min}(x)) / (\text{Max}(x) - \text{Min}(x))$$

Where Min(x) and Max(x) are, respectively, the lowest and highest values in the countries that compose the database for any selected indicator. The normalised value is then transformed from a 0-1 value to a 0-100 score to make it directly comparable with other indicators. This in effect means that the country with the highest raw data value will score 100, while the lowest will score 0.

For the indicators for which a high value indicates an unfavourable environment for food security or food system sustainability – such as volatility of agricultural production or political stability risk - the normalisation function takes the form of:

$$x = (x - \text{Max}(x)) / (\text{Max}(x) - \text{Min}(x))$$

Where Min(x) and Max(x) are, respectively, the lowest and highest values in the countries that compose the database for any selected indicator. The normalised value is then transformed into a positive number on a scale of 0-100 to make it directly comparable with other indicators.

4) Presentation of a Food security or Food System country profile (suite of indicators)

Once that the indicators chosen have been normalised according to the Min-Max method, the scores of the different indicators from different countries are finally comparable and can be evaluated according to a common scale (from 0 to 100, or from 0 to 1). The comparative analysis between scores of different indicators belonging to different countries provides a suite of indicators that can be practically visualised to give an overview of the food security and food system conditions that are selected to be studied (fig. 3).

5) Measurement of a Food security or Food System index (composite indicator).

A composite indicator of food security or food system sustainability can be developed according to the dimensions chosen and the conceptual framework adopted. As an example, we can decide to develop a composite indicator of food security building on the Availability, Access, and Utilisation dimensions. We can establish that we use an equal weighting system for the three dimensions.

In this case a Food Security Index (FSI) will be calculated as follows:

$$FSI = 1/3\ Availability + 1/3\ Access + 1/3\ Utilization$$

Each dimension can be composed or one or many indicators. If, for example, each of the three dimension of our composite indicator is composed by two indicators and they are weighted equally, the FSI will be calculated as follows:

$$Availability: 1/3(1/2\ Indicator_a + 1/2\ Indicator_b)$$

$$Access: 1/3(1/2\ Indicator_c + 1/2\ Indicator_d)$$

$$Utilization: 1/3(1/2\ Indicator_e + 1/2\ Indicator_f)$$

In this case the weights assigned to each dimension and to each indicator are based on an uniform weighting. The option of neutral weights involves equal importance of all indicators and sub-indicators and evenly distributes weights on that basis. This scheme provide simplicity to the calculation and does not implicate subjective judgment. However, this method assumes that all indicators are equally significant.

Other systems of weighting are the Expert-based weighting (the weights are established according to expert opinion, knowledge, perspective and discussion) and the policy-driven weightings (based on the policy orientations to address food security and sustainability aims).

FOOD SECURITY DIMENSIONS	INDICATORS	DEFINITION	UNIT	MIN	MAX	CORRELATION TO FOOD SECURITY	FORMULA	
AVAILABILITY	Dietary Energy Supply	Estimate of the per capita amount of energy (kcal) in food available for human consumption, during the reference period (3-year average period).	(kcal/caput/day)	1604	3688	+	x = (x - Min(x)) / (Max(x) - Min(x))	where Min(x) and Max(x) are, respectively, the lowest and highest values in the World for any given indicator.
AVAILABILITY	Food Production Index	Food production index covers food crops that are considered edible and that contain nutrients. Coffee and tea are excluded because, although edible, they have no nutritive value.	index	36,27	200,21	+	x = (x - Min(x)) / (Max(x) - Min(x))	where Min(x) and Max(x) are, respectively, the lowest and highest values in the World for any given indicator.
AVAILABILITY	Share of Dietary Energy Supply Derived from Cereals, Roots and Tubers	Energy supply (in kcal/caput/day) provided by cereals, roots and tubers divided by total Dietary Energy Supply (DES) (in kcal/caput/day).	%	23	81	-	x = (x - Max(x)) / (Max(x) - Min(x))	where Min(x) and Max(x) are, respectively, the lowest and highest values in the World for any given indicator.
AVAILABILITY	Average Protein Supply	National average protein supply (expressed in grams per caput per day).	gr/caput/day	18	133	+	x = (x - Min(x)) / (Max(x) - Min(x))	where Min(x) and Max(x) are, respectively, the lowest and highest values in the World for any given indicator.
ACCESS	Prevalence of Undernourishment	The Prevalence of Undernourishment expresses the probability that a randomly selected individual from the population consumes an amount of calories that is insufficient to cover her/his energy requirement for an active and healthy life.	%	0	67,3	-	x = (x - Max(x)) / (Max(x) - Min(x))	where Min(x) and Max(x) are, respectively, the lowest and highest values in the World for any given indicator.
ACCESS	Prevalence of Food Inadequacy	It measures the percentage of the population that is at risk of not covering the food requirements associated with normal physical activity.	%	0	76,7	-	x = (x - Max(x)) / (Max(x) - Min(x))	where Min(x) and Max(x) are, respectively, the lowest and highest values in the World for any given indicator.
ACCESS	Domestic Food Price Level Index	The Domestic Food Price Level Index is calculated by dividing the Food Purchasing Power Parity (FPPP) by the General PPP.	index	0,76	2,46	-	x = (x - Max(x)) / (Max(x) - Min(x))	where Min(x) and Max(x) are, respectively, the lowest and highest values in the World for any given indicator.
ACCESS	Percent of Paved Roads over Total Roads	Paved roads are those surfaced with crushed stone (macadam) and hydrocarbon binder or bituminized agents, with concrete, or with cobblestones, as a percentage of all the country's roads, measured in length.	%	6,8	100	+	x = (x - Min(x)) / (Max(x) - Min(x))	where Min(x) and Max(x) are, respectively, the lowest and highest values in the World for any given indicator.

		AVAILABILITY				ACCESS			
		Dietary Energy Supply	Food Production Index	Share of Dietary Energy Supply Derived from Cereals, Roots and Tubers	Average Protein Supply	Prevalence of Undernourishment	Prevalence of Food Inadequacy	Domestic Food Price Level Index	Percent of Paved Roads over Total Roads
	YEARS	Last available	Last available	Last available	Last available	Last available	Last available	Last available	Last available
WEST AFRICA	Burkina Faso	2647	107,68	72	80	25,0	30,7	2,12	4,2
	Côte d'Ivoire	2670	113,86	67	54	20,5	27,0	2,14	7,9
	Ghana	2934	128,34	64	60	<5	5,8	1,72	12,6
SOUTHERN AFRICA	Mozambique	2112	163,77	75	43	36,8	43,8	2,13	20,8
	Zambia	1879	158,44	74	47	43,1	52,5	1,42	22,0
	Botswana	2164	142,02	48	61	25,7	37,8	1,95	32,6
SOUTHERN ASIA	Bangladesh	2481	131,89	80	55	16,3	25,3	1,59	9,5
	India	2321	131,04	62	58	17,0	27,0	1,57	49,5
	Pakistan	2423	121,11	50	64	17,2	24,3	2,14	72,2

Figure 7 Examples of spreadsheets to organise the selected indicators according to their food security/food system dimensions,, their minimum and maximum values available from the database of all countries available, and their positive or negative correlation with the objective of food security or food system sustainability.

