SMALLDERS PROJECT

SMART MODELS FOR AGRIFOOD LOCAL VALUE CHAIN BASED ON DIGITAL TECHNOLOGIES FOR ENABLING COVID-19 RESILIENCE AND SUSTAINABILITY

D6.1

Study of the sustainability context of the agri-food supply chain for smallholders

Project Information

Acronym: SMALLDERS

Title: **S**mart **M**odels for **A**grifood **L**ocal Va**L**ue Chain Based on **Di**gital Technologies for **E**nabling Covid-19 **R**esilience and **S**ustainability

Coordinator: The University of Calabria (Italy)

Programme: PRIMA. Thematic area Agro-food value chain. Topic 2.3.1

Start: 2022-05-01

Duration: 36 months

Web: https://mel.cgiar.org/projects/smallders

Consortium:

University of Calabria, Italy (UNICAL)

University of Parma, Italy (UNIPR)

University of Extremadura, Spain (UEX)

IMT Mines Ales, France (LSR)

Faculty of Science