Università degli Studi di Padova

Dipartimento di Scienze Storiche, Geografiche e dell'Antichità

Dipartimento di scienze satistiche

Corso di Laurea Magistrale in Local Development

"Developing a training kit through participatory approach to promote food innovations towards sustainable food systems in sub-Saharan Africa"

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ACADEMIC YEAR 2021/22

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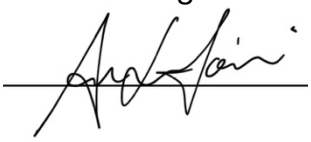

Acknowledgments

This research work is the result of a curricular internship, carried out as part of the master's program Local Development (University of Padua, Italy). The internship was held at the Mediterranean Agronomic Institute of Montpellier (CIHEAM-IAMM). The research lasted eight months, in which I conducted bibliographic research and I collaborate in the realisation of the "Training kit for innovative food product and process development" within the project HealthyFoodAfrica (EU Horizon 2020).

I would like to thank Paolo Prosperi, professor and researcher at CIHEAM-IAMM, for giving me the opportunity to carry out this wonderful experience and for guiding me throughout the research. For supporting me throughout my time in Montpellier and helping me to better integrate in the new environment.

A special thought goes to Daniel Alpizar, my desk colleague and friend.

I express my gratitude to Professor Anna Giraldo, for supporting me humanly and professionally, in the preparation of the thesis and all along the academic journey.

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Abstract

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.

Therefore, there is an urgent need for a transition to sustainable food systems capable of generating benefits, or economic value-added for all stakeholders; promoting socio-cultural outcomes such as nutrition and health, traditions, labour conditions, and animal welfare, while considering possible vulnerabilities such as gender, age, or ethnicity; employing processes with a neutral or positive impact on the surrounding natural environment to restore biodiversity, water, soil, animal and plant health.

To achieve these results a systematic transformation is required, employing solutions based on real problems, expressed by the most disadvantaged populations.

The proposed research addresses the role of innovations in fostering the transition to sustainable food systems. In particular, it aims to investigate a Multi-actor approach employed in the development of a training course through the employment of four main methods: co-creation, co-learning, co-management and interdisciplinarity. Targeting the generation of innovative and bottom-up solutions to address context-specific problems.

The “training kit for innovative food product and process development”, used as a case study, is part of the broader HealthyFoodAfrica (HFA) project funded by Horizon 2020. HFA is a research & innovation project aiming at more sustainable, equitable and resilient food systems in 10 African cities. Moreover, the project represents the collaborative effort of 17 partners in Europe and Africa and will be implemented in the period between June 2021 and December 2023.

The T-kit is essentially 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. It also represents the scientific framework for the organisation of the summer school which will be held in July 2022 and 2023. During the summer school students and local entrepreneurs, guided by the project partners, will have the opportunity to submit real problems related to their geographical context and collaborate to find innovative solutions and opportunities.

My contribution to the realisation of the training course was mainly related to the knowledge I acquired during my academic career (Food Science and Local Development). In the project I could combine the two experiences to support practical applications in the use of food systems for local development, mainly in Ghana and Kenya.
Therefore, food plays a decisive role in strengthening local populations, improving their economy, and limiting the consequences of climate change. Attributes implicit within sustainable food systems.

Abstract in italiano

Attualmente i sistemi alimentari mondiali non sono sostenibili. Le tecniche di produzione non rispettano le esigenze ecologiche, prosciugando ed esaurendo le riserve idriche, impoverendo e degradando il suolo, erodendo la biodiversità e contribuendo fortemente alle emissioni di gas serra. Nel frattempo, il valore della produzione lungo la catena agroalimentare non è ridistribuito in modo equo e trasparente e le disuguaglianze sono in costante aumento. Le pratiche di "business-as-usual" creano enormi sprechi e di cibo causando dunque un inutile impatto ambientale. Inoltre, la domanda di cibo aumenta costantemente a causa della crescita della popolazione mondiale, dell'urbanizzazione e dell'aumento dei consumi indotti da modelli economici non sostenibili.
È quindi urgente una transizione verso sistemi alimentari sostenibili in grado di generare benefici economici per tutte le parti interessate; di promuovere risultati socio-culturali come la nutrizione e la salute, le tradizioni, le condizioni di lavoro e il benessere degli animali, tenendo conto di eventuali vulnerabilità come il genere, l'età o l'etnia; di utilizzare processi con un impatto neutro o positivo sull'ambiente naturale circostante per ripristinare la biodiversità, la qualità dell'acqua e del suolo cosi come la salute degli animali e delle piante. Per raggiungere questi risultati è necessaria una trasformazione sistematica, impiegando soluzioni basate su problemi reali, espressi dalle popolazioni più svantaggiate.

La ricerca proposta affronta il ruolo delle innovazioni alimentari per favorire la transizione verso sistemi alimentari sostenibili. In particolare, si propone di indagare l'approccio multi-attore impiegato nello sviluppo di un percorso formativo attraverso l'impiego di quattro metodi principali: co-creazione, co-apprendimento, co-gestione e interdisciplinarità. Con lo scopo di generare soluzioni innovative e "bottom up" per affrontare problemi specifici al contesto socio-geografico.
Il " training kit for innovative food product and process development ", utilizzato come caso studio, fa parte del più ampio progetto HealthyFoodAfrica (HFA) finanziato da Horizon 2020. HFA è un progetto di ricerca e innovazione che mira a promuovere un'alimentazione più sostenibile e sistemi alimentari equi e resilienti in 10 città africane. Inoltre, il progetto rappresenta lo sforzo collaborativo di 17 partner in Europa e Africa e sarà attuato nel periodo compreso tra giugno 2021 e dicembre 2023.

Il T-kit è essenzialmente un manuale di formazione a consultazione libera destinato a formatori e studenti a diversi livelli di istruzione nel contesto subsahariano. Rappresenta inoltre il quadro scientifico per l'organizzazione della summer-school che si terrà a luglio 2022 e 2023. Durante la summer-school studenti e imprenditori locali, guidati dai partner di progetto, avranno l'opportunità di presentare problemi reali legati al loro contesto geografico e collaborare a trovare soluzioni e opportunità innovative.

Il mio contributo alla realizzazione del percorso formativo è stato principalmente legato alle conoscenze acquisite durante il mio percorso accademico (Food science e Local Development). Nel progetto ho potuto unire le due esperienze per supportare applicazioni pratiche nell'uso dei sistemi alimentari per lo sviluppo locale, principalmente in Ghana e Kenya. Pertanto, l'alimentazione assume un ruolo decisivo nel rafforzare le popolazioni locali, nel migliorare la loro economia e nel limitare le conseguenze dei cambiamenti climatici. Attributi impliciti dei sistemi alimentari sostenibili.

Introduction

This research work is part of the contemporary debate regarding sustainable food systems, defined by FAO as a "food system that delivers 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" (2018).

The concept of sustainability and sustainable development has been discussed and analysed in various ways. The modern concept is derived mostly from the 1987 Brundtland Report in which sustainability is composed of three spheres interconnected and the FAO (2014) proposed the model "Three dimensions of food sustainability" (figure 1).

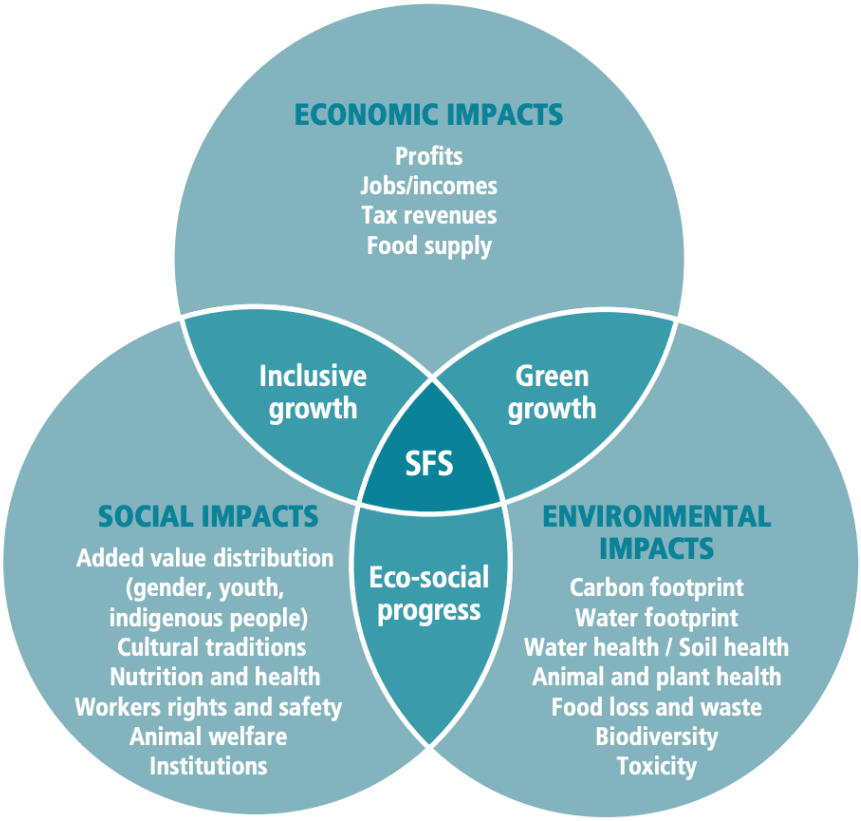

Figure 1 The three dimension of food sustainability, FAO (2014)

Systems that combine these three components could ensure a sustainable development. In fact, on the economic side, 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. Socially, food system operations should contribute to the promotion of vital socio-cultural outcomes such as nutrition and health, traditions, labour conditions, and animal welfare, considering possible vulnerabilities such as gender,

age, or ethnicity. On the environmental side food system activities should 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. However, a range of pressures including rapid population growth, urbanization, production techniques which harm the ecosystem, growing wealth and consequent changes in consumption patterns are challenging our food systems' ability to provide nutritious food, and to contribute to enhanced livelihood opportunities in an environmentally sustainable way.

The main challenge that currents food systems are facing relates to the production model. The agricultural sector, which includes crop and livestock production, forestry, fisheries, and manufacturing activities that process agricultural products, is directly dependent on natural resources. Food systems are accountable for a quarter of global greenhouse gas emissions (IPCC, *Climate change 2014 – mitigation of climate change*), as well as creating significant waste and contaminants due to the production techniques employed. Hence, agriculture has an impact on the entire earth system, threatening the ecosystem, and yet it cannot guarantee food security for all.

Unsustainable production techniques have led to a general increase in food crop productivity over the last 50 years, helping much of the developing world to overcome its chronic food deficits and today humanity produces enough calories to feed everyone on the planet. However, the number of undernourished people in 2018 is estimated to be around 820 million and about 1.9 billion people were overweight, with very high health and environmental costs (FAO, *The state of food security and nutrition in the world*, 2019). It has been calculated that for every dollar spent for food production, the society pays two dollars in health, environmental and economic damages (Ellen MacArthur foundation, 2017). In addition to planetary limits and malnutrition, the current food system is confronted with new challenges. Rapid population growth is increasing the demand for food in urban and rural areas of both low- and middle-income countries (LMICs). Urbanisation, changing lifestyles and the associated shifts in food consumption patterns have a significant influence on the food system. Moreover, poverty and inequality of various nature, including unequal access to productive resources, are still prevalent in many countries. In LMIC, local economies are closely dependent on agriculture, accounting for a large part of the GDP.

Thus, food systems are essential to contribute to inclusive economic development by creating and maintaining jobs, especially for the most vulnerable population groups (the poorest, youth and women) who depend on the informal food sector.

The state of food insecurity and food unsustainability is particularly acute in sub-Saharan regions (SSA). Currently, SSA is the sub-continent with the highest proportion of undernourished people. The nutritional outcomes of food systems are diverse and multifaceted. Negative outcomes are often associated with hunger, yet malnutrition is a complex problem that manifests itself in different forms. Malnutrition represents inadequate food intake relative to the nutritional needs of individuals and includes undernutrition (food energy deficiency); micronutrient deficiencies; overweight and obesity (excess food energy). Indeed, both macro and micronutrients are essential for human growth and development, and both can be affected by changing food systems and evolving consumer preferences.

The number of people that are chronically undernourished continues to rise in Africa, reaching 250.3 million in 2019: nearly one-fifth of the population. Of these, 15.6 million are in Northern Africa and 234.7 million in sub-Saharan Africa. In addition to the severely food insecure, though, a further 426 million people also experience moderate food insecurity, i.e. they typically eat low-quality diets. Looking to the future, population growth and climate change may worsen the situation.

Access is a key determinant of healthy diets. Nearly three-quarter of Africans cannot afford a “healthy diet,” and 51 percent cannot afford a “nutrient adequate” diet. For the nearly 430 million Africans that live in extreme poverty, the “energy sufficient” diet costs about 50 percent of their food expenditure budgets. No household living in extreme poverty can afford a “nutrient adequate” or “healthy diet.” Extreme poverty is defined by UN as “a condition characterized by severe deprivation of basic human needs, including food, safe drinking water, sanitation facilities, health, shelter, education and information. It depends not only on income but also on access to services”. It also refers to incomes below the international poverty line of $1.90 per day (in 2011 prices, equivalent to $2.29 in 2021), set by the World Bank.