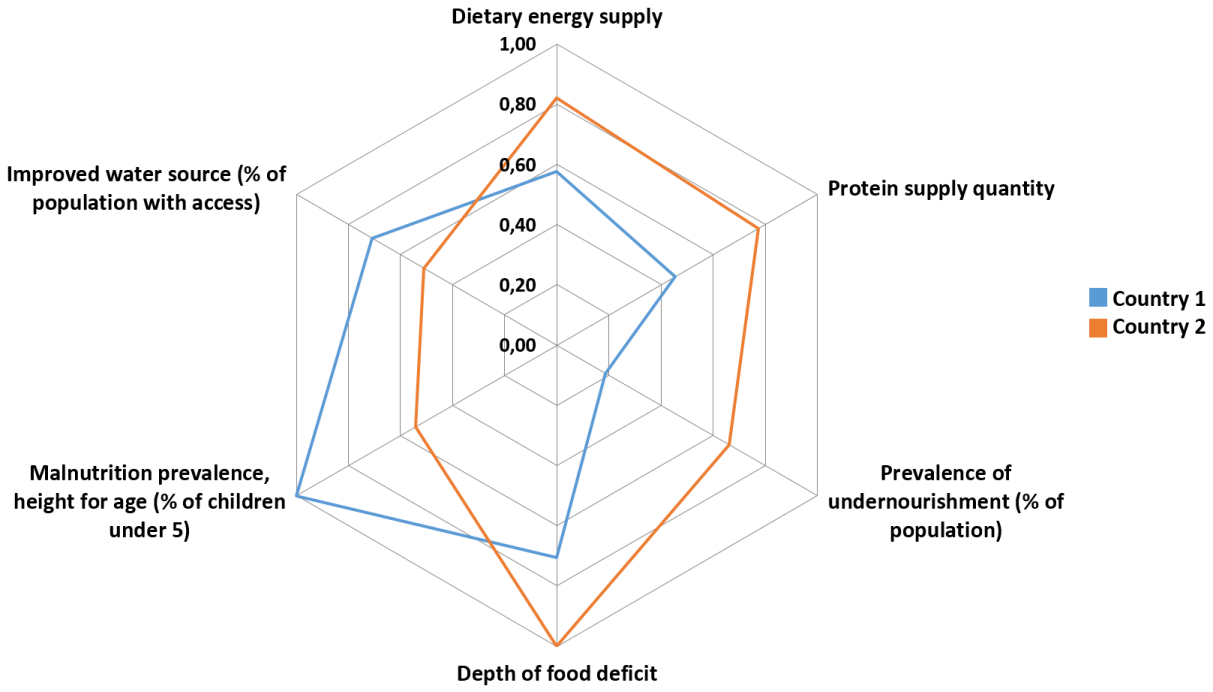


Figure 8 Suite of indicators and their normalised score for different countries.

5. Life cycle thinking for sustainable products

This section builds on the previous description of sustainability and sustainable food systems' dynamics. In particular, the chapter deals with Life Cycle Assessment (LCA), Social Life Cycle Assessment (SLCA) and Life Cycle Costing (LCC). The aim Is to provide trainees with knowledge on the sustainability requirements in the agri-food sector and the way sustainability can be assessed and managed. The chapter is supplemented with guidelines for applying LCA.

At the end of this section, you will be able to:

- Understand the importance of considering the entire supply chain to achieve long-term sustainability
- Discuss the basics of Life Cycle Assessment (LCA), Social Life Cycle Assessment (SLCA) and Life Cycle Costing (LCC)
- Start your journey with the applications of the methods

5.1 Why does the entire life cycle matter?

A product does not exist and is not consumed in a void, it is part of a system that starts with raw materials and ends when it is e.g. composted or burnt for energy. Businesses that strive for sustainability must look at the entire life cycle of the product they produce, minimise impacts throughout and ensure that impacts are not shifted between life cycle stages (so-called "burden shifting").

Below (Fig. 9) is an example of the life cycle of a product, with its main stages. The entire life cycle of a single product can span the entire globe: seeds coming from Africa can be planted in Europe and fertilised with chemicals made in Asia; the grown produce can be transported to North America for transformation before being shipped to Australia for consumption. Thus, what one makes can touch societies across the world.

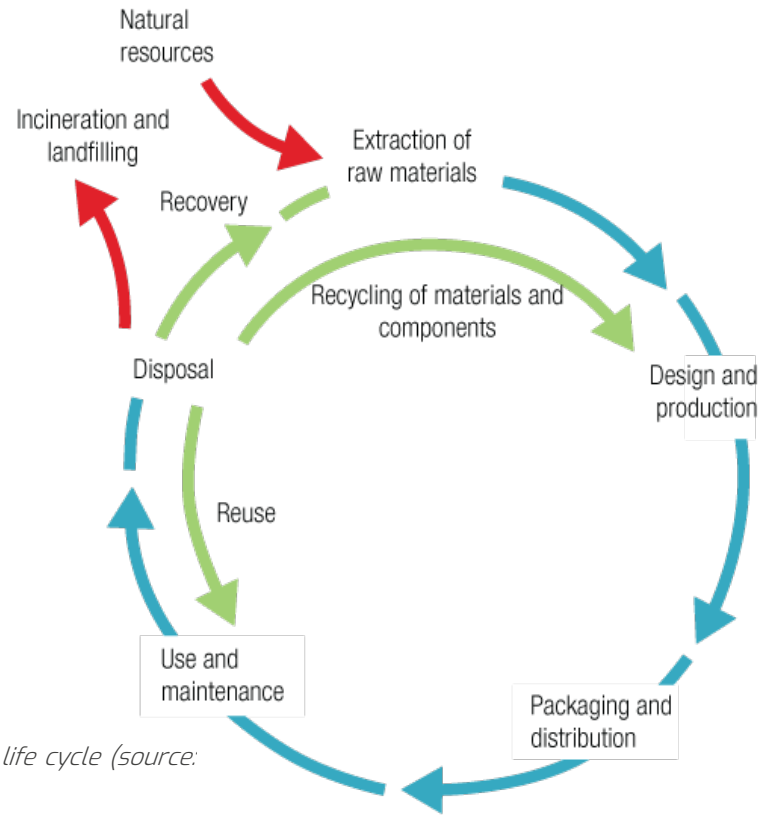


Figure 9 Representation of a product's life cycle (source: Life Cycle Initiative)

5.1 Life cycle approaches

Several sustainability assessments have been developed throughout the years, looking at the three pillars of environmental, social and economic impacts. In this T-kit, we are focusing on Life Cycle Assessment (LCA), with considerations of Social Life Cycle Assessment (SLCA) and Life Cycle Costing (LCC).

LCA explores the potential environmental impacts of a product system throughout its life cycle, by looking at the inputs and outputs of the system. It is based on the 14040 series of standards issued by the International Organization for Standardization (ISO). This approach was originally developed in the late 1960s and early 1970s, focusing on energy and resource use efficiency. As the framework has developed, new impacts have been added for a more thorough assessment including ecotoxity, ozone depletion, human toxicity, etc. The number of LCA studies and the range of products and services studied has grown exponentially, with peer reviewed publications that can be found in journals such as the International Journal of Life Cycle Assessment.

SLCA is a more recent development, as the understanding of sustainability has shifted to pay more attention to social risks. This is a methodology that can be used to assess the

potential social impacts of products along their life cycle from raw materials' extraction to final products' disposal (Benoît et al., 2010). LCC helps calculate the whole-life cost of a product and can be useful to e.g. public authorities in understanding the real price of a product throughout its lifetime instead of just its purchase price. Thus, a product's LCC would include the purchase price and all associated costs (e.g. delivery) as well as operating costs (e.g. fuel consumed) and the costs associated with its end-of-life (e.g. disposal). Due to better understanding of the cost of climate change and other environmental impacts on society, some externalities can also be included within the costing.

5.2 Applying Life Cycle Assessment

As stated above, LCA is based on the 14040 series of standards issued by the International Organization for Standardization (ISO). We especially invite interested reading in consulting ISO 14044, which was developed with LCA practitioners in mind and lists the requirements and guidelines for performing an LCA.

An LCA study is comprised of four iterative phases:

- goal and scope definition,
- inventory analysis,
- impact assessment,
- interpretation.

To illustrate how to start an LCA study, we will be using the case of the soy pancake mix, one of the pilot products developed in HealthyFoodAfrica. This will be further elaborated during a workshop at the summer school that will take place during the summers of 2022-2023. Further reading and resources are provided at the end of this section.

5.2.1 Goal and scope

The first step is to define as clearly as possible what is the intended application (e.g. product improvement, informing policy making), why the study is carried out, who the target audience is and how the results will be disclosed, if at all. In the case of the HealthyFoodAfrica soy pancake mix, the study will be used to inform future entrepreneurs about the environmental hotspots so that they can develop strategies to lower them and the results will be published as part of Technical Fiches available publicly on the project website.

Now that we have our goal, we must determine the scope. What is the functional unit, which will serve us to quantifiably describe the function and that will be used for comparisons between systems? For food products, the functional unit is generally a quantity of food but it can also be based on nutrients. In our case, the functional unit is a 500g pouch of soy pancake mix (corresponding X pancakes - amount to be determined later).

It is also essential to determine the boundaries of the study, the quality of the data that is expected for a successful study, the allocation procedure and the choice of impact categories that are deemed important for the type of product under study. It is recommended to consult existing LCAs on similar products to get familiar with the procedure before starting on your own LCA journey. For the soy pancake mix, the initial study can be limited to the "cradle-to-factory gate", which will take into consideration the inputs necessary for the raw materials, their harvesting and transport to the factory, their processing and packaging. For best results, it is always suggested to collected primary data from suppliers, although this can be resource intensive for complex products with long value chains.

5.2.2 Life Cycle Inventory (LCI)

LCI is often the most time-consuming stage as it requires the practitioner to establish all the inputs and outputs over the life cycle of the product. This includes raw materials, energy inputs, land/water/air emissions, and so forth. It is recommended to draw a flowchart of the different activities that make the product possible and establish the inputs/outputs at each stage. It is possible that the goal and scope of the project need to be revised based on information obtained during the LCI. It is always possible to repeat the first stage to obtain more accurate results. The most important part is to always document all decisions and assumptions made.

One of the best ways to obtain primary data for the LCI is through questionnaires distributed to suppliers along the value chain. The information to obtain includes date of data collection, general information (location of farm, size of farm, type of farm), inputs (amount and type of chemical fertilizers, amount of water used for watering, amount of fuel used for machinery, etc.) and outputs (total yield). In some cases, the information that the practitioner wishes to gather is deemed proprietary by the company and in that case secondary data sources may be used, such as peer reviewed articles, industry reports and databases.

It is commonly said that LCA results are only as good as the data. If the data is incorrect, no matter how well the next steps are executed, the results cannot be correct! Thus, it is essential to spend enough time to develop questionnaires that are easy to understand and easy to fill for supply chain actors. If possible, the practitioner can visit the suppliers themselves and collect the data in the field.

Section 7.1 illustrates the steps that are necessary for the making of the soy pancake mix after all the dry ingredients are brought to the factory. The practitioner wishing to perform an LCA on the product must thus reconstruct the anterior stages, including:

- growing of the plant-based ingredients (wheat, soy, fruit, nutmeg, sugarcane, maize and vanilla bean for the vanilla flavour powder)
- extraction of mineral ingredients (salt, baking powder)
- harvesting and treatment/drying of plant-based ingredients
- transport from the farm to the processing plant
- processing of wheat and soy into flour, packaging
- processing of sugarcane into sugar, packaging
- cutting and drying of fruit, packaging
- transport of all dry ingredients to the soy pancake mix factory

Following these steps, those of Section 7.1 follow. For each step, a questionnaire should be filled out by the supplier(s) so that it is possible to understand the actual inputs and outputs that are necessary.

5.2.3 Life Cycle Impacts Assessment (LCIA)

LCIA follows to understand the impacts that are linked to the flows established in LCI. The ISO standards list mandatory (selection, classification, characterization) and optional (normalization, grouping, weighting) steps to perform LCIA.

First, it is necessary to select the impaction categories, category indicators, and characterization models that will be used for the assessment. These should cover the most relevant impacts for the type of product and region. In practice, an existing LCIA method (e.g. ReCiPe) can be chosen in an LCA software (e.g. OpenLCA). This step is followed by the classification of the inventory results into the chosen impact categories - once again, this is generally done through an LCA software or LCI databases. The characterization step allows

all results to be converted into common units for comparison. For Global Warming Potential is communicated in CO_2eq.

For this stage, it is recommended that the practitioner becomes acquainted with LCA software and databases that are available on the market as they can greatly facilitate work. Many include student and academic licences that are free or cost relatively little. The most common software include: OpenLCA, SimaPro, Gabi. The most common databases can often be found bunded to LCA software and the Global LCA Data Access Network is a great starting point for finding the databases that cover the needs of your study.

5.2.4 Interpretation

In this last stage of an LCA, the practitioner summarizes the inventory and impact results and puts them into context. The final result should highlight:

- the environmental hotspots and potential areas for improvement
- the completely and sensitivity of the results (an uncertainty analysis may be performed to see the impact of assumptions and other input factors)
- limitations and recommendations for the product and future studies on the subject.

In the case of the soy pancake mix, the results will be published in the Technical Fiches. They may highlight such issues as the high energy needed to produce chemical fertilizers and the higher raw material needs due to food loss during post-harvest. There are also many solutions that can come from an LCA - for example, different packaging types can be assessed, and these will have an impact on the overall shelf life (and thus food waste) as well as transport weight.

A full product LCA can be a time and resource consuming endeavour but it is a very useful tool to understand where the environmental hotspots are located and how they can be addressed without shifting the impacts on another stage of the life cycle. As you set out on your LCA journey, remember to document all the stages, and take the time needed to collect the best data available!

6. Business Model Innovations

This section deals with different aspects of innovative and sustainable business models (BM). In particular, the chapter provides guidelines on how to build and plan a strategic agri-food business models through the practical tool of Business Models Canvas (BMC). The unit will present an exercise based on a case study to develop a BMC.

At the end of this section, you will be able to:

- Understand what a business model is
- Identify sustainable innovations
- Comprehend the characteristics of the Business Model Canvas
- Learning from practical use
- Develop your own business model

6.1 Definition of Innovation

In the context of HealthyFoodAfrica project, we can define innovation as new and renewed food products of high nutritional value and attractive commercial value, the use of local knowledge and agrobiodiversity sources, and improved connections between systems (e.g., aquaculture, sustainable cropping) and healthy, diverse, and nutrient-rich diets.

Starting from the definition proposed above, this chapter will be mainly dedicated to Business Model Canvas with an explanation of the various steps that compose it, ending with an activity focused on the development of a model with the support of selected case study on fruity soy pancake mix.

6.2 Introduction to Business Models

A business model describes the rationale of how an organization creates, delivers, and captures value. Business models (BM) have been an integral part of economic behaviours since pre-classical times. Indeed, firms have always operated according to a business model but, since 1990s, firms traditionally operated following similar logics in which a product/service is delivered to a customer from which revenues re-collected. Even if instances of firms adopting innovative business models have been recognised, it is in the

past 10 years that the scale and speed at which innovative BMs are transforming industries, and indirectly civil society, has attracted the attention of research and practitioners.