In low-income African countries, the energy sufficient diet costs about 56 percent of the food poverty line, and in lower- and upper-middle- income African countries, the share is

64 percent and 70 percent, respectively. The cost of nutrient adequate and healthy diets significantly exceeds the food poverty line.
Affordability is therefore a crucial component in ensuring a healthy diet. In low-income countries, child undernutrition remains the most significant risk factor. However, in lower- and upper-middle-income countries, dietary risk factors and overweight gain in importance mainly due to changes in diets, shifting towards the consumption of energy-dense foods of minimal nutritional value. Consumption patterns are also a reflection of the relative cost of different foods, and in Africa, cereals, fats and sugars are relatively cheap when compared to more nutritious foods such as fruit, vegetables and animal-source foods.

Urbanization rates in SSA have been one of the highest in the world for the last 70 years. The urbanization rate according to the World Bank has increased from 11.2% in 1950, to 24.1% in 1980, reaching 40.7% in 2019. The UN forecasts that SSA's urbanization rate will continue to grow and it is expected to reach 46% by 2030 and 57% by 2050. This phenomenon has put a strong pressure on food systems and (Cervantes-Godoy et al., 2014) suggest that this is one of the main causes of transitions of food systems from traditional to modern. As more people live in cities, the demand for food increases and therefore the supply needs to shift to meet that growing demand. This includes changes to transportation, intrinsic cost, often cold storage, among other technologies, to make sure the food arrives from the rural areas the urban areas safe and retains good quality. The rural-urban migration is also forcing food systems to adopt more technology-intensive practices since fewer people are working in the food production fields but the demand for food is higher.

In SSA, the food sector is the largest economic sector and employs 57% of the population respectively. Most of these people are small family farmers, women, and young employees, struggling to make a decent living and thereby falling into the vulnerable and working poor category. Providing decent employment is therefore the SSA's challenge of the century and failing to meet this challenge could mean a tragic increase in inequality and malnutrition. Within this economic environment, women play a key role in urban and rural food systems. They cook for their families but also work in the food sector, as traders or processors and in West Africa, they represent more than 70 percent of employees in the food processing

and marketing sectors. Yet, women have less access than men to productive resources and opportunities.
The gender gap exists in many forms, especially legal rights to land and livestock ownership, for agricultural inputs but also for extension and financial services. Inequalities in access to resources and services, as well as in their ability to seize emerging employment and entrepreneurial opportunities, cause differences in access to remunerative opportunities between men and women farmers. In addition, despite their huge contribution, women are generally under-represented in the governance of food systems and in the shaping of policies as well as in the implementation of effective research and development programmes.

African food systems are therefore facing several challenges to achieve food sustainability. Moreover, ensuring a transition to sustainable food systems is an extremely complex pathway that seeks systematic solutions capable of addressing a multitude of problems simultaneously. The desirable system has been identified and will be presented in Chapter 1, through the framework provided by the FAO on sustainable food systems. Yet processes that can facilitate the transition without creating negative externalities are extremely complex to implement. Over the years, development projects and world policies have shifted their focus in search of sustainable solutions as evidenced by the Sustainable Development Goals promoted by the United Nations. There is therefore no single path, but a joint effort accompanied by social and technological innovations could lead to positive outcomes.

Research question

The research aims to analyse the role of food innovations in the transition process towards sustainable food systems. The concept of innovation is extremely broad and complex: innovations range from food production, land use and emissions to improved diets and waste management. At the same time, innovations require an appropriate set of incentives, regulations and political support to be implemented and deliver positive results. The great complexity of innovations merges with multifaceted food systems, composed of subsets and drivers capable of causing enormous changes that complicate predictions of trends, diets, climatic conditions, social tensions, migration, economic flows, conflicts, and so on.

Within this research, I will try to comprehend the role of innovations in the transition process to sustainable food systems, especially in Ghana and Kenya. How the creation of a training manual developed with a participatory approach, that includes local partners, European and international researchers, can facilitate the identification of real issues and opportunities within the local context. And finally, what educational aspects are needed to be transferred to facilitate this process.

Methodology

The methodology used in this research is based on the study of past literature on food systems and food innovations in the context of the debate on the transition to sustainable food systems, supported by the case study developed during the internship period. The research is divided into four main parts:

Through an analysis of past literature, the first part provides the reader with information on the topics covered in the research to contextualize the research question following two main themes. The first refers to sustainable food systems and analysing the sustainable food system framework offered by the High-Level Panel of Experts (HLPE), provides an overview of societal challenges where innovations can contribute to food security and nutrition. The second provides information on the role of innovations in the transition to sustainable food systems, emphasizing their central role in the transforming process. This section includes the definition of innovation, the analysis of the concept of "innovative approach" and the key principles of innovations.

The third part present the approach used to build the training kit with the aim of co-creating and sharing knowledge among different types of actors with complementary expertise known as the Multi-Actor Approach (MAA).

The last part presents the case study used to answer the research question. After the presentation of the project within which the training course was created, the context and approach used will be presented. This will be followed by the methodology used to create the training course, then results will be presented. The research will conclude with a discussion of the results obtained in creating a training course using a participatory approach to foster capacity in developing innovative food products, processes and agri-business models, enhance capacity in food innovation as well as new approaches in agribusiness. The discussion will focus on the possible impact these innovations may have in the transition to a sustainable food system.

Chapter 1: Innovations toward sustainable food systems

1.1 Sustainable food systems

Over the years, food systems sustainability has become a mainstream topic, acquiring a central role in the debate on sustainable development. Since 2015, the close link between food systems and sustainable development has been embodied in the United Nations 2030 Agenda which envisage “a world of universal respect for human rights and human dignity, the rule of law, justice, equality and non-discrimination”. The agenda presents 17 interlinked global goals that individual governments and the world as a whole are striving to meet through concrete action and food appears central to many of them including: Zero Hunger (SDG 2); Good Health and Wellbeing (SDG 3); Responsible Consumption and Production (SDG 12); Life on Land (SDG 15), which includes sustainable agriculture; Life Below the Water (SDG 14) where the focus on seafood is clustered.
Therefore, the 2030 Agenda recognises that we can no longer look at food, livelihoods and the management of natural resources separately. And according to FAO (2016) agriculture has a major role to play in combating climate change. Similarly, the framework used to analyse the complexity of food systems, sustainability, the outcomes that are generated and the drivers that condition their change recognises the interrelatedness of food systems with other systems. In addition, it recognises the complexity of relationships among the systems that support food production, food supply chains, food environments, the behaviours of individual consumers, diets, and nutritional and wider outcomes that feed back into the system (Fanzo et al 2020).
This framework is the result of the research carried out by the High-Level Panel of Experts over the past years. The proposed image (figure1) was published in the HLPE 15 report of 2021 and is the most up-to-date scheme for capturing the multiple facets of this system with the aim of ensuring food security to all.

High-Level Panel of Experts (HLPE 8, 2014, p.29) defined food systems as: “A food system gathers all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution,

preparation and consumption of food, and the output of these activities, including socio-economic and environmental outcomes".

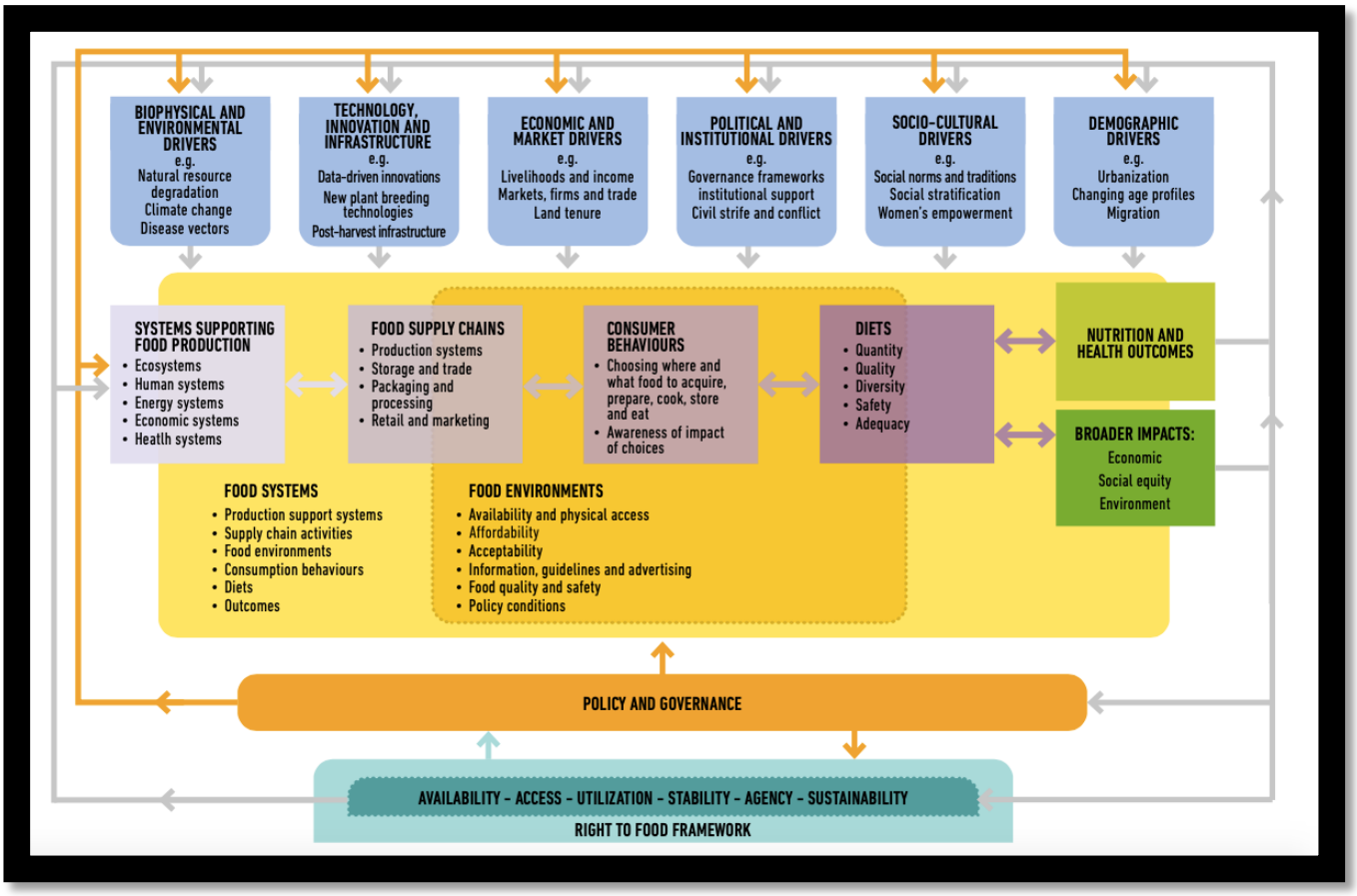

Figure 2 Sultaniale food system framework (HLPE 15, 2021)

This definition includes people who play a role in producing food, such as farmers and retailers, as well as people who are influenced by these activities, such as shoppers at a grocery store or market. In addition to individuals, institutions and organizations are critical components of food systems. Food systems also include the environment; agricultural inputs, such as fertilizer and water; and infrastructure, such as roads, stores, and machinery on farms. Through the many activities and processes of the food system, food can be grown and produced, processed, distributed, prepared, and, ultimately, consumed. In addition, it should be considered within the system everything that influences and results from it such as climate events, political actions, innovations or socio-economic factors.

The HLPE 15 illustrates several sub-sets that will be briefly presented. First, there are systems that support food production and include ecosystems, human systems, energy

systems, economic systems and health systems, which provide essential inputs to the food system. Then there is the food supply chain, meaning the set of activities and actors that take food from production to consumption and waste disposal (Hawkes and Ruel, 2012). This sub-set consist of agricultural production, storage and distribution, processing and packaging, and retail and marketing. Farmers, processors, wholesalers, transporters, and retailers are some of the people involved in food supply chains. All steps and actors are interconnected. Indeed, changes to one step affect other steps along the chain: for example, processing and packaging affect a food product's nutritional quality and affordability by increasing access to macronutrients as well as micronutrients or extending the shelf life of a product and reaching a larger population. However, the nutritional value of food can also diminish along the food supply chain in the case of food losses and contamination.

Food supply chains operate at different scales and levels, depending on the food system. In large urban settings, food supply chains may be long and complex: food is typically produced farther away, and more people are involved in the chain. In rural areas, food supply chains may be shorter: generally, farmers and food producers either eat the food directly or sell it in the local market.

The 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 (HLPE 12, 2017). It includes physical places, like stores or markets where people buy food but also social, economic, and cultural factors that underlie these interactions. Thereby, food availability and affordability; safety, quality, and convenience; and advertising are all part of the food environment. These characteristics affect diets by influencing the way people access foods.