While the study of BMs has traditionally focused on business activities, innovative BMs have been designed for purposes other than the economic profits, such as solving social problems and sustainability issues.

6.3 Sustainable BM Innovations

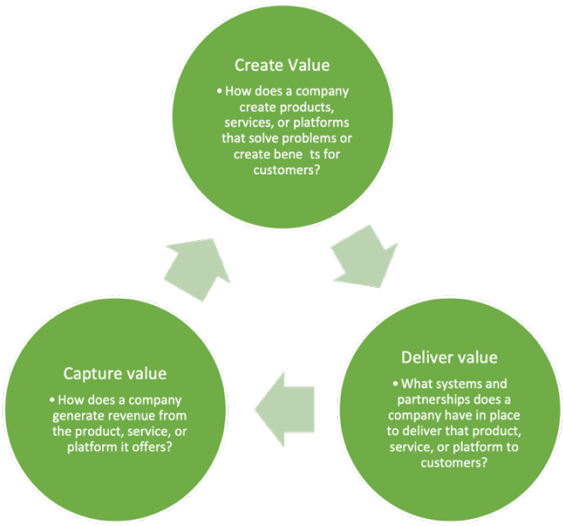
The definition of sustainable BMs innovations combines business model innovation element with sustainability considerations. BM innovation is seen as a process of business model exploration, adjustment, improvement, redesign, revision, creation, development, adoption, and transformation.

The process could be qualified as a sustainable business model innovation or a business model innovation for sustainability, when it aims at:

- Sustainable development or positive, respectively reduced, negative impacts for the environment, society, and the long-term prosperity of the organisation and its stakeholders
- Adopting solutions or characteristics that foster sustainability in its value proposition, creation, and capture elements or its value-network.

6.4 Business Model Canvas

The business model canvas has the function to create a model that shows how an organization does three things: creates, delivers, and captures value. According to Alex Osterwalder, which is primarily known for developing the Business Model Canvas. It means that this model helps to think of how the organization interact with the customers, how it will design or manufacture the products or services offered, and how deliver those products or services to the costumers' doorstep or corner store, and



not less importantly the cost related with doing business to set an equilibrium price in which the sustainability of the business is guarantee.

Business Model Canvas

Designed for:	*Designed by:*	*Date:*	*Version:*

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
Who are our Key Partners? Who are our key suppliers? Which Key Resources are we acquiring from partners? Which Key Activities do partners perform? MOTIVATIONS FOR PARTNERSHIPS: Optimization and economy, Reduction of risk and uncertainty, Acquisition of particular resources and activities	What Key Activities do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue streams? CATEGORIES: Production, Problem Solving, Platform/Network **Key Resources** What Key Resources do our Value Propositions require? Our Distribution Channels? Customer Relationships Revenue Streams? TYPES OF RESOURCES: Physical, Intellectual (brand patents, copyrights, data), Human, Financial	What value do we deliver to the customer? Which one of our customer's problems are we helping to solve? What bundles of products and services are we offering to each Customer Segment? Which customer needs are we satisfying? CHARACTERISTICS: Newness, Performance, Customization, "Getting the Job Done", Design, Brand/Status, Price, Cost Reduction, Risk Reduction, Accessibility, Convenience/Usability	What type of relationship does each of our Customer Segments expect us to establish and maintain with them? Which ones have we established? How are they integrated with the rest of our business model? How costly are they? **Channels** Through which Channels do our Customer Segments want to be reached? How are we reaching them now? How are our Channels integrated? Which ones work best? Which ones are most cost-efficient? How are we integrating them with customer routines?	For whom are we creating value? Who are our most important customers? Is our customer base a Mass Market, Niche Market, Segmented, Diversified, Multi-sided Platform

Cost Structure	Revenue Streams
What are the most important costs inherent in our business model? Which Key Resources are most expensive? Which Key Activities are most expensive? IS YOUR BUSINESS MORE: Cost Driven (leanest cost structure, low price value proposition, maximum automation, extensive outsourcing), Value Driven (focused on value creation, premium value proposition). SAMPLE CHARACTERISTICS: Fixed Costs (salaries, rents, utilities), Variable costs, Economies of scale, Economies of scope	For what value are our customers really willing to pay? For what do they currently pay? How are they currently paying? How would they prefer to pay? How much does each Revenue Stream contribute to overall revenues? TYPES: Asset sale, Usage fee, Subscription Fees, Lending/Renting/Leasing, Licensing, Brokerage fees, Advertising FIXED PRICING: List Price, Product feature dependent, Customer segment dependent, Volume dependent DYNAMIC PRICING: Negotiation (bargaining), Yield Management, Real-time-Market

Figure 10 The Business Model Foundry (www.businessmodelgeneration.com/canvas). Word implementation by: Neos Chronos Limited (https://neoschronos.com).

Figure 10 present an example of BMC developed by Alex Osterwalder that shows a first glimpse on how is structured and the main functions.

The BMC is a tool that envision your enterprise down into 9 building blocks that describe how the company will create, deliver, and capture value. You can visualise the nine main components directly in the graphic model (figure 11).

On the top right the four boxes are related on how your company will create value, the three boxes on the left side are related on how to deliver value and the top two boxes are made to identified how to capture value. The table above can be found blank as annex number 1 at the end of the T-Kit. This matrix will help you in the development of your business model canvas.

6.5 Case study: Business Canvas model development for fruity soy pancake mix

The case study on fruity soy pancakes refers to a questionnaire which can be consulted in the annexe 1. The questionnaire can be used as a guideline for the realisation of your own innovative business model.

Customer value proposition: (Customer Value Proposition for fruity pancake mix must be assessed by research questionnaire)

- Contributes to a healthy diet by adding plant protein.
- Fruits add antioxidant and fibre properties to the pancake
- Good for kids who don't want to eat fruit, as they will indirectly receive the nutritional properties.
- The fruit used can be diversified to vary the product. In this case different customer segments would be served, delivery services, party services etc.,

Note: The characteristics of such activities should include: Newness, Performance. Customization "Getting the Job Done", Design of products, Brand/Status, Pricing of products, Cost Reduction, Risk Reduction Accessibility, Convenience/Usability, and affordability. Key Activities: (that a processor can undertake to ensure that the customer value proposed is included in the product)

- Ensure that fruit is obtained cheaply, of high quality, stored hygienically and available in good quantities
- Ensure that the necessary commodities are available: milled soy can be obtained from processors or prepared from soybeans locally, soft wheat flour are obtained from wholesale flour mills they import, fruity chunks are obtained from fruit drying companies on wholesale, sugar, vanilla flavour, nut meg, baking powder are all obtained from wholesale stores importers,
- The packaging material is a food grade zippered sealed bag obtained from importers that comes with size and price, cardboard boxes are obtained as secondary packaging material that is strong enough to withstand transportation
- Transport should preferably be carried out in a closed van
- The processing of the innovative fruity pancake must be done in premises certified by national food safety authorities, with a standardised procedure according to GMP, GHP and SOP, the pre-requisite for HACCP.
- A standardised flow chart with declared instructions and parameters is needed
- Labels must meet food safety authorities' requirement as indicated below.

General labelling FDA requirements	Additional labelling
- Product's name - Ingredient's list - Quantitative ingredients declaration (where indicated) - Net contents and drained weights - location name and address if possible - Country of origin - Production date - Shelf life and expiry date - Instructions for use and special storage requirement - Nutritional facts labelling - Allergy specifications	- General claims and the use of nutrition and health claims in food labelling - Labelling and claims of organic foods - Food additives when sold as such

Table 4 FDA labelling requirements

Note: The categories of activities should be cost effective and efficient production schedules, innovative problem solving, and platform/Network driven.

3. Key partners' activities to accomplish customer's proposed desire:

- The key direct partners are traders' wholesalers, retailers, outsource processors and technology transfer and accredited analytical laboratory agency CSIR-FRI
- The key indirect partners are the farmers, regulators, traders etc
- The key suppliers are the wheat mills and outsourced partners are the fruity chunk processors
- The key resources we require from partners, skill trained human resource, commodities resources we require from farmers, traders and a certified processing premise
- The key activities to be carried out by the partners are: training on how to prepare the fruity soy pancake mix, providing good quality commodities and availability
- Engage partners with remuneration, increase in demand of the commodities, increase in customers' loyalty
- Optimise goods from suppliers by cleaning and maintaining good storage conditions.
- Economise by buying in bulk and in season to avoid price increases.

Note: The categories of partners established should be reliable and trustworthy, efficient supply schedules, solve innovative problem and be a member of our platform with network driven.

4. Key Resources to accomplish customer's proposed desire:

- The key resource that are needed to complete the values proposed by customers to process fruity soy pancake mix, includes wheat flour, soybeans flour, fruit chunks, vanilla flavour, nut meg, sugar, baking powder, fuel energy, processing facility, storage facility, distribution channel etc.,
- The fruits and the soy flour adds health value
- The key suppliers, key internal customers (staff-regular and casuals) and external (pancake consumers and potential fruit pancake) are very important to maintain these relationships?
- As entrepreneurs it is necessary to reduce risk and adopt calculated risk, for example by using cost-benefit analysis to understand margins. It is also necessary to reduce uncertainty in the acquisition of particular resources and assets from partners, especially quality and quantity of raw materials.

- The types of registers, databases and network resources needed depend on physical resources (infrastructure, equipment), intellectual resources (copyrights and data), human resources (manpower) and financial resources (loan, capital, march grant).

Note: The categories of resources should be cost effective and efficient in production schedules, innovative problem solving, and consolidated platform/Network driven.

5. Customer Relationships to establish and maintain to create loyalty

- How can we meet their proposal for innovative value-added products? A good delivery system has to be established and maintained - personal, private, confidential, regulatory
- Regular and potential customers have to be integrated with the rest of the building blocks of our business model to meet their needs and desires
- The cost implications of maintaining clients and other services must be assessed
- It is necessary to analyse the competition and establish how our fruity soy pancake mix proposal relates to other brands, products or staff services
- The loyalty of regular and potential customer's relationship can be simulated with market access sensory test.

Note: Examples of effective relationship depends on personal, assistance, dedicated personal assistance needed, self-service, automated services, communities' interactions, co-creation with technology etc.,

6. Key Channels of distribution for products and services:

- The packaged novel product fruity soy pancake mix needs to reach the consumer in the proposed form
- Processes and services must be organised to make the product available and accessible
- The distribution channels do not need special condition (e.g., cold chain). Nevertheless, the product must be stored in a cool, dry environment before reaching our customer segments in the ideal form.
- Personal sales or food vendor chains must be organised in a planned pathway to reach customers

- In whatever form our customers propose, there must be integrated or networked channels
- It has to be established which channels work best or satisfy the customer most
- It is also necessary to consider which channels are the most convenient and efficient
- Distribution channels must be integrated with market research data

The Channel phases to be considered
Awareness/promotion; raise awareness about our company's fruity soy pancake mix and the services to be rendered
Coordination/facilitation; network the activities of customers. So that customers can learn from each other's experience. There is the need to support themselves without us
Monitoring/evaluation; help customers evaluate our organization's customer value Proposed product
Purchase/experience; allow customers to purchase specifically what they have required
Delivery/availability; deliver a value proposed to customers. We need to package the product for convenience
Affordability/purchase decision; help our customers to make the right choice amongst competitive by reducing cost effectively
After sales/support; provide post-purchase customer support such as make the advertisement on preparation and showing results after use so that customers can sustain continuous purchase and maintenance

Table 5 Channel phases

7. Costs Structure of all activities that lead to customer proposed value product or services:

- The main components of fruity soy pancake mix must be costed by activity base costing which is more scientific so that activities/processes employed along the value chain can be grouped into low and high activity or process cost
- It is necessary to identify each cost activity/processes by records/data to minimize cost
- The most important activity/processor costs base inherent in our business model must be identified
- It is necessary to identify which key resources/activities/processes are most costly
- The production cost must be compared with an industrial production cost to understand the competitiveness of the product

- investigate what your value-adding activities are:

1.Cost driven (leanest cost structure, low price value proposition, maximum automation, extensive outsourcing)	2. Value driven (focused on value creation, premium value proposition)? Sample characteristics are fixed costs (regulatory commitment, salaries, rents, utilities)

- Then identify variable costs (disposables, cleaning, and waste management).

Note: Economies of scale and economies of scope are employed to ensure prudence of expenditure:

1. Economies of scale for a firm primarily will enable it consider reductions in the average cost (cost per unit, margin per unit) associated with commercially increasing the scale of production for a single product type	2. Economies of scope will enable it to consider diversity or variety for lowering the average cost by producing two or more products types or forms (brands in a single portfolio)

8. Revenue Streams from value proposed fruity soy pancake mix and services rendered to customer:

Revenue or incomes are the key inflow streams and must be identified and sustained with the following interrogations:

- From sensory analysis we can access the value that customers are willing to pay
- We need to know and understand how much customers are currently paying for pancake without fruit
- Through what means are our customers currently paying for pancake?
- It must be identified how our customers prefer to pay the fruity soy pancake mix and how much each revenue stream would contribute to overall income
- Identify the other types of revenue streams available; Service fees, Asset sale, Usage fee, Subscription fees, Lending/Renting/Leasing, Licensing, Brokerage fees, Advertising fees.
- It is necessary to decide what type of pricing would be employed
    1. Fixed pricing; List Price, Product feature price dependent, Customer segment price dependent, Volume price dependent
    2. Dynamic pricing; Negotiation (bargaining), Yield management, Real-time Market price

Note: Developing countries like Ghana mostly practice imperfect monopolistic market system, which is a market structure in which several or many sellers produce similar, but slightly differentiated products for sale. Each producer can set its price and quantity without affecting the marketplace as a whole. For these reason in monopolistic competition, products and services seek to gain advantage through differentiation in physical appearance, marketing strategies, human capital, distribution, and other factors such as technology.

9. Key customer segment: (regular and potential)

- It is necessary to classify consumers according to the product, process, and services in the value chain. This has to be done carefully because it could be a cause of dissatisfaction
- In Ghana, it is the middle class that can afford to buy snacks, creating a status symbol of rich people's food
- Segmentation of consumers must be done by their association with value added to the product, process and service
- It is necessary to develop the offer or assessment of needs and desires as segments for customers in the fulfilment/satisfaction for customer loyalty
- Consumers should be provided with a great amount of information on the innovative potential of the fruity soy pancake mix, the capacity and improved service provided by our innovative creation to generate more revenue streams and increase the number of consumers

Note: Customer segmentation is also necessary to be able to serve all categories of potential clients and so the interrogation include:

1. To whom are we creating the value addition in fruity soy pancake mix for
2. We must identify our most important customer demand
3. We need to prioritize our customer demands, fruity of soy in what percentage.
4. We must identify how many types of customers we can have
5. We can classify our customers by their demand.
6. We must identify what type of market we would be joining, the Mass Market or Niche Market or Multi-sided Platform.