Consumer behaviours 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). Those choice are mainly influenced by the food environment, by the availability and affordability but also by individual factor such as a person's economic status, thought process, dreams and aspirations, and overall life situation. For example, nutrition knowledge or environmental awareness affects what they purchase and eat, or home

environments can affect how much time people have to shop for and prepare food. These individual factors influence how people interact with their food environment and, ultimately, what they choose to buy and eat.

Food systems give rise to a variety of outcomes, not only from a nutritional and health point of view but also from an environmental, economic, and social one. Healthy diets are essential to prevent malnutrition in all its forms (undernutrition, micronutrient deficiencies, overweight and obesity). The demand for certain diets influences water and land use, biodiversity, and climate change. Agriculture and food production provide income and employment for millions of people, particularly smallholders and poor people in rural areas. A fair distribution of food and work could improve the health and economy of the most vulnerable by increasing social equity, which could have a positive impact on vulnerable groups such as those living in poverty, women, children, and smallholders.

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). There are several current and emerging interconnected socio- economic and environmental drivers impacting food and agricultural systems. Drivers may be endogenous and exogenous affecting in particular food access and livelihoods, food and agricultural production and distribution processes, and environmental systems.

Drivers can be grouped into four main groups according to their impact's context:

1. **Systemic / independent drivers:** these are drivers not directly dependent on the outcomes of the food system itself such as population dynamics and urbanisation, which in turn are expected to increase shifting food demand. This group also includes economic growth, structural and macro-economic transformation; Leadership and governance mechanisms which shape agri-food policies; Globalisation and trade which link agri-food systems globally; Big data generation, control use and ownership which enable real-time innovative technologies, connections, and communications in different fields, also in agriculture; Conflicts and humanitarian crisis which increase pressure in the world's most vulnerable areas; Cultures, religions, rituals and social traditions plus all unpredictable events.

2. **Drivers directly affecting food access and livelihoods:** these drivers refer to mainly social conditions that limit the possibility of equitable access to food as for instance the diffuse issue of rural and urban poverty. Other drivers include social inequalities mainly characterised by high income disproportionality and inequalities in employment opportunities, gender, access to goods, basic services, and unequal tax burden; Food prices and volatility which directly affect the quantity and quality of food consumed (e.g., sharper reductions in the prices of unhealthy foods than of healthy foods (Wiggins et al., 2015) are expected to increase the consumption of unhealthy foods).

3. **Drivers affecting food and agricultural production and distribution processes:** these drivers can directly influence positively or negatively the food supply chain. Among these are Innovation and science including more innovative technologies (including biotechnologies and digitalisation) or innovative production techniques such as agroecology, and conservation or organic agriculture; Public investments in agri-food systems; Production capabilities which are increasing due to mechanisation and digitalisation of production; Market concentration of food and agricultural inputs and outputs, posing a challenge to the resilience and equity of agri-food systems; Consumption and nutrition patterns, resulting from consumers behavioural changes.

4. **Drivers regarding environmental systems:** food production is heavily dependent on natural resources and ecosystem services therefore these drivers refer to those limits imposed by our planet like Scarcity and degradation of natural resources, including land, water, biodiversity and soil; Epidemics and ecosystem degradation caused by increasing trends of pests and plant diseases, by intensive agriculture and the growing production and consumption of animal products; Climate change, which is already affecting agri-food systems and is expected to exacerbate hunger and poverty in the most vulnerable areas; The loss of marine habitats caused by intensive fishing and waste from industrialised agriculture as well as excessive plastic consumption.

Drivers play a central role in identifying the main problems affecting food systems, highlighting the importance of finding systematic solutions given the high level of

interconnectedness between them. At the same time, drivers can represent opportunities and key elements to focus actions to achieve sustainable food systems.
Food systems could be considered 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” (FAO 2018).

This definition points out food security as one the main objective of food sustainability. According to the definition raised during the 1996 World Food Summit “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”.

This definition features six core dimensions:

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

Indeed, sustainable food systems embody qualities that support the six dimensions of food security. They aim at being productive and prosperous, to ensurethe 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. Healthy and nutritious, to ensure nutrient uptake and utilization. When food systems embody these qualities in an integrated, holistic way, they are more likely to support the realisation of the right to food and to meet the goals of the 2030 Agenda (HLPE 15, 2021).

1.2 Innovation, a major driver of food system change

As presented earlier, there are many drivers that impact the functionality of food systems and their ability to deliver healthy and sustainable diets (HLPE 12, 2017). This text will address the role of innovations in the transition to a sustainable food system.

According to the HLPE 12, innovation has been a major engine for food system transformation in the past decades and will be critical to address the needs of a rapidly growing population in a context of climate change and natural resource scarcity. Building more sustainable food systems to enhance FSN will require not only new research and new technologies, but also better access to and use of existing technologies and developing context-specific solutions that are adapted to local ecosystems and to local socio-economic and socio-cultural conditions. Furthermore, it is essential to consider the potential limits and risks of innovation and technologies to the various outcomes of food systems such as FSN, human health, cultures, livelihoods and the environment.

Innovation enables people to do all sorts of things differently than they used to do in the past. Its definition has shifted over the years from the concept of technological invention to the concept of bringing about a change that includes benefits and positive externalities in the environment or socio-economic context in which the innovation takes place. Past research on innovation in agriculture refers to Rogers (1962). Rogers characterised the different stages of innovation as successive phases involving different individuals: from innovators, early adopters and the late majority adopters to those adverse to change. This characterization assumes that innovation – taken as the adoption of externally introduced technologies – is always progress, that innovations are technology-based, and that they disrupt past ways of conducting business (Joly, 2018). Yet, it is becoming increasingly clear that many innovations in agriculture have generated significant negative externalities, so innovation in agriculture and food systems needs to address key social and environmental challenges in order to facilitate transitions to SFS (TEEB, 2018). Schumpeter in 1939 stated that “innovation is possible without anything we should identify as invention, and invention does not necessarily induce innovation” thus distinguishing innovation from research and invention. The World Bank (2010) further explains this distinction by defining innovation as “the dissemination of something new in a given context, not as something new in absolute terms“, so “what is not disseminated and used is not an innovation”.

In line with this school of thought, FAO (2016b) defined innovation, as “the process by which individuals or organizations master and implement the design and production of goods and services that are new to them, irrespective of whether they are new to their competitors, their country or the world”.

This definition indicates that there is a need not only to develop new technologies, market mechanisms or institutional arrangements (Klerkx and Leeuwis, 2009) but to close implementation gaps by making existing innovations more affordable, more accessible, especially for the poorest, and more adapted to different local conditions – whether political, social, cultural, economic or environmental (Wyckoff 2016; FAO, 2014b; HLPE, 2017a). Therefore, innovation should be seen also as a dynamic learning process, challenging and changing norms, practices and relationships, and generally requiring interactions between many actors and new institutional arrangements (Devaux et al., 2018).

Innovations in agriculture and food systems are distinct from those in many other sectors, because ecological relationships and social interactions have a central role (HLPE 14, 2019). The suitability of an agri-food innovation to local environmental and social conditions can be crucial, and thus local adaptations are an integral part of the innovation process. Actors in the food system (particularly smallholders) have an intimate knowledge of the landscapes in which they operate, a knowledge that is usually passed on from farmer to farmer or from professional to apprentice (van der Veen, 2010; Coudel et al., 2013). This means that agricultural innovation systems frequently rely on local knowledge and practices to ensure that they are adapted to the local context (Coe et al., 2019). In recognising the importance of adaptation, some authors of agri-food innovation systems have recently placed greater emphasis on locally generated innovation (Saravanan and Suchiradipta, 2017) and paid more attention to capacity building through multi-stakeholder processes, with a focus on innovations emerging from the grassroots (Loconto et al. 2017). While this does not devalue the importance of technological breakthroughs in the innovation process, such as the advent of smartphones or genetic engineering, it places emphasis on how and by whom they are used and incorporated into local contexts (Sinclair and Coe, 2019).

Indeed, innovations, and in particular food innovations, present an important paradigm since the introduction of a system-transforming innovations can trigger profound and

disruptive changes, leading to simultaneous and interlinked reconfigurations of multiple parts of the global food system with favourable consequences for some SDGs and unintended adverse side-effects for others (Herrero et al. 2021). For example, the introduction of new technologies, such as the use of small ovens to cook food and reduce the risks associated with eating raw fish in Kenya, may be obsolete in Europe. Or labour-saving technologies such as herbicides and agricultural mechanisation could eliminate important sources of income and employment for low-income and marginalised rural workers, thus threatening their FSN status. In contrast, agroecological approaches, which can be labour and knowledge-intensive, and which encourage experimentation, continuous learning and knowledge sharing among farmers, could provide more opportunities for decent work, especially for smallholders at the expense of large farms (Bezner Kerr et al., 2019). It is therefore crucial to identify the potential consequences and interactions of food system innovations in relation to the SDGs and the transition to SFS. Such information is useful for guiding investment and policy formulation and for coordinating action across the food system to improve human well-being while safeguarding our planet.

1.3 Food Innovations

Food innovation is an incredibly broad theme that has many facets and just as many perspectives from which it can be looked at. The main reason is because the food supply chain is extremely complex and requires the participation of different players with very specific and extremely diversified skills and roles. This means that for each phase and for each of these players there may be different technical innovations to be implemented that specifically affect various aspects of the final product. Food innovations range from food production, processing and distribution, land use and emissions, business models and social interactions to improved diets and waste management.

Based on the FAO (2016) definition, it appears that food innovation can cover processes as well as products and services, and thus the effects can extend along the entire food chain. Innovation has become a key issue in the debate on the relationship between agriculture and sustainability (FAO, 2012; EIP-AGRI, 2013; IPES-FOOD, 2015). In general, there is a broad consensus on the critical role of innovation in making agriculture not only more competitive but also sustainable. In fact, agricultural innovation is considered vital for addressing agricultural development challenges, adapting to climate change, and achieving food security (IAASTD, 2009). Modern innovations and techniques can strengthen food system resilience, improve resource efficiency in agriculture and ensure social equity, thus contributing to the achievement of sustainable food security (HLPE, 2017). The relationship between innovation and sustainability (including sustainability transitions) in the food system is more complicated than in other systems and sectors. Although more recent research on sustainability transitions has emphasised that innovations important for sustainability may be social rather than technological. Today, it is widely acknowledged that addressing sustainability challenges requires paying more attention to social innovations, actors and grassroots innovation processes (Moulaert, 2013; Loconto et al., 2017).

Given the impossibility of describing all innovations with a positive or negative impact on the transition to sustainable food systems, the HLPE 14 on Agroecology introduced the concept of "innovative approach" by defining it as “a well-articulated and widely practised set of principles, practices and methods that is intended to foster transitions towards more

sustainable food systems that enhance FSN and is set within an overarching philosophy and a strategic vision for the future". This definition highlights key principles of innovations to provide an overview of the characteristics that food innovations can display and deliver. In order to facilitate the reader's understanding of these principles, they have been divided into the subsets that make up food systems and the main factors that influence their outcomes (such as socio-economic aspects, the environment and consumer behaviour).

Starting from the supply chain, which includes the production, storage, processing and distribution stages, we can highlight all innovation which include the principle of regenerative production. By regenerative production is meant the use of natural processes in agricultural and food systems rather than their substitution with alternatives such as inputs that often involve the use of fossil fuels in their manufacture. It can enhance soil health through managing soil organic matter and biological activity, thereby regenerating the capacity of land to provide Ecosystem services. Recycling and efficiency, which embraces food systems management that promotes recycling with the aim of reducing dependence on purchased inputs and the risk or debt associated with their use, eliminates or reduces losses of key resources (such as biomass and nutrients) and can improve resource use efficiency and resilience. The principle of synergy, including the management of interactions and synergies between functionally different components of agro-ecosystems enabling the development of more efficient and resilient systems. Diversity, which aim at maintaining and enhance diversity of species and genetic resources and maintain biodiversity in the agroecosystem over time and space, at field, farm, and landscape scales. The focus on climate change adaptation and mitigation, designing and using agricultural practices that contribute to climate change adaptation and mitigation by improving livelihood resilience, as well as sequestering carbon and reducing greenhouse gas emissions.

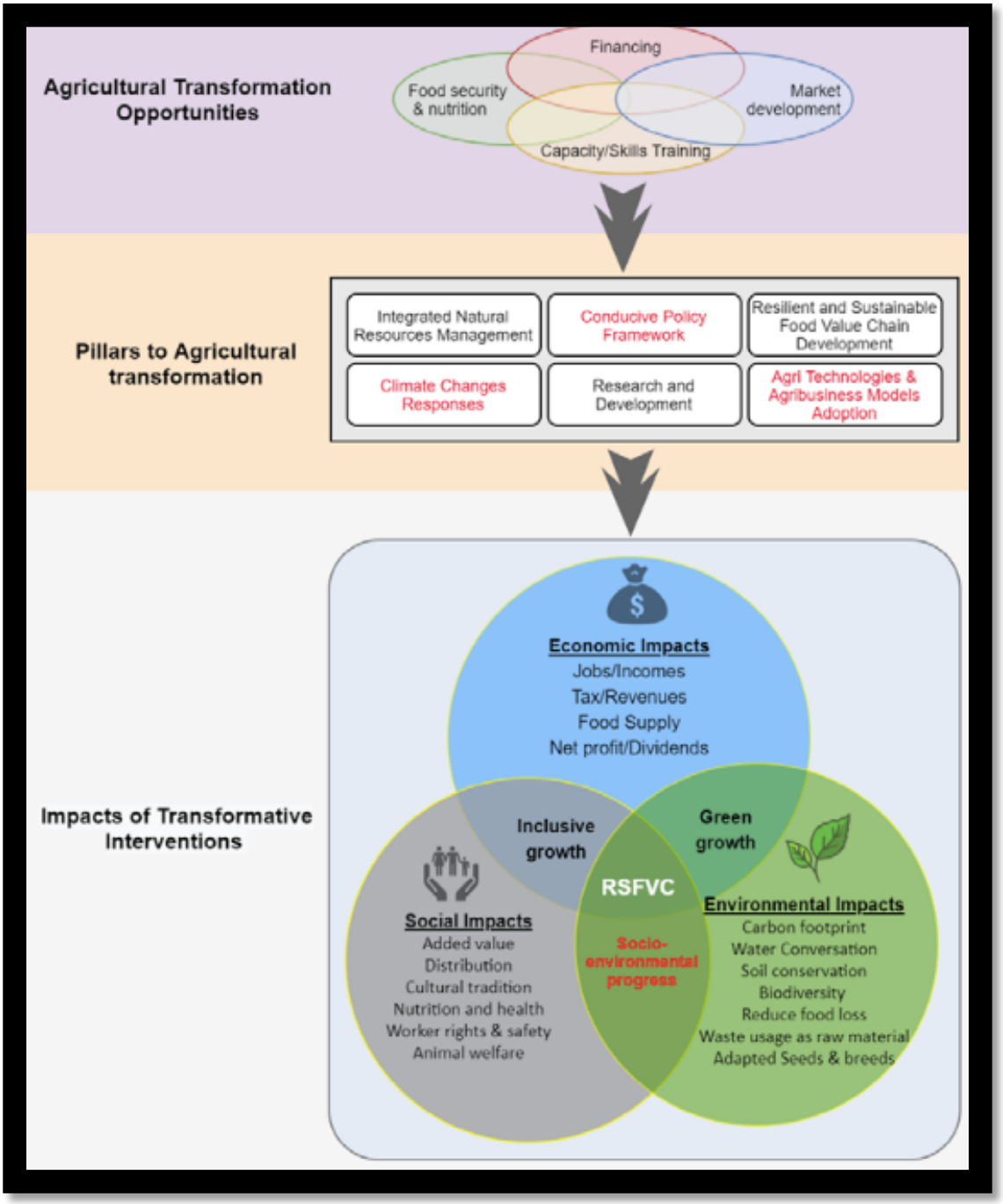

Figure 3 - Process of agricultural innovation impact on Resilient and Sustainable Food Value Chain (RSFVC) (Source: FAO, 2014)

From a socio-economic point of view, the principles proposed by HLPE 14 mainly focus on knowledge sharing, the importance of local culture, participation and empowerment. Among these principles are co-creation and horizontal knowledge sharing, including local and scientific knowledge and innovation. Experiential learning and knowledge sharing among practitioners and knowledge co-production between multi-stakeholder networks enhance legitimacy and generate innovation adapted to the local context. The cultural coherence to build food systems based on culture, identity, social and gender equity, innovation and knowledge, including healthy, diverse, seasonal and culturally appropriate diets for local communities and livelihoods. The principle of human and social values to support dignified and robust livelihoods for all actors engaged in food systems, especially small-scale food producers, based on fair trade, fair employment and fair treatment of intellectual property rights. The connectivity aiming at increasing the proximity and trust of producers and consumers. A better connection between producers and consumers through shorter supply chains, the reintegration of food systems into local economies and the encouragement of a circular economy leads to increased producer and consumer confidence in the quality and safety of food and reduced waste along food chains. Governance meaning recognising food as a basic human right while democratising[1] the process of innovation and control of food systems. Empowerment such as recognise and support the needs and interests of key stakeholders in food systems especially family farmers, smallholders and peasant food producers, and consumers. The principle of participation intended to encourage social organisation and greater participation of food producers and consumers in the functioning of food systems, with special measures to include marginalised groups. Alternative business models with the ability to incorporate environmental and social values to enable a decent livelihood without striving for profit and exploitation of resources (human, energy and environmental).

[1] Democratization of innovations promotes ways that communities of people can share information and knowledge across distributed networks and contributes to innovation most appropriate for local contexts (HLPE 14, 2019)

1.4 Modes and structures for scaling-up and disseminate innovations

In a system such as the food system, innovations are a fundamental resource of change. They can occur at policy level, through an innovative practice introduce by politics, in the market, for example through the use of a technological innovation, or in the civil society, though the experimentation of new relations and actions. This same tripartite conceptualization was mentioned by Richez-Battesti et al. (2012), who set out three ways of conceiving innovation, which correspond to the three main actors of governance who can implement it. Unfortunately, not all innovation can impact the food system. Most of them, loose their transformative power, remaining only alternative experiences.

Over the past decade, scaling up innovations to “achieve impact at scale” has garnered enormous interest among researchers, donor agencies and policymakers. These actors have embraced language around scaling as it relates to tackling climate change, food insecurity, and achieving the Sustainable Development Goals (Jonasova et al., 2012; Hartmann et al. 2013). In small agricultural and food systems, however, the adoption and impact of new innovations have been limited, and many agricultural technologies, particularly in sub-Saharan Africa, remain "on the shelf" (IAASTD, 2009; FARA, 2018). The causes can be traced to two main problems: on the one hand, low uptake of innovations is largely attributed to the design of technologies that are not compatible with or relevant to local socio-ecological systems and producers' capacities (Venot et al., 2017). On the other hand, proven innovations see low adoption because the actors implementing them have not sufficiently understood or effectively engaged in the scaling-up process. In fact, the contextual and relational factors that influence the diffusion or adoption of innovations, including economic incentives, policy objectives, and social learning, are often not adequately addressed.

In recent years, several scholars have drawn theoretical insights from multi-level perspective (MLP) to explain the dynamic interplays between different actors that help to facilitate scaling up processes in food and agriculture systems. The MLP theory proposed by Frank W. Geels in 2002 tries to explain the evolutionary pattern of technological transitions. He defines technological transitions (TT) as “long-term technological changes in the way societal functions/needs are fulfilled”, they happen in transportation, communication, housing, feeding sectors etc. and they follow particular evolutionary reconfiguration processes. Thus, transitions are not intended as changes in only

technology, but also in user practices, regulation, industrial networks, infrastructure, symbolical meaning or culture. The sociology of technology field, in which Geels' model fits, cannot consider technology separated from human agency. In fact, technology in itself has no power, only in combination with social structures and organizations it can be used and produce changes in society.

According to the World Bank (2004), "scaling up means expanding, adapting and sustaining successful policies, programs or projects in different places and over time to reach a greater number of people". This "expanding" trend is particularly evident in the agricultural sector. where experts are looking for new solutions to feed 9 billion people, reduce environmental and climate damage, and distribute economic development revenues more broadly and equitably (Hinrichs 2014). However, there are questions about how these objectives would be achieved considering the earth's planetary boundaries, social inequalities associated with accessing adequate and nutritious food, including the long-term marginalisation of small-scale food producers (IPES-Food 2016). Yet, transitions are about fundamental changes in the processes and structures that underlie socio-technological systems, that is, in ways that can facilitate investment and diffusion of innovations that meet development and sustainability challenges.

MLP is a well-established theory used to conceptualise transitions and is increasingly applied to the scaling up literature, but the complex interactive processes involved in MLP socio-technological transitions are comparable to how new innovations scale up (Hall et al. 2016). Most scaling up interventions begin with an idea that seeks to address a specific challenge, developed at an experimental field site. When this idea evolves into a product, technology or model, its innovators must build a network of supporters around it, consisting of end users, supply chains, policy makers and so on. Innovators therefore need to collaborate, support, negotiate or pressure these different actors to create space for their solution within the regime and, in the long run, influence the political and cultural perspective. Scaling up innovations, as well as transition processes in MLP, tend to focus on individual socio-technological systems. However, this approach pays less attention to the interconnections of multiple socio-technological systems, typical of food systems, and how they combine to form common directions in (globalized) economies, policies, cultural structures and everyday practices over time.

Lundvall (1985), followed by many authors, emphasises the importance of interactions between several actors and institutions in innovations implementation and diffusion. He

introduced the concept of 'innovation system' defining it as sets of interacting actors and institutions, or as human social networks that determine the innovative performance of a community, constituting the necessary resources for successful innovation". In relation to the transition of food systems towards sustainability, HLPE 14 (2012, pg. 54) considers innovation systems as "networks of organizations, communities, enterprises and individuals within which changes fostering transitions to SFS for FSN are generated and spread in the form of processes, forms of organization, dissemination of knowledge or bringing new products into use, together with the institutions and policies that affect their behaviour and performance". In addition to innovation system, the World Bank (2007) also recognises the importance of innovation platforms as a tool to 'bring together groups of individuals (often representing organisations) with different backgrounds, skills and interests - farmers, traders, food processors, researchers, government officials - and provide them with a space for learning, action and change'.

From the concept of "innovation system" and the relevance it places on the interaction among the actors that determine the performance of innovations emerges the concept of Multi-Actor approach. The MAA is part of the 'interactive innovation model' promoted by the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) which is defined as: "the collaboration between various actors to make best use of complementary types of knowledge (scientific, practical, organisational etc.) in view of co-creation and diffusion of solutions and opportunities ready to implement in practice." (EIP-AGRI Service Point, 2017, p. 3). This model is applied via a classical tool of EU policy implementation: project funding (Büttner and Leopold, 2016). Projects funded in the frame of the EIP-AGRI are required to apply the 'multi-actor approach' (MAA) and focus on real problems that farmers, foresters or other 'users' are facing.

Co-creating solutions and sharing knowledge between different actors that have complementary expertise are key to promoting innovation in agriculture and forestry (Feo et al. 2022). Through this approach, innovation becomes a nonlinear and iterative learning process with intense collaboration among different actors when solutions are co-created (Frow et al. 2015; Lundsgaarde and Keijzer 2019).

Indeed, collaboration offers the opportunity to share ideas and transform existing knowledge and research results into innovative solutions that can be more easily put into practice. The MAA represents the joint forces of actors in project activities from the ideation phase to the post-execution phase. In addition, according to Brunori et al. (2020) and

Schwarz et al. (2021), interaction and co-creation among actors are key elements of a transdisciplinary approach that has the potential to address future challenges in forestry and agri-food systems by helping actors themselves develop new skills and abilities.
MAA is implemented through different types of projects related to agriculture and forestry. In these projects, innovative ideas can be further developed into products and services by bringing together all relevant regional, national and international stakeholders (Van Oost et al. 2017). In addition, project users are directly involved in the process of developing the results. Through the transdisciplinary work of complementary actors, knowledge and solutions for everyday needs at the field level are created together with farmers and foresters (Contini et al. 2020). Therefore, the MAA not only ensures the active participation of project consortium members, but also connects external actors through the use of innovation platforms.
Although the EIP-AGRI approach is relatively new, having been implemented from 2013 onwards, results have already been widely studied. By contrast, systematic and comparative research on the multi-actor H2020 projects is scarce since the concept is not easily applicable due to a vast heterogeneity of actors and different ways of interaction in projects (Macken-Walsh 2019). Strategies for this approach have been developed over the years but still it remains a case-dependent concept. Therefore, there is still no uniform implementation model in which actors can follow specific guidelines .

MMA is the approach used in the implementation of the case study considered to answer the research question. Despite the limited information on its application, there are several projects that have applied this method providing different conceptual frameworks. In this context, my hypothesis is: *The MAA applied in the creation of an educational course in a specific socio-geographical context can foster capacity in developing innovative food products, processes and agri-business models as well as enhance capacity in food innovation towards sustainable food systems.*

The hypothesis formulated is based on the central role that education can play in the formulation, promotion and dissemination of innovations. Historical evidence indicates that the design of the educational process has significant consequences for the individuals engaged in innovative activities (W. J. Baumol, 2005). On the one hand, education provides technical competence and mastery of the analytical tools currently available to future

entrepreneurs and others who will engage in activities related to innovation. On the other hand, education can stimulate creativity and imagination and foster their use.

Education and raising public awareness about sustainable food systems using participatory and grassroots approaches is a key condition for food systems transformation (HLPE 14, 2019). Indeed, examples of successful "scaling out" of SFSs have often involved public awareness campaigns that have worked to change dominant narratives about the food system (FAO and INRA, 2018; Chappell, 2018) and community actions. Raising public awareness to enable and promote innovations in sustainable food systems through education can enable the involvement of citizens in "democratizing innovation"-sharing information and knowledge through networks, addressing social problems, and co-producing solutions among communities and researchers (Schot and Steinmueller, 2016).