7. Novel Product: Fruity Soy Pancake mix

Following the description of the main principles of sustainable food systems and the application of a practical tool for managing business model strategies, this section involves the description of technological aspects and provides information on novel products describing the steps to produce a fruity soy pancake mix and its characteristics as a case study.

The next figures are illustrations of a product developed by CSIR in Ghana, as a way to show how a novel product could be developed with semi-industrial or industrial tools. This product is meant to be easy to prepare that incorporates soy and fruits into the consumers diet, making heathier foods attractive.

Good practices of the process are shown including the packaging, and later the business model. Product design and consumer behaviour could take a relevant role on the presentation of the product, in case it is meant to address environmental aware consumers, biodegradable packages or bulk selling could be considered. Also, additives like sugar could be avoided, reduced or substituted with other ingredients like stevia or fruit sweeteners in case the product is targeting population with diabetes or obesity. The quantity of dried fruits can also be Increased.

7.1 Processing of fruity Soy Pancake mix

SOYBEAN FLOUR PRODUCTION

STEP I – SORTING

Remove all foreign materials which include stones, sticks and immature beans

STEP 2 – WASHING

Wash beans with clean portable water in a strainer to remove any residue of sand and dirt

STEP 3 – BLANCHING

Put a pot of water to boil (100°C). Add washed beans to boiling water and blanch for 20 mins

STEP 4 – RAPID COOLING

Strain blanched beans in a strainer and put under running cool water to ensure that there is no continuous cooking of the beans and in order to retain colour and nutrients.

STEP 5 – DRYING

Spread out the beans thinly on drying trays and dry for six hours (6hrs) at 55°C

STEP 6 – DEHULLING AND WINNOWING

Dehull and winnow to get rid of the chaff

STEP 7 – MILLING

Mill into flour in 250micron (Hammer or Attrition mill).

SOFT WHEAT FLOUR

STEP 1 – HEATING

Sieve, weigh and spread-out flour on drying trays and heat for thirty minutes (30 minutes) at 80°C

MIXING (BASIC FORMULATION – 1000g of main ingredients[3])

850g of soft wheat flour
100g of soy flour
50g of dried fruits in small chunks
5g of nutmeg powder
1.4g of salt
282g of sugar
22.14g of baking powder
12.5g of vanilla flavour powder

WEIGHING

Weigh out the final product into preferred packaging material such as clear pouch material composed of Polyethylene terephthalate (PET) + Polyethylene (PE) or high density PET cans

PACKAGING

Properly clean and seal to prolong shelf-life.

PACKAGING CHARACTERISTICS:

Plastic pouches of different types can be used for packing the fruity soy pancake mix. Packaging pouches are used with the same functionality as cans but can be imported at a

[3] The main ingredients are wheat flour, soy flour and dried fruits. The rest of the additives could vary depending on the market preference.

better price since they are trans-shipped collapsed. The figures below show the types, prices per pack for plastic pouches currently available in Ghana and sample of 50ml-800ml size/capacity of Polyethylene terephthalate (PET or PETE) cans.

Instruction for pancake flour use

- Fetch two levelled cups (160g) of the pancake flour into a bowl
- Add a cup of water and cream or stir with a wooden spoon until a smooth texture is obtained
- Allow the batter to rest for 5 minutes and
- Shallow fry until golden brown
- Serve with extras (side dishes/toppings) of your choice

The production process can also be watched in its entirety at this link: https://www.dropbox.com/s/8qylgzg4wmwnus1/HFA%20WP6%20Pancake%20Video.mp4?dl=0

7.2 Fruity soy pancake mix cost/benefit analysis

Cost/benefit analysis is a tool that businesses use to take decisions whether to invest in the production of a product or better invest the money and effort in something more profitable, this is called opportunity cost. This tool sums the rewards expected from the economic activities and then subtract the total cost involved in the action of making the product. In other words, the sum of total revenue with a minimum and maximum market price minus the fix and variable costs.

The example bellow takes into account the unit cost of each input to make 500g of soy pancake mix. The maximum revenue is GHS 20.00/pack and the minimum revenue is GHS 18.00/pack. With a total lot of production of 150 packs of soy pancake mix.

Cost/benefit analysis of Fruity soy pancake mix

#	item	Metric of unit	Amount of unit	Unit cost (GHS)	Total cost	Weight (g)	Remarks
1	Soya bean	tin	10	15	150	25000	Local purchase
2	Wheat flour	kg	25	11,2	280	50000	Imported
3	Sugar 5tins	tin	5	16,67	83,35	12000	
4	Dried fruity mix/ dried Fruits chunks	kg	12	24,74	296,88	4455	
5	Vanilla flavor 1 pack	Pack	1	50	50	500	
6	Nut meg 1 pack	Pack	2	50	50	3500	
7	Baking powder 2tins	tin	2	20	40	10000	
8	Drying/milling process	Lot	2	60	120		
9	Sealable polythene pouch	Bag	150	1,52	228		
10	Transportation	Shipping	1	100	100		
11	labels (150/1.50 GHS)	Label	150	1.50	225		
12	Labor (2 persons @ 100 GHS)	Person	2	100	200		

	Subtotal and weight				**1823,23**	**105455**	
	Overheads (energy, administrative cost) = 20% of Subtotal				364		
	Total Cost and weight				**2187,23**	**75000**	
	Yield of products = 150 pieces/packs of 500g						
	Revenue minimum price			(150 packs x GHS 18.00/pack)	2700		
	Revenue maximum price			(150packs x GHS 20.00/pack)	3000		
	Profit on minimum price				516		
	Profit on maximum price				816		
	Weight recovery ratio			105455/75000	71,12%		
	Expense ratio on minimum revenue			2187,23/2700	81%		
	Expense ratio on maximum revenue			2187,23/3000	73%		
	15 pieces of fried pancake can be made from each fruity Soy pancake of 500g						

Table 6 CSIR, Fruity Soy Pancake mix cost/benefit analysis

The total maximum profit with a 20 GHS unit price is 816 GHS and the total minimum profit with 18 GHS unit price is 516 GHS for 150 packs of 500g of soy pancake mix. The total expense ratio means that for 1 GHS invested 81% will be use in expenses with a minimum ratio and 73% with a maximum revenue.