Morevover, education and embedding community perspectives in policies (Benyam et al., 2018), as well as consumer awareness and standards-setting organization, could help people make healthy choices about available sustainable foods. Indeed, adequate education, training, and extension systems can improve the innovative capacity of the population and facilitate the articulation and implementation of innovative initiatives (World Bank, 2010; FAO, 2014b). Improving access to knowledge by small-scale food producers, particularly women, is critical to filling information, knowledge, and technology gaps to promote a systematic transition

Chapter 2: Multi-actor approach to develop a training course

We state here the hypotheses mentioned at the end of the previous chapter:

1) The MAA can be used to develop a training kit that foster capacity in developing innovative food products, process and agri-business models.
2) The innovative process collected in the training course can tackle real need, according to the local context, and that these innovations can support the transition to sustainable food systems.

To test these hypotheses, a methodology was constructed from a multi-actor approach applicable to the creation of a training manual. The methodology should highlight the interactions between actors from different backgrounds in the research and co-creation of the manual. Once applied, the processes used in the creation of the manual and the reasons for its creation will be analysed. The product delivered at the end of the process will then be presented among the results. Based on the selected innovations, their innovative value will be discussed using the literature reviewed in the previous chapter.

Building a methodology

Projects that apply the "multi-actor approach" focus on real problems or opportunities that farmers, foresters, or others in need of a solution ("end users") face. At the same time, partners with complementary types of knowledge (scientific, practical and other) join forces in project activities from beginning to end (EIP-AGRI 2020).

Within the EU, MAA has been analysed under two different conceptual frameworks, the LIAISON and the HEURAKNOS 2020. H2020LIAISON's conceptual framework (LIASON 2020, 2019) takes care to identify and define the processes involved both in the formation of partnerships and in the subsequent co-creation and dissemination of new ideas that have real application in agriculture, forestry, and rural development. The aim is to establish a robust basis for their empirical investigation and to identify relevant practical actions and policy interventions to facilitate and foster them. It relies on the optimising interactive process to make collaborative working practices more effective. This includes consolidating and building upon the consortium partners' own considerable experience of using participatory tools for co-creation and co-learning.

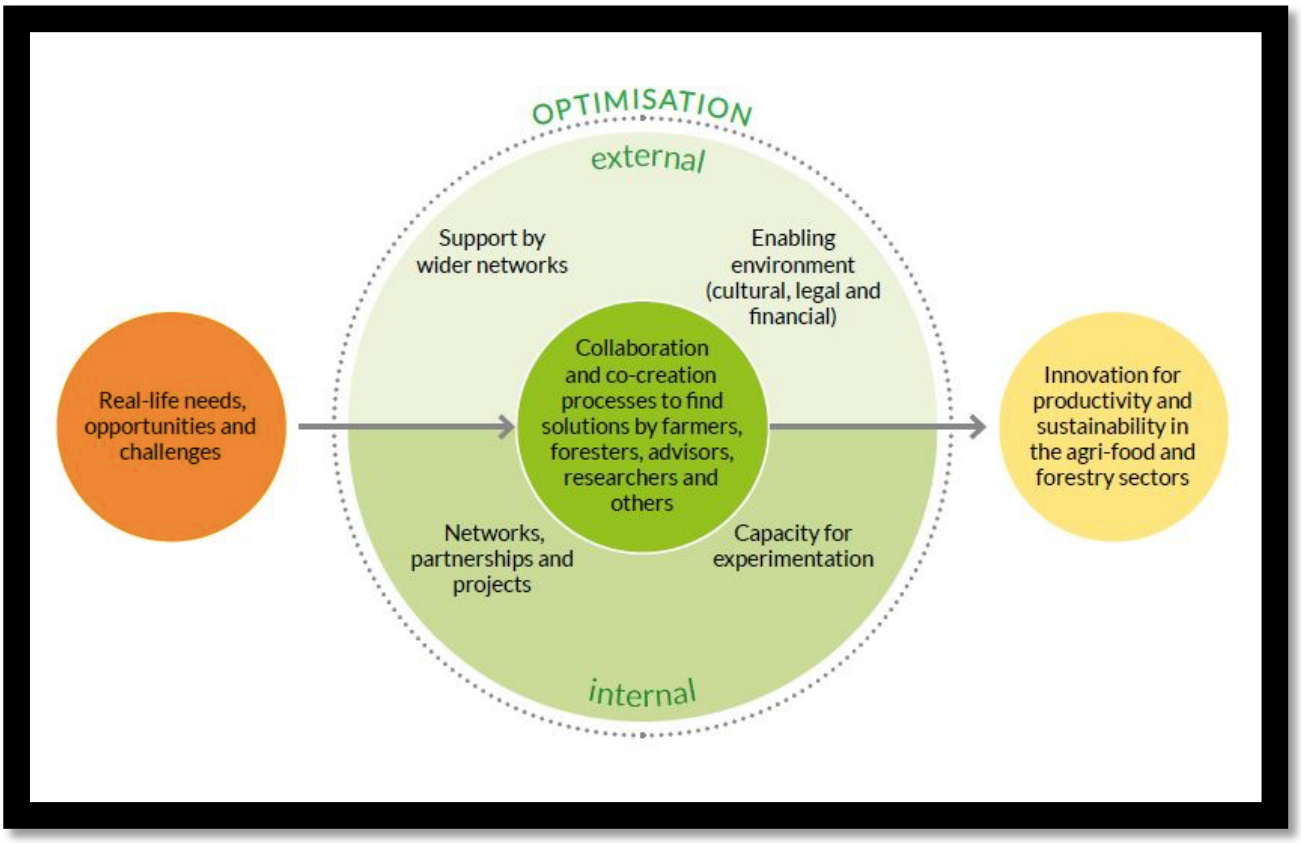

Figure 4 H2020 LIAISON's conceptual framework

On the other hand, the HEURAKNOS 2020 project stimulates the exchange of existing approaches, methodologies and tools between Thematic Networks (TN). TNs are considered as tools to put into practice and implements the MAA along with Operational Groups (OGs), Multi-Actor Projects (MAPs). TNs seek to disseminate existing knowledge and best practices in a given agricultural and forestry topic. Their goal is to share innovative ready-to-practice solutions in formats easily understood by users (e.g., farmers, foresters, and consultants). They also follow a bottom-up approach, taking into account the experiences of farmers and foresters and supporting them with scientific knowledge (Curry and Kirwan 2014). In addition, EURAKONS seeks a coordinated approach for the creation of future TNs to maximize MAA and the impact of TNs on their users. The project explores user needs and the possibility of creating a European open-source agricultural knowledge and innovation system that connects all TNs, enhancing knowledge exchange.

According to the EURAKNOS explorer's guide, in a TN, the MAA is implemented on two levels: The consortium level with the formation of a multi-actor TN involving all actors

relevant to the purpose of the TN, for example advisory, research, farmer and forestry organisations. The project implementation level where project activities revolve around working directly with users to co-create ready for practice knowledge to ensure uptake by users directly involved in the TN, and dissemination and exploitation of results to the wider farming and forestry community

The MMA in the context of the case study, relies on the tools provided in the EIP-AGRI since the project is part of Horizon2020. The methodology used lies between the two theoretical models by combining the concept of thematic networks and the innovative optimisation process in order to build a participatory training course.

Training has become an integral component of most development programmes, whether in areas of community health, improvement of agricultural production, social forestry or income generation. Both government and non-governmental organisations use training extensively in various forms, with varying and diverse impacts (PRIA, 2014).

Training has always been viewed as a learning process, learning of new skills, concepts and behaviour. It connotes a structured event, with boundaries of time, place and people. The conventional meaning of training has been the transfer of expertise from trainer to learner, where the trainer defines what a particular set of learners needs to learn. This approach assumes a unidirectional flow of knowledge from the trainer, who is the ‘expert’, to the learner. Learners play a passive role and are bound to learn what the trainer teaches. This training approach does not allow learners to participate actively and gives the trainer total control over the process. Everything in this type of training, from defining the objectives to evaluating the learner, is done by the trainer. Therefore, this conventional approach to training is very close to formal education or schooling.

In response to the unidirectionality of conventional training approaches, alternative approaches to training developed in the second half of the 20th century (Freire, 1989). In this alternative view, training is not limited to "transferring skills" or "imparting knowledge”. Rather, it is seen as a process of growth and discovery, aimed at changing behaviours. The focus is on building one's critical consciousness, examining one's values, attitudes and orientation, questioning, rethinking, and relearning. This alternative view of training is also known as ‘training for change’. Learners are encouraged to voice their own ideas, explore ways to solve their problems, and investigate their own reality based on their experiences. Its methodology is learner-centred, experience-based and open-ended.

Developing a training kit through a multi-Actor approach

The T-kit "Training kit for innovative food product and process development" realised within the HealthyFoodAfrica project represents the collective effort of local stakeholders, international researchers, and private partners through a multi actor approach.

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 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 T-kit is essentially 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. And it represents the scientific framework for the organisation of the in-presence and online summer school (2022-2023). The content of the T-Kit is structured into 4 main themes that move from the fundamental principles and thoughts on sustainability to concrete analysis of innovative food products and business models. The core thematic network focuses on food sustainability.

The main partners involved were 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 expected outcome is to boost 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. Moreover, the specific 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. Furthermore, the T-kit

proposes a type of training that differs from the typical unidirectionality of conventional training approaches. In fact, it promotes an alternative view of training, also known as "training for change", which aims at fostering critical discussions among participants, analysing past real cases and avoiding any expectation of final outcome by making the learning process open-ended.

Project overview

HealthyFoodAfrica (HFA) is a research & innovation project aiming at more sustainable, equitable and resilient food systems in 10 African cities. The project is a collaborative effort by 17 partners in Europe and Africa, funded by the European Union Horizon2020 programme and will be implemented in the period between June 2021 and December 2023. The overall goal of 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. In order to maximise sustainable impact, attention will be paid to extracting and disseminating lessons learnt, capacity building, and the factors and policies that enable promising and scalable governance arrangements, technologies and business models.

Using an interactive, multi-actor approach, the project work with 10 Food System Labs (FSLs) in East, West and Southern Africa. Each FSL will bring together social entrepreneurs, farmers, activists, businesses and policy makers to tackle specific challenges in the local food system.

The ambition is to facilitate and support joint action across entire food chains – that is from the producer to the consumer aiming to make city-region food systems more sustainable, inclusive and resilient, while simultaneously improving their dietary performance and the nutritional status of rural and urban people. Attention is paid to improving the sustainability and resilience of food production systems, and providing new livelihood opportunities for farmers, in particular smallholders, and small food enterprises, improving the governance and efficiency of food chains; and strengthening consumer awareness of food and dietary diversity.

HFA project operates with specific working groups to target interrelated specific objectives which can be summarised as:

• Foster an equitable multi-stakeholder approach to transformations in local food systems, through a structured participatory, transdisciplinary, co-creating and co-learning process.
• Improve nutrition and mainstream healthy dietary patterns through increased awareness and rapid but sustainable transformation of consumption habits.
• Promote sustainable production of healthy and nutritious food products through resource-efficient, climate-resilient production systems – including crop, aquaculture and integrated systems.
• Increase the efficiency of agri-food chains and improve food safety, through the development of innovative post-harvest innovations, new technologies and the minimisation of food waste.
• Create more equitable and sustainable agri-food chains through innovative governance arrangements which strengthen the links between and empower local food chain actors in providing consumers with sustainable, healthy, nutritious and affordable food products.
• Foster innovation in novel, sustainable and nutritious food products and test associated tools and processes, including the use of local under-utilised agro-biodiversity.
• Maximise sustainable impact by kick-starting a self-propelling process leading to wider uptake of enabling, promising and scalable approaches, technologies, business models and policies in Africa.

Food System Labs as spaces for experimentation and innovation

As we have seen above, an MAA can be applied at different levels, resulting in the formation of a multi actor thematic network involving all actors relevant to the project's purpose. Likewise, Food System Labs bring together social entrepreneurs, farmers, activists, businesses and policy makers to tackle specific challenges in the local food system.
HealthyFoodAfrica is based on 10 localised FSLs covering a broad spectrum of food systems and contexts in East, West, and Southern Africa. Together they represent a spatial, structural, institutional, socio-cultural, and economic diversity of food systems in Africa. They provide unique local knowledge and expertise as well as a space for experimentation,

innovation, transformation, application of knowledge, co-learning and the formation of new, collective insights. Each FSL focuses on reconnecting sustainable food production with (urban) food consumption, healthy eating, and related local food system challenges to promote sustainable food systems. All FSLs are led by local partners, while researchers (local and international) play a supporting and facilitating role.

FSL's focus, challenges and specific contribution are briefly summarised in this table:

FSL focus	**Challenges and emerging priorities of FSL**	**Specific contribution**
FSL-Ki | Kisumu, Kisumu County, W. Kenya, Lead: Bioversity *Enhancing leafy vegetables and fish value chains for diverse, safe, nutritious and affordable food for urban poor*	Effects of monotonous and nutrient poor diets of many urban dwellers. Fish and leafy vegetable production will be supported and the awareness and capacity of both farmers and consumers improved through targeted training for outreach workers and policymakers.	Training materials and policy briefs on the importance of nutritious food; model for training-of- trainers that bridges the rural-urban divide.
FSL-Ta | Tamale, N. Ghana, Lead: NRFA *Awareness raising for improved child nutrition and innovative food products*	Specific challenges of dry areas, with only one cropping season. Particular attention will be paid to high-value products from fruit trees. FSL-Ta will specifically work with schools and raise awareness and empowerment of school children through youth ambassadors.	New high-value products from fruit trees. Development of a youth-ambassador approach for awareness raising and transformation of dietary patterns.
FSL-Ac | Accra, Greater Accra Region, S. Ghana, Lead: CSIR *Enhancing use of fish as part of a healthy diet & agri-food chain development*	Food safety and efficiency in fish production in and around Accra. In order to provide healthy protein rich foods to improve local diets, new processing and post-harvest options will be developed and evaluated	A range of new processing methods for fish, including smoking, rapid freezing, vacuum packing, extrusion cooking.

To ensure diversity in the selection of FSLs, these criteria were used: Characteristics of the main actor/initiative, e.g., CSO, farmers' association, processor, retailer; Apparent innovativeness of the initiative and potential for learning; Coverage in terms of geographic, governance, economic, environmental and social conditions. FSLs involved in the realisation of the training kit are the one of Kisumu (Kenya) and two from Ghana, Tamale and Accra.

Geographical context

The analysis of the geographical context is based on research conducted by D. Alpizar in the preparatory stages for the development of the training course gathered in the “Report on opportunities in food products and processes: an analysis of innovative alternatives in Ghana and Kenya using a Food System Framework”. The report was produced in collaboration with local stakeholders and by means of the sustainable food system framework (HLPE 15, 2021), presented in the first chapter, to investigate the trends, diets and agri-food chains of food systems in Ghana and Kenya. It employs a set of indicators linked to the main subsets of the framework (e.g., indicators that provide information on drivers, diets, and food supply chain) obtained mainly from open data sources such as FAOSTAT, data from the World Bank, Eurostat, UNICEF Division of Data Research, and Policy, and Economist Intelligence Unit.

Ghana

According to Ghana's National Bureau of Statistics, the country's population in 2019 was about 31.3 million. About 56.6 percent of the total population now lives in an urban setting. Ghana has one of the highest urban growth rates in West Africa, where, on average, 46 % of the population lives in urban areas. Migration from rural to urban areas is growing at a rapid rate as most of the workers who have moved out of low-productivity agriculture are moving into low-productivity informal services, usually in urban or peri-urban areas. With rural areas neglected and a high concentration of the poor, people are forced to migrate to cities in search of work. This has led to excessive and unplanned

urbanization, keeping poverty levels high in both areas, and in some cases, migration can increase poverty levels (Somanje et al., 2020).

Biophysical and environmental drivers: In Ghana agriculture is the main source of income. The contribution of agriculture to the national GDP is on average 21.2% according to the 2019 budget. The agricultural sector employs more than half of the total labour force. 51% of the labour force are women and 49% are men. 44% of the total cultivable land, which is estimated to be 69% of the total land size, is used for crop production. Agriculture is mainly produced by small farmers who cultivate an average of 1.2 ha each and their efforts represent 80% of agricultural activities.

Agriculture uses around 69% of the total land of the country according to the World Bank (2020), and the largest increases in agricultural land use can be seen in the northeast, east central, and southwestern regions of Ghana. However, the urbanization rates are high and this creates competition between agricultural, residential and commercial land usage (Appiah et al., 2019). The tendency to transform agricultural lands into other land use is mainly due to higher potential profitability.

Lake Volta is the largest inland reservoir and the largest man-made reservoir in the world. In addition to generating an important amount of electricity for Ghana and for export, it is a source of income and food for local families, who obtain fish from the lake (Kumi, 2017). About 58,000 people or 0.22% of Ghana's population of 26,4 million are actively engaged in aquaculture as an economic activity providing livelihood activities for many along the value chain. Further, fish notably accounts for as much as 60 percent of animal protein in the average Ghanaian diet, and 22.4% of household food expenditures.

In Ghana CO2 gases represent 64.7% of total emissions (NIR/UN Environment, 2019). Total emissions increased by 22.49% in Ghana from 2009 to 2017. Land use change is the main contributor to these emissions with 30.5 percent, followed by agricultural activities with 23.8 percent (FAOSTAT, 2020), and livestock is the main contributor to total agricultural activities in Ghana.

Tech and infrastructure trends: Internet service in Ghana is among the best in Africa, but rural communities still lack access to the internet. There are around 19 million mobile subscribers which represent 67% of the population in 2018 (Hatt et al., 2017). Regarding agricultural infrastructure, Ghana has a greater ability to store crops and good

transportation to markets compared to the Western African Region, according to the Agricultural infrastructure index Score. However, in some remote areas of Ghana, food access is constrained by limited infrastructure, and this is reflected by losses in cereals and vegetables.

Economic trends: Prices of goods and services have increased over the past 10 years. The cost of agricultural inputs, such as fertilizer, has also increased over the past 5 years in Ghana, which could mean that rising food prices may stem from agricultural input prices, as agricultural wages as a factor of production have not increased significantly since 2015. For 2019, households in Ghana spent an average of 50 percent of their income on food, and a steady increase in food prices puts food security and nutrition at risk.

Politics and institutional trends: Ghana's government is expected to invest in innovation and technologies in Agriculture. An amount of GH¢ 2,051,675 will be destined on conducting on-farm research on low cost, appropriate technologies, and developing/delivering these technologies as packages, researching into improved crop varieties and breeding stock and feedstuffs, and developing new food products and equipment for 2020 (MOFA, 2019). At the national policy level, several programs have been implemented in recent years being part Agenda for Jobs: Creating Prosperity and Equal Opportunity for All (2018 - 2024). The main objectives are to secure more public investment, improve production efficiency and yield, improve post-harvest management, enhance the application of science, technology and innovation, promote agriculture as a profitable activity among young people, and promote livestock and poultry development for food security and income generation. Moreover, there are traditional forms of cooperation among small scale farmers based on solidarity that constitute an essential role in local development.

Sociocultural trends: Ghana's Human Development Index value in 2018 was 0.596— which puts the country in the middle of the human development category— positioning it at 142 out of 189 countries and territories. Between 1990 and 2018, Ghana's HDI value increased from 0.454 to 0.596. In this period life expectancy at birth increased by 7.0 years, mean years of schooling increased by 2.3 years, and expected years of schooling increased by 3.9 years.

The Gender Inequality Index (GII) reflects gender-based disadvantage in three dimensions: reproductive health, empowerment, and employment. From 2016 to 2017, the GII coefficient in Ghana decreased from 0.6 to 0.5, but still this ratio is still very high when compared to the global ratio. Moreover, participation in decisions about cultivation, agricultural earnings, and agricultural workload is generally unequal. (Yokying & Lambrecht, 2019). About 80 % of the land in Ghana is controlled by the traditional lineage or clan head. Most women, especially those in patrilineal groups, do not inherit their fathers' land because their families do not want the land transferred to another family upon marriage (Boakye-Yiadom, 2011).

Kenya

The population of Kenya was approximately 52.5 million in 2019 according to the World Bank (2019), with an annual population growth of 2.3%. The majority of the population lives in rural areas, with only 27% of the total population living in an urban context. In recent years, the phenomenon of migration from rural areas to cities has become more pronounced especially between the ages of 18 and 40. Of this percentage, 62.5 percent are male migrants between the ages of 15 and 29 and 25 percent are female migrants in the same age group (AMADPOC, 2012). The main reason for young people to migrate from rural to urban areas is the need to find work and education.

Biophysical and environmental drivers: The agricultural sector in Kenya engages over 40% of the total population, 70% of which is rural and 18% in formal employment. Agriculture covers around 48.5% of the total land of the country according to the World Bank (2020). However, pressure on agricultural land arises as soil fertility declines, causing low yields by continuous cropping, soil erosion, non-use, or inadequate use of organic and

inorganic fertilizers . In Kenya agriculture is the main contributor to greenhouse emissions with an estimated in 2018 of 62.8% of total emission, followed by the energy sector (31.2%), industrial processes sector (4.6%), and waste sector (1.4%) (FAOSTAT, 2020). In agriculture, the main contributor to greenhouses are burning savannas, which represents 51.2% on average from 1990 to 2017 of the total agricultural share (FAOSTAT, 2020).
In 2016 the forest cover was 4413 thousand hectares and represents 7.8% of the total land in Kenya. Kenya's forests have great biodiversity and are important at a global scale since they host 1847 species of amphibians, birds, mammals, and reptiles of which 4% are only found in Kenya.
Kenya has 1123 thousand hectares of inland water. Lake Turkana is the largest (300 Km long and 50 Km wide) and a part of Lake Victoria is located in Kenya. Fishery is mainly held in Lake Victoria and accounts for 96 - 97% of annual national total production for capture fisheries. The total capture fisheries production was 171,391 metric tons for 2018 (FAO, 2020).

Tech and infrastructure trends: In Kenya, many efforts have been made to introduce innovations in technologies that improve yields and thus increase productivity. The Innovation Platform for Technology Adoption (IPTA) is a forum for stakeholders with the common goal of creating, disseminating, and improving agricultural production and services through constraint analysis and intervention planning using a value chain approach. It generally includes representatives of farmers and farmer organizations, extension services, agro-processors, traders, agribusinesses, transporters, and research (ASACARECA, 2014). Efforts are mainly aimed at increasing production, resulting in increased food and nutrition security. However, the main challenges include lack of technical expertise, governance, and leadership challenges (Makini et al, 2016).
Regarding agricultural infrastructure, Kenya has a lesser ability to store crops and transport to markets than the average from the Eastern African Region, according to the Agricultural infrastructure indexScore. The main cause is the limited infrastructure to transform perishable food into more durable products through refrigeration, shorten the time in transportation and use of packages that make products more durable.
Kenya is the leader in Internet penetration in Africa, with a total penetration of 86 percent in 2017, and is ranked as one of the most innovative countries in Africa (Harry Derksen, 2018). The number of mobile phone subscriptions in Kenya was 55.2 million as of March

2020, and 8.4 percent of the adult population has computer access, according to data from the Kenya National Bureau of Statistics.

Economic trends: Policies in Kenya support producer prices as Kenyan maize prices are higher than those in neighbouring countries due to prolonged drought, pest infections, and uncertainties in maize production. Moreover, the government subsidizes fertilizer, but small farmers have great difficulty accessing this commodity. Poor connectivity with rural areas limits the access to government depots, translating into additional production costs. In addition, the quantities needed are often not large enough to incentivize the purchase of subsidized fertilizer.

Kenya imports approximately 75% of the rice and wheat consumed, therefore it relies on the stock and international market of these staple foods. Export and import policies often discourage domestic production because the price of imported products is lower than that of domestic production.

Political trends: The Kenyan government has a medium-term investment plan to improve the agricultural sector through innovation. Kenya's National Agriculture Investment Plan (NAIP) for 2019-2024 is a five-year investment plan that accompanies the country's 10-year Agricultural Sector Transformation and Growth Strategy (ASTGS). In this plan, the government has emphasized the importance of agriculture by focusing on the importance of 100 percent food and nutrition security for all Kenyans. The plan includes an Increase small-scale farmer income, increase agricultural output and value addition and boost household food resilience. The implementation of this national plan involves various ministries, research centres, and non-governmental organizations.

The number of agricultural institutions has increased over time in Kenya, as well as investment and expenditure in agricultural innovation from the government. Nonetheless, innovation has not been sufficient to maintain high levels of annual growth in crop yields nor to conduct research in climate resilient agriculture (EF, FARA, KALRO. 2018).

Sociocultural trends: Kenya’s HDI value for 2018 is 0.579— which puts the country in the middle of the human development category— positioning it at 147 out of 189 countries and territories. Between 1990 and 2018, Kenya’s HDI value increased from 0.467 to 0.579, an increase of 23.9%. Between 1990 and 2018, Kenya’s life expectancy at birth increased by 8.9 years, mean years of schooling increased by 2.8 years, and expected years of schooling

increased by 2.0 years. Kenya's GNI per capita increased by about 34.7% between 1990 and 2018 (UNDP, 2019b).

The Gender Inequality Index (GII) in Kenya for 2018 was 0.545. This score is better than in Sub- Saharan Africa where the average is 0.573 (UNDP, 2019a). In Kenya, 23.3 percent of parliamentary seats are held by women, and 29.8 percent of adult women have reached at least a secondary level of education compared to 37.3 percent of their male counterparts.

Methodology

The methodology captures the entire process of creating and developing the training programme. It includes the meetings with stakeholders and project partners where knowledge sharing, and co-learning and co-creation processes took place. The processes that led to the choice of topics to be covered and the space dedicated to each of them members such as the choice of audience and venue. The processes that led to the choice of the activities to be developed, the exercises presented, the case studies presented and so on. Finally, the preparation of the summer school to be implemented in the summers of 2022/2023.