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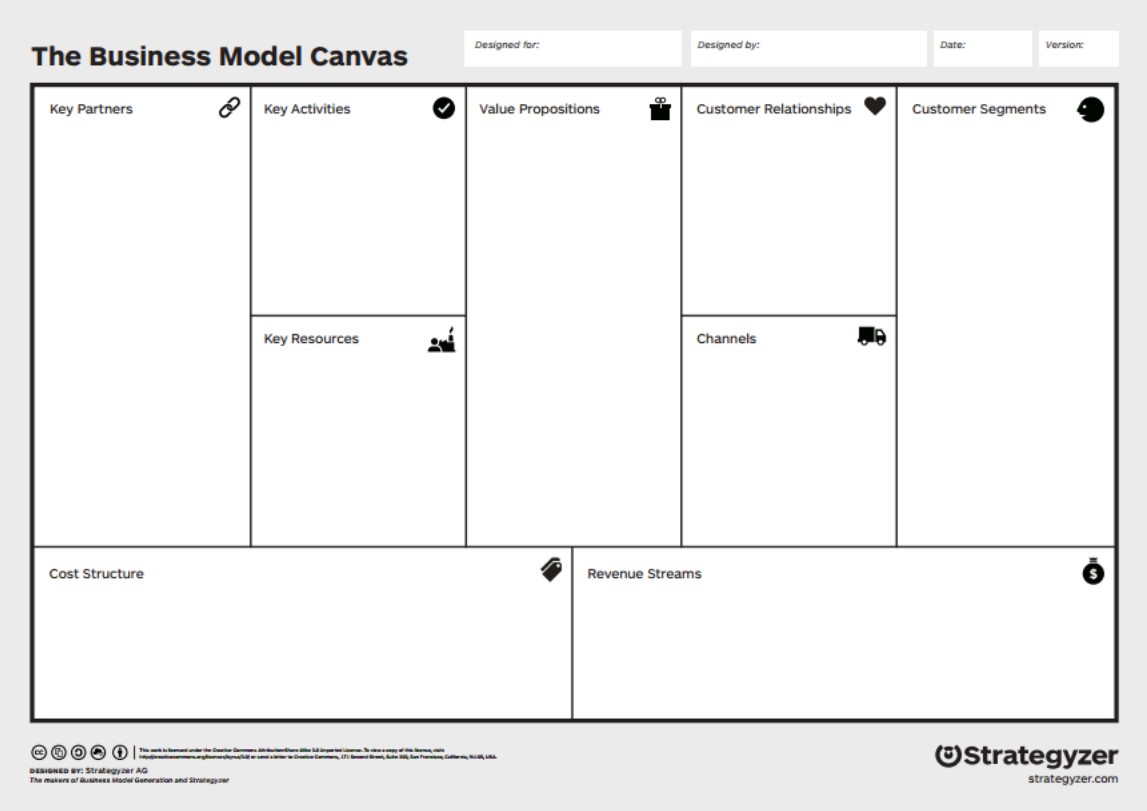
9. Annexes

9.1 Annex 1



Above the tool you can use to answer the question to create the BMC. This canvas should be a working document that could be used to test hypothesis of the creation of your business and to test it in real live with actual costumers. This tool also helps to map different business models to test in order the one might work best. Sometimes even three or more are canvas are necessary to conclude with the more profitable and sustainable business. For more detail on how to build the canvas see this link.

In order to understand how to build a BMC, an explanation of each box is provided with a set of questions to answer, follow with the soy pancake case study BMC.

9.1 Annex 2

Economic Business Model Canvas

1. Key activities:

- What key activities do our customer demand value propositions required?
- How are our commodity supply chain and distribution channels managed?
- How do we reduce cost on the most expensive activity?
- What types of customer and consumer relationships are established?

How do we ensure profitable revenue streams?

Note: The categories of activities should be effective and efficient production schedules, innovative problem solving, and platform/Network driven.

2. Key partners:

- who are our key direct and indirect Partners?
- Who are our key suppliers?
- Which Key Resources are we requiring from partners?
- Which key Activities do partners perform?
- What do the Motivations for partnerships comes from?
- How do we optimize and economize supplier's goods?
- How do we reduce risk and uncertainty in acquisition of particular resources and activities from partners?

3. Customer Value Proposition:

- What are the values proposed along the value chain of post-harvest agro-processing?
- What does the customer need or wants has effect on the finished product?
- Which of the customer proposed values must be noted and adhere to will include?
- What value do we deliver to the customer?
- Which one of our customer's problems/pains are we helping to solve?
- What bundles of products and services are we offering to each Customer Segment?
- Which customer needs/wants are we satisfying?

Note: The characteristics of such activities include; Newness, Performance. Customization "Getting the Job Done", Design, Brand/Status, Price, Cost Reduction, Risk Reduction Accessibility, Convenience/Usability and affordability.

4. Key Resources:

- What key resource do we need to complete the value proposed by customers along the value chain?
- What proposed value must be noted and the right attention assigned to them for innovative value addition,
- What type of Distribution Channels can we employ?
- Who are the key suppliers, key internal and external customers and how do we maintain these Relationships?
- What types of resources are Physical (infrastructure, equipment), Intellectual (brand patents, copyrights, and data), Human (labour) and Financial (equity)?

5. Customer Relationships:

- What type of relationship does each of our internal and external Customer Segments expect us to establish and maintain with them?
- Which ones have we established and which once has not been established or work in progress? iii. How are they integrated with the rest of our business model building blocks?
- How costly are they?
- How are they related to your brand, product or personnel?
- How are they loyal to your product?

Note: Examples Personal, assistance, Dedicated Personal Assistance, Self-Service, Automated Services, Communities, Co-creation,

6. Key Channels of distribution:

- Which novel products, processes and services must be considered to be moved?
- Through which Channels do our Customer Segments want to be reached?
- How are we reaching them now?
- How are our Channels integrated?
- Which ones work best?
- Which ones are most cost-efficient?
- How are we integrating them with customer routines?

Note: The *Channel phases to considered are*,

1. *Awareness/promotion*; How do we raise awareness about our company's products and services?
2. *Coordination/facilitation*; How do we network the activities of customers? How do customers learn from each other? How do they support themselves without us?
3. Monitoring/*Evaluation*; How do we help customers evaluate our organization's Value Proposition?
4. *Purchase/Experience;* How do we allow customers to purchase specific products and services?
5. *Delivery/availability;* How do we deliver a Value Proposition to customers? How do we package the product for convenience? How do we conduct personal sales?
6. *After sales/Support*; how do we provide post-purchase customer support? How do we sustain continuous purchase and maintenance?

7. Costs Structure:

- What are the main cost activities do we employ along the value chain?
- How do we identify and thorough analyses each cost activity by records/data to minimize cost?
- What are the most important activity costs base inherent in our business model?
- Which Key Resources are most expensive?
- Which Key Activities are most expensive?
- Is your business costlier done the industrial average?
- Which of your value addition activities are;

    1. Cost Driven (leanest cost structure, low price value proposition, maximum automation, extensive outsourcing) or
    2. Value Driven (focused on value creation, premium value proposition)? Sample characteristics are Fixed Costs (regulatory commitment, salaries, rents, utilities),

- Variable costs (disposables, waste management).

Note: Economies of scale and economies of scope are employed to ensure prudence of expenditure:

1. Economies of scale for a firm primarily will enable it consider reductions in the average cost (cost per unit) associated with increasing the scale of production for a single product type,

2. Economies of scopewill enable it to consider lowering the average cost by producing two or more products types or forms (brands).

8. Revenue Streams:

- Which incomes are the key Revenue Streams? must be identified and sustained with the following questions; for
- What value are our customers really willing to pay?
- What do they currently pay?
- How are they currently paying?
- How would they prefer to pay?
- How much does each Revenue Stream contribute to overall revenues? Types of revenue streams are; Asset sale, Usage fee, Subscription Fees, Lending/Renting/Leasing, Licensing, Brokerage fees, Advertising.
- What type of pricing are employed?

3. *Fixed pricing*; List Price, Product feature dependent, Customer segment dependent, Volume dependent
4. *Dynamic pricing,* Negotiation (bargaining), Yield management, Real-time Market price,

Note: The developing countries like Ghana, mostly practice imperfect *monopolistic market system* which is a market structure in which several or many sellers each produce similar, but slightly differentiated products. Each producer can set its price and quantity without affecting the marketplace as a whole. For these reason in *monopolistic competition*, products and services seek to gain advantage through differentiation in physical appearance, marketing strategies, human capital, distribution and other factors.

9. The key customer segment:

- How do we identify consumers and classify them along the product, process and services in the value chain? This must be done with care since it could bread dissatisfaction.
- How do we segment who are internal customers and external consumers by association product, process and service?
- How do we develop offering or need and want assessment? In fulfilment/satisfaction which is important for customer or consumer loyalty.

Note: Customer Segmentation is also necessary to be able to serve all categories of potential clients and so the questions asked include; for

1. whom are we creating value addition?
2. Who is our most important customer demand?
3. How do we prioritize our customer demands?
4. How many types of customers can we have?
5. How can we classify our customers by their demand?
6. What type of market are we joining; the Mass Market or Niche Market or Multi-sided Platform?