A series of major phases and activities took place for the realisation of the training kit:

- Desktop study of the main documents and reports related to food innovations and food sustainability mainly published by FAO (HLPE), WFP and WB.
- Brainstorming activities to choose the main topics to be addressed, provide guidelines, choose the type of training methods and case studies.
- Bilateral meetings with each partner to define content, degree of participation, availability of resources to realise the training kit. Plus, the audience and location of the summer school.
- Webinars with all partners also from different working groups to obtain feedback or find new partners interested in collaborating.
- Collection of all materials from the various partners and drafting of the document.
- Presentation of the draft and final discussion.
- Delivery of the complete training kit.

Tools used

"Zoom meeting" and "Microsoft teams" were the platforms used to conduct the meetings and webinars among stakeholders. "Microsoft word" was the platform that enabled a shared document drafting. The use of a leaving document, formally a report in which all the information from the meetings were collected through the recordings and notes produced during the meetings. In addition, a 'cloud' was used to enable the constant exchange of materials and information among partners.

Learning practices

Transdisciplinary approach: actors with different expertise and backgrounds participated in the realisation of the training kit. Participants include research institutes and universities, NGOs, farmers' associations and small and medium-sized enterprises from the target countries where the research and innovation activities will take place. Each FSI will reach out to other actors as needed, including, for example, policy makers, experts in local or thematic contexts, local residents and institutions, etc. Research partners in Europe will support the LFS by providing expertise and experience related to the functioning and transformation of food systems according to the objective.

Adaptive co-management: in this type of management, responsibilities are distributed among the participants, along with the decision-making process. It seeks to build trust, strengthen ownership and continuous learning.

Co-creation: Co-creation is a process by which ideas and solutions are developed collaboratively. It is the mechanism for creating sustainable solutions to real problems with the participation all partners involved. The process starts by ordering and grouping together ideas by thematic similarity, and it combine practical and research knowledge to elaborate new actionable pathways for particular initiative. It also represents a strategy to engage stakeholders since it promotes the sharing and interaction of information through the project's communication channels, or through an internal platform.

Co-learning: it is an innovative collaborative learning approach that brings people together who face common challenges to systematically share and adapt knowledge and produce new ideas that enable them to successfully tackle practical yet complex issues and achieve their goals. Co-learning goes beyond the static exchange of information between peers, providing a structured learning process in which priorities are defined and then solutions to common challenges are developed together. Co-learning involves personal workshops and virtual exchanges where actors exchange experiences and work to develop practical tools and knowledge products together. This leads to greater appropriation and adoption of knowledge and best practices by those who have participated in the process.

Partners involved

In a multi-actor approach, the process of co-creating and sharing knowledge takes place between different types of actors with complementary competences. The partners involved in the creation of the training kit were mainly local representatives, researchers and academics. The division of tasks was done based on the grant agreement signed at the beginning of the project and on the basis of brainstorming meetings in which the partners expressed their willingness to participate in a preliminary form.

The table summarise the partners involved and their expertise:

Institute	**Actors**	**Expertise / Role**
FSL of Accra (Ghana) The Council for Scientific and Industrial Research (CSIR)	Amy Atter Seth Koranteng Agyakwah Stephen Nketia	Representant of the FSL. Development-oriented Fisheries and Aquaculture research scientist. Food microbiology researcher scientist.
FSL of Kisumu (Kenya) The Alliance of Bioversity International and CIAT (Bioversity) Kenya regional office	Robert Ouko Christine Chege	Representant of the FSL. Agricultural biodiversity, healthy diets, nutrition, and drivers of food choice. Rural development
FSL of Tamale (Ghana) The Northern Region Farmers Association (NRFA).	Mohammed Adam Nashiru Victor Yakubu,	Representant of the FSL. Agricultural policies. Agri-food business
Luke Research Institute (LUKE)	Galyna Medyna	LCA and sustainability assessment specialist. Actor in charge of ensuring the consistency of the training kit with the HelathyFoodAfrica guidelines.
The University of Helsinki (UH)	Hanna Koivula Zahra Safaei	Post-harvest techniques and practices, food processing and food safety, food waste and food losses.
Böna Factory	Sara Ahlberg	Private partner. Start-up, founded by food technologists and scientist with extensive knowledge from food safety, quality, processing, industry, nutrition, product development, innovation, consumer behaviour, branding and concept development.
The University of Pisa (UNIPI), Mediterranean Agronomic Institute of Montpellier (CIHEAM-IAMM)	Gianluca Brunori Paolo Prosperi Daniel Alpizar Arturo Di Gianni	Food sustainability. Food systems. Business environment and agri-food policies.

Brainstorming activities

Once the project partners and actors had been defined, a series of brainstorming meetings were held to discuss the main issues related to the training course. In this phase all partners participated simultaneously through the online platform designed. It is important to remember that the training course consists of two main parts, the training kit (theoretical part) and the summer school (practical part).

These activities had no specific structure, preferring a flexible approach to encourage the exchange of ideas without any degree of priority. Nevertheless, the lead actor provided a set of themes consistent with the objectives of the HealthyFoodAfrica project, thus identifying a central theme, food sustainability. Starting from this theme, the various partners cooperated to identify the most relevant issues according to the geographical context (Ghana and Kenya region), the existing needs of local communities and consequently the opportunities for the development of food innovations.

On the side of the training kit, the main topics discussed were the theoretical elements to be included in the document, the distribution of these in percentages, provide definitions to ensure a common background and address the concept of innovations seeking to answer the question " How can we foster innovation with this training kit?".

On the side of the summer school the best location to host the summer school, the type of audience that could participate as well as the degree of involvement of local entrepreneurs as direct beneficiaries of the course or invited to share their experience to promote the discussion.

For instance, the first challenge was to define the scope of the training kit, the contents and to understand the strategies to engage students and local entrepreneurs in the development of innovative products. Once the objectives and core themes were established with all partners, the phase of bilateral meetings began in order to collect everyone's views and ensure a full participation.

Bilateral meetings

The bilateral meetings were a series of forums where UNIPI and IAMM (the partners in charge of keeping track of each progress and facilitating the collaboration of all actors) met each partner individually to deepen the discussion started during the brainstorming activity. The aim was to create a favourable environment for the exchange of visions and to trigger debates on these key points: topics to be included in the training kit, possibility of providing help and resources (time and knowledge), willingness to participate, limiting factors, possible problems that may arise, ways of implementing the summer school (reference to audience and location).

Each meeting was structured according to the topics discussed during the brainstorming activity. 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. A report was produced after each meeting to keep track of and collect all the topics discussed, updates and proposals along with participants' ideas and perspectives with the aim to create a comprehensive and mutual outcome.

Bilateral meetings represented the key method to foster open participation and to enable a deeper understanding on the need for training (students and young entrepreneurs) about sustainable food systems as well as on the needs of the FSLs and the commitment of the partners. They have been instrumental in defining the willingness to contribute and the modalities for doing so. In fact, the degree of participation was at the discretion of the partner: this could vary from attending only the meetings and providing feedback, to providing inputs, providing resources, taking over the development of a chapter, providing case studies, developing dedicated materials, and so on. Clarifying responsibilities in the development of individual tasks can be crucial for partners empowerment and ensuring accountability.

Webinar

On a monthly basis, the stakeholder consortium met to monitor and discuss their progress. These meetings consisted of a power point presentation by the stakeholder who wanted to bring attention to specific topics related to food sustainability (gender issues, added value, food security, ...). After the presentation, a wide debate followed in which

advancement, critical points and limitations were addressed or to assist with complementary information. Monthly meetings were crucial to stimulate partners accountability for task accomplishment and to enable the confrontation with the rest of the group, thus fostering co-learning and co-creation process.
The process of training kit design ended through a long process of documents merging (single chapters, insights, case studies, exercises, etc.) into a single, harmonious final output. The results will be presented in the next section.

Innovative product identification

One of the sated objectives of the T-kit was to develop innovative products that could then be scaled-up in other FSLs. For this reason, a extended research and selection process was conducted, which led to the identification of a single product (Fruity soy pancake) further processed and integrated in the T-Kit.

The main steps:

- Identify basic products to use according to local trends; The key objective was the research and development of sustainable ready-to-eat products. To understand which products to develop, trends in the areas in which the 3 FSLs operate were analysed (raw materials available and identification of the main needs to be met)Invite key stakeholders and organise a workshop
- Introduce project background to contextualise the product's purpose
- Engage stakeholders by stimulating the exchange of views. Participation in the workshop extended to all stakeholders involved (politicians, private agencies, inspection and certification bodies, local researchers, etc.)
- Propose a draft with the products which can be developed (45 products). The products for presentation purposes were developed in theoretical form, it was not possible to physically test all 45 products for economic reasons
- Collect feedback from participants. Encourage discussion and gather results
- Develop the most promising products and carry out sensory analysis and optimisation. Once three products had been identified, it was possible to physically realise them and submit them to the optimisation process.

- The three products were then submitted to the T-kit participants who, through an online forum, chose the product they considered most significant.

Limitations

The methodology encounters some limitations in its design and implementation phases. Indeed, there are no clear results related to the use of the multi actor approach for the development of a training manual. Research on this subject is scarce, and the implementation of this approach is mainly described for other types of processes such as the development of a project. Consequently, the methodology is based on the principles of the MA approach and not on a defined and stated model.
From the point of view of utilization, several limitations may arise: transdisciplinarity and diversity of partners imply considerable mediation activities. All of them have different forms of knowledge (practical, scientific, policy based, etc.) and there is the need to create conditions for interaction between them and combine their knowledge, perspectives, resources, and experiences, to identify and discuss solutions and new ideas. Ensuring the active participation of all partners is a great challenge, especially when the strategy involves co-creating a document that aims to meet everyone's concerns and needs. It is necessary to use specific tools to stimulate participants' interest. These strategy and actions must be clearly stated at the beginning of the process to prevent the degree of participation from declining along the project stages.

In addition, technical problems may influence the results. For instance, the meetings were mainly conducted through Internet platforms, encountering several problems related to the stability of the connection. In particular, it has been challenging to interact with the FSL in Tamale, due to insufficient IT infrastructure. Meeting schedules must also be carefully planned when the work involves international partners. Indeed, accessible times must be found to accommodate every partner, despite the time zone. In the case of the training kit, no language-related communication problems emerged, but in different contexts a translator may be needed.

Result and findings

The main result of the process was the execution of the training kit "Training kit for innovative food product and process development " published in January 2022. The results related to the implementation of the summer school will not be analysed as the methodology and lectures were realised in the post-internship period (February-June 2022). In fact, the methodology explained above mainly refers to the realisation of the training manual, which will then be used as a framework for the implementation of the summer school. However, in the various meetings and interviews that were held, information was gathered, and opinions were exchanged regarding the two outcomes for a matter of efficiency.

As presented earlier, the realisation of the training course followed several phases that brought different results, which represent the development pathway by means of the co-learning, co-creation, interdisciplinary and co-management practices.

Content structure and main objectives

The brainstorming activity led to the selection of the main themes and guidelines according to common agreement of the partners.

The guidelines concerned the learning approach which follows the principle of participatory training (such as in the case of the summer school) and the case study method. According to FAO, participatory training is “an interactive learning process enabling individuals and communities to develop skills, knowledge and attitudes, and to share lessons learnt, so that they actively contribute to food security and poverty alleviation”. Learners are regarded as active participants in the educational process. Their needs and questions, reflection, analysis and strategies for change carry the process forward. Participatory training thus holds an implicit bias towards the empowerment of the poor and marginalised, towards the creation of a more just and equal society (PRIA, 2014). It seeks to promote social change by strengthening people’s understanding that change is possible, encouraging them to critically examine their own experiences, and to exert their latent powers for autonomous constructive action.

On the other hand, the case study method is one of the most effective methodologies for participatory training and is the method adopted to build the training kit, as well as the framework for the implementation of participatory training in the summer school.
The case study method is not new (Chicago School, 1935). It is a written description or visual representation of a situation or problem, based on available facts. The aim is to stimulate learning through real-life situations that can stimulate discussion and the ability to make decisions.
Therefore, the training kit should provide theoretical information on the topics covered complemented by exercises and case studies to encourage discussion in an innovative training context.

The basic structure of the course is summarised in this table:

Percentage allocated	**MAIN TOPICS**
20%	Overview on sustainability and gender aspects
20%	Agri-food system sustainability
20%	Innovative business models
40%	Technical aspects (practical and active part for the students. Analysis of case study with entrepreneurs and FSL. Technical training on specific need previously identified)

Likewise, this phase led to the definition of the main objectives:

- Boost innovation capacity of project partners, food entrepreneurs and SMEs in developing novel products and business models for nutritious and healthy foods.
- Building capacity in developing innovative (agri-food) business models.
- Involve FSL entrepreneurs in summer school.
- Prepare a training kit aimed at illustrating the potential of innovative, nutritious and locally based products, and at developing methodological skills for assessment and strategy development

The division of tasks was done mainly according to the bilateral meetings in which the partners presented their available resources. These included knowledge about the different topics, the availability of time and the available materials as far as the European partners were concerned. In the case of the FSL, the bilateral meetings were essential in highlighting

the needs of the local context. In the case of the Accra FSL, for example, it emerged the need to develop reinforced soya products to address the issue of providing healthy diets without altering eating habits (the product will be presented later with more details).

Partner	**Resources**	**Material provided**
LUKE	Training materials and knowledge concerning Life Cycle Assessment (LCA)	Theoretical part accompanied by practical exercises on the use of the LCA
Helsinki University	Experience and training materials on food waste, packaging innovations and post-harvest practices	Development of the supply chain section of the training kit, especially the parts related to food waste management, transformation, and packaging
Bona Factory	Private company active in Kenya that develops innovative products mainly based on reinforced flours. The company disposes of a laboratory that may be visited by summer school participants.	Bona factory will be mainly involved in the summer school. In the preparation of the T-Kit it mostly represented the point of view of a local entrepreneur
CSIR (Accra FSL)	Research centre and laboratory specialised in the production of innovative food products, process and tools. Local knowledge and close ties with local stakeholders	Development of the case study (practical part) accompanying the theoretical part on the Business Model Canvas use. Development of a food product manual that local entrepreneurs can use in their companies
UNIPI / IAMM	Knowledge and training material on food systems and sustainability	Manual development co-ordination. Theoretical part related to food systems and sustainability. Practical part consisting of exercises on indicators assessing food security and food systems sustainability.
Tamale / Kisumu FSLs	Local knowledge and strong connections with local stakeholders	Support in the implementation of case studies and practical examples from the socio-geographical context involved (Ghana and Kenya)

After the consultation phase (Brainstorming / bilateral meetings), all materials were collected and merged into one document. This was then presented in the monthly webinar. The feedback received brought to the final structure of the T-kit.

The T-Kit is structured around 5 main chapters which move from basic principles and reflections on sustainability to a concrete analysis of innovative food products and business 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 a “sustainable food systems”, including the main elements composing the system and its interrelations. Moreover, it explores the 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. Therefore, it discusses the principles of Life Cycle Assessment (LCA), Social Life Cycle Assessment (SLCA) and Life Cycle Costing (LCC). The chapter is supplemented with guidelines for applying LCA to context specific situations.

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. This unit 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.

Training Objectives

The training objectives represent the educational purposes which the user may achieve at the end of each chapter and summarise the path from theoretical notions to practical experience.

1. Develop a vision on sustainable and food agriculture; Identify the principles of food sustainability; Be able to elaborate a method to facilitate the transition to sustainable production
2. Understand the framing of food systems and its interactions; Recognise major trends that affects food systems; Know who to map a food supply chain
3. Practices and technologies to stimulate innovative processes; Recognising needs and opportunities within the supply chain
4. Recognise how consumer behaviours change and the importance of healthier foods and diets; Comprehend the dimensions of food security and how to measure it with

indicators; Understand the interrelations between food systems and the drivers of Food System change with a special focus on gender and inequalities issues

5. Recognition of the importance of business models in food systems; Handle the 9 steps to build the Business model Canvas
6. Become aware of how to apply an innovative business model to a sustainable product, already manufactured and ready to be implemented

Innovative Product development

The last two chapters of the T-kit are dedicated to the innovative product developed by the CSIR research centre accompanied by the case study for the use of the business model canvas. The training manual in fact also functions as a detailed guide for the realisation of the identified product and the BMC supports it with an applicable business example.
The product developed following the methodology described above is a fruity soya-based pancake. It is meant to be an attractive food that incorporates soy into the consumer diet and is and mix that makes pancakes easy to prepare.

The T-kit contains a list of steps accompanied by video material and photos to demonstrate how a novel product could be developed with semi-industrial or industrial tools. It provides information on possible packaging to be used according to transport and cost-effectiveness as well as a section with instructions for use.
The technical fiche of the product also includes the cost and 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. However, it is important to note that the product does not claim to be innovative or healthy but shows the process that can lead to the identification of an innovative product. In fact, ingredients may vary according to local needs or according to the availability of resources.

Innovative business model

BM innovation is seen as a process of exploring, adapting, improving, redesigning, revising, creating, developing, adopting and transforming the business model. Sustainable business model innovation is about creating superior customer and firm value through addressing societal and environmental needs (Boons and Lüdeke-Freund, 2013). Alternative business models are numerous (blitzscaling canvas, lean canvas, VTDF framework, 3C business model, and more) and the training kit proposes the Business Model Canvas.
The business model canvas is a framework proposed by Alexander Osterwalder and Yves Pigneur in the book “Business Model Generation” (2010). The model enables the design of business models through nine building blocks comprising: key partners, key activities, value propositions, customer relationships, customer segments, critical resources, channels, cost structure, and revenue streams. BMC aim is to establish a simple and relevant concept so that any company could describe and manipulate its business model to create new strategies, challenge its preconceptions and create value efficiently and effectively.
The BMC is considered the most complete model in the business model theory, as it addresses, in detail, the relationship of all internal and external organizational components, and shows how these relate to create and capture the value proposed by the organization.

Within the training kit, the business part together with the product forms most of the practical content. The Business Model Canvas is applied to the development of the innovative product (fruity soy pancake). Its nine steps follow the evolution of the product, providing the users with a practical example of how the business model is used. The main objective is to provide eventual entrepreneurs (Training course users) with all technical material required to implement the product in their respective locations. The case study can also provide information on possible limitations and problems to be considered as well as strategies to capture value or make production more efficient.
In addition, a sheet with a list of questions that can be used to construct one's own business model canvas is provided in the appendix, so as to make its application open to different contexts.

Discussion

The multi-actor approach is usually applied to ensure that newly developed technical solutions meet real needs. Indeed, only a clear understanding of the problem and the expectations of all stakeholders leads to a solution that meets real needs, i.e., is truly useful. To ensure acceptance of the technical solution and thus its long-term use, usability is crucial. In addition, the MAA supports communication and knowledge exchange across existing boundaries (such as local, national, or cultural), so that the knowledge gained can be made available.

In the HealthyFoodAfrica project the Multi-actor approach takes an innovative, practice-driven form in which the food system is central and is addressed both from different disciplinary angles and through context-specific cases using interdisciplinary approaches. HealthyFoodAfrica seeks to transcend disciplinary boundaries and arrive at a broader systemic framework that involves engagement with the needs identified by practice partners. In this way, the project can generate new understandings and develop new knowledge.

The interdisciplinary approach focuses on the use of a food systems perspective. The food systems perspective allows for simultaneous consideration of the different activities, actors, challenges, and interrelationships that constitute food systems. Using interdisciplinary methods in combination with a systems perspective, could allow to develop innovations that span multiple domains, levels and actors. Understanding the attitudes and practices of the different actors involved in relevant food systems and agri-food chains (farmers, processors, sellers, consumers) and recognizing their different positions and interests is critical to improving food systems performance. A food system approach also provides the analytical basis for assessing the outcomes of food system activities on the environment, economy, and society. At the same time, it promotes un understanding of the interactions among food system activities and actors, their influences and effects. A food systems approach could also represent an interdisciplinary framework to identify the drivers and barriers to innovation within and among food system activities.

In order to achieve transformative change in the FSLs, it is crucial to identify the potential for innovation, new sustainable business models and new forms of cooperation.

The MAA approach employed in the development of a training course, as we have seen in the methodology and results obtained, can foster the use of stakeholder knowledge, support dynamic co-learning relationships among research and practice participants, strengthen innovation capacity, and ensure adoption and impact. The FSLs involved, by means of their capillary structure and strong connections with local actors, have enabled a profound understanding of the needs of the area in order to develop effective solutions. Indeed, FSLs' partners have determined the selection of the thematic areas based on the issues they consider most relevant to their work. In addition, encouraging partners to engage in ad hoc discussions on topics that have higher-level relevance to their LDFs through brainstorming activities and bilateral meetings has enabled the development of a training course with specific objectives, relevant to the geographic areas involved.

Researchers, stakeholders from the entire food supply chain, decision makers, and local government administrators investigated and experienced changes in the food system together, thus activating different kinds of knowledge. Participants in the FSLs, including local citizens and entrepreneurs, through structured co-creation processes, including deliberation and coaching, could change their practical and research knowledge to develop new actionable pathways for their particular initiative.

The training kit accompanied by the summer school functions as a bridge between FSLs and local entrepreneurs and students. Through the training course, co-created knowledge is provided to the end-users in order to become aware of the challenges that global food systems are facing and in turn disseminate the acquired knowledge. In addition to knowledge, practical tools that can lead to professional development, the use of new technologies, and strategic support to develop new business ideas are provided.

Co-learning related to the operation of equitable and sustainable food chains and knowledge about the context-dependence of what is sustainable will empower small farmers and small food enterprises, with an emphasis on women and creating new opportunities for young people.

At the same time, supporting local agrobiodiversity-based product development and innovation capabilities through summer school and extended training activities can induce the use of new plant-based protein options, boosting local food industry and agri-business opportunities.

As was extensively discussed in the first chapter, food system innovations can be a decisive factor in the transition to sustainable food systems. Unfortunately, there are multiple factors that limit the use of innovations or halt the transformative process.
There is a widespread lack of awareness among decision makers and stakeholders in the food sector of the importance of nutrition, environmental sustainability and socioeconomic sustainability. Competing priorities in the policy arena limit adoption of practices that support nutritious, sustainable, and resilient diets. The common lack in sub-Saharan Africa of public acceptance of women as decision makers reduces the efficiency of food systems and increases gender inequality. Limited awareness by decision-makers is also common among consumers who may underestimate the importance of nutrition and healthy diets, as well as environmental and socioeconomic sustainability. Economic availability and investment capacity is crucial to encourage small entrepreneurs; The limited access to microfinance and credit hinders livelihood diversification, business development and expansion. In addition, infrastructure in the African environment reduces the viability of food systems and business environments as they are often insufficient. Similarly, the lack of cold chain infrastructure along the food chain raises food safety issues and increases food waste and related economic losses.

The training course does not promise to solve all problems concerning unsustainable food systems but believes in spreading knowledge and raising awareness to stimulate bottom-up actions that can generate alternative systems with strong impactful potential.

Conclusion

In this research paper, I sought to understand what conditions allow an innovation to influence the transition to a sustainable food system. How the creation of a training course with a participatory approach can gather innovations applicable to a given geographic context. How education done through participatory training can facilitate the transition to sustainable food systems and what aspects of training are needed.

An innovative methodology was applied, concentrated on 4 main elements: co-creation, co-learning, co-management and interdisciplinary approach. In particular, I was interested in understanding how a multi-actor approach applied to a training course development could help select and disseminate food innovations as well as raise awareness in the area of intervention.

For example, it was observed that the most important aspects of training according to the Food Systems labs in Accra, Tamale, and Kisumu were related to the functioning of food supply chains, and that an agile and viable business model could foster the emergence of new businesses in the agribusiness sector. In fact, the CSIR research centre (Accra FSL) focuses its work on food innovations involving food transformation. Transformation allows the use of different technologies, increases the value of the product, involves more people along the value chain, and increases the shelf life of the product. In this way, many problems related to transportation and storage can be solved, the economy benefits, and the local social sphere improves consequently.

It was then observed how the co-creation of the document encouraged the participation of all stakeholders in the decision-making process. An environment favourable to discussion and debate fostered the disclosure of real problematics. These issues through the co-learning process were transformed into opportunities. The opportunities then became the subject of case studies in the training kit to show end-users alternative models and stimulate critical thinking and innovative process.

The multi-actor approach fostered knowledge exchange and a transdisciplinary approach supported the development of systematic solutions. An effective, efficient and equitable shared vision, transdisciplinary processes, tools and indicators, and built capacity could be used as models for future research and sustainable development projects.

The enormous complexity of African food systems has also been observed through a profound study of the territory. However, there is no single solution to make food systems

sustainable, but there are several pathways that can facilitate the transition. Some of these pathways, such as the use of agroecology, the use of food waste management, the improvement of food processing, and the use of protein flours to improve the quality of everyday products and address malnutrition, became part of the central themes of the training course.

However, the methodology used and the results obtained have not yet been applied in the summer school, which will only start on July 4, 2022. Therefore, there are no verified results of the effectiveness of the training kit even though it will be used as a framework for the implementation of the summer school. Thus, this research leaves room for further study. Once data from the 2022 and 2023 summer school and data on the implementation of innovations on the ground will be collected, the research will be able to provide definitive answers.

The ambition of the summer school is to encourage and support local students and entrepreneurs to co-create further innovations (products, businesses, services, and so on). Later, the most promising innovations will be piloted in the other FSLs. Piloting includes product design, procurement of raw materials, development of processes and production systems to be used, and modelling of customer use and disposal. The strategies will also explore the potential contribution of new products to the development of local food systems. Entrepreneurs participating in the project will receive support and guidance on food product development, from identifying market relevance and brand potential, both locally and internationally, to creating brand communication, culinary development, supply chain and distribution. The team will also assist in finding appropriate partnerships and collaborations in Africa and elsewhere.

Regardless, it is possible to say that a multi-actor approach applied to the development of a training course in a specific geographic context carefully analysed, through the participation of local partners representing the needs of local actors, along with European and international researchers has led to the identification of innovations that are effectively applicable to the geographic context.

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