How do the consumers need to know much information about the product capability and service enhancement provided by our innovative creation to generate more revenue streams?

Environmental Life Cycle Business Model Canvas

1. **Supplies and Out-sourcing:**

All other various material and production necessary for functional value

- How can we identify and classify are suppliers?
- How should we categorize our suppliers?
- Which of our resources do we out-source?
- How can we ensure environmental safety during our choice for suppliers or out-sourcing?
- How do we ensure that core and non-core functional values are considered?

2. Production:

- How do we create value in products, process and services from customer value proposition?
- How do we manufacture market oriented innovative product ensuring safe and sound environment?
- How do we identify challenges in manufacturing processes that may affect the environment?
- How do we infuse innovative technological processes in manufacturing processes?
- How do we transform raw materials or unfinished material into higher value outputs?

- How do we use innovative technology to reduce time/cost/improve quality/affordability/availability?
- How do we use IT to improve logistics supply chain for production, processes and services?
- How do we utilize resources- human skilled, technology use, intellectual property and Material resources to ensure safe and sound environment?
- How do we offer services to ensure safe and sound environment?

3. Materials:

- How do we acquire Bio-physical stocks that is needed to render processes or services to ensure functional value for consumers?
- How do reduce wastage of materials Fish/veggies/species along the supply chain from the source of material to processing centre and distribute consumers?
- How do we innovate packaging material – biodegradable and non-biodegradable?
- How do we educate consumers to appreciate modification of old material or introduction of new material amid influence of social quality/safety?
- How do we ensure that safer processes or services are undertaken and practiced?
- How do we ensure that all materials needed are obtained in high quantities and quality with high safety measures?

4. Functional Value:

- How do we ensure that Functional values and units are identified in a life cycle assessment?
- How do we ensure service performance as in functional value proposed by consumers with their needs/wants fulfilled?
- How do we ensure that each functional unit is made to satisfy consumers?
- How does the functional values and units affect the environmental life cycle?

Note: Difference between functional unit and functional value is that the value is what has been proposed to support life cycle in that product but the Unit is the of usage for the total of unit consumed per year/month

5. End-of-life:

- How are we going to reuse material (cold boxes)?
- How are we going to use waste from materials; fish/vegetables, legumes and cereals?

- How are we issues of material reuse;
- Repurposing/ recycling/disassembling/incineration/ disposal
- How are we going to produce service system to regenerate or re-engineer service systems?
- How are we going to improve on industrial symbiosis partnership/outsourcing?

6. Distribution:

- How are we going to transport goods; packaged, conditioned?
- How are we going to transport from production site to marketcenter?
- What are the different channels needed to transport products?
- What channel environment conditions do we adopt?
- What distances are going to be covered?
- What time would we use to travel?
- What will be the main delivery logistics?

7. Use phase:

- What would be the main use phases to be considered?
- Where are the serving places?

Note: These could be;

1. School feeding programme in canteen, cafeteria
2. Public eating places in restaurants. Chop bars,
3. Households

- How are the products going to be served?
- How are the left overs going to be utilized?

8. Environmental impact:

- How will we address the ecological cost?
- Will the ecological cost be part of the production cost or overhead cost?
- How will be recovered to support the environment?
- How will the Bio-physical measures such as carbon dioxide emission be done to obtain data?
- How will the Carbon Footprint measures be done to obtain data?

9. Environmental benefit:

- How will we reengineer environmental systems to sustain a safe and healthy co-existence with nature?
- How will recycle of waste materials such as water, solid waste be managed for production?
- How will Environmental safety measures be taken to ensure sustainable use of the natural resources?
- What are the benefits that can be derived from technology innovation?

Social Stakeholder Business Model Canvas

1. Local Communities:

- How are we going to identify the local Food System Laboratories (FSL)?
- How are going to categorize the FSLs identified?
- What basis of elements are going to be used?

1. Will it be access to nutritious, safe, quality food?
2. Sustenance of serving nutritious, safe, quality food?

2. Governance:

- How are we going to engage the governance systems in place in the selected communities?
- How autonomous are the private organization who are stakeholders in our food systems?
- How are the governance policies authorized to ensure nutritious, safe and quality food system?
- Do stakeholders need to register with policy implementers such as government agencies, district and municipal assemblies?
- Do stakeholders need certification of their food products to enter the market systems such as FDA, GSA?
- How are the ownership structures registered; Co-operative, non-profit, private-own for profit, publicly traded for profit, non-financial, partnership profit sharing.?

- How are decision-making policy made; is it done in transparency, consultation, or consent.

3. Employees:

- How are the internal and external customers of the manufacturing facilities?
- How are the internal customers oriented to ensure production of nutritious, safe and quality food?
- How are the external customers oriented to ensure strong loyal customer relationship?
- How are the internal customer organized;
- Elements

1. Ruler of employees and the demographics
2. Varying pay, gender, ethnicity and education

- Programs

3. Employee-oriented programme
4. Training and professional developments
5. Additional support programmes
6. Oriented to viability, sustainability and success

- Consuming

7. Different nationalities mean big coverage response relationship with customers
8. Training in good manufacturing practices, good hygienic practice

Note: Positive workforce and strong customer relationship likely needed to be considered as core part of business.

4. Social Value:

- How will we access the customer value proposition data obtained?
- How are we going to addressed the concerns of the value proposed by customers?
- How are we use technology researched to ensure value in Fish/veggies/species food systems?

1. Nutrient boast of food systems
2. Serve food in warmth

3. Serve food with strong taste
4. Serve convenience food system

- How do we ensure that every social value access with sensory analysis?

5. Social Culture:

- How are we going to identify culture of individuals in the FSL communities?
- How are the culture of social responsibility ensured;

1. Base line cultural belief
2. How nutrition is understood
3. How mal-nutrition impact the community
4. Change programs trailing for sustainable success
5. Production and serving point/sales points

- How are the societal standards – serving through local markets, chop bars, restaurant?
- How do we orient our customers for cultural accountability and pro-activeness?

6. Scale of Outreach:

- How will we segment the societal settings according to demand?
- How will we manage the supply chain activities?
- How will we determine the extent of supply in terms of volume/quantities and types?
- How will the product niches outlets be served?
- How will support systems operate direct or indirect; micro-credit services to support discounted sales lines

7. End-User:

- How will we identify the end-users of our products in the selected communities?
- How will we segment consumers by their social status; age, income and educational background?
- How will we segment customers by their ethnicity affiliation?
- How will we access the utility of the food systems in the communities?

8. Social impact:

- How can we use activity base costing to access the social cost?
- How can we analyse the displacement of traditional foods systems?
- How can we analyse the dependency of consumers on species of food systems?
- How can we access the change in cultural heritage?
- How can we access the changes in health and safety of consumers?
- How can we engage the customer successfully in the communities?
- How can we ensure that there is fair competition?
- How can we ensure that intellectual property rights are respected?

9. Social benefits:

- How can we strengthening the association of women processors in the same way as men processors are strengthen?
- How can we analyse the benefit of newly introduced foods systems into the traditional food systems?
- How can we analyse the benefit of newly introduced food systems to children in the communities?
- How can we access the benefits of the newly introduced food system there in cultural heritage?
- How can we access the benefit of changes in health and safety to consumers?

Annex 2. References:

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Stubbs, W., Cocklin, C., (2008). *Conceptualizing a 'sustainability business model'.* Organ. Environ. 21 (2), 103e127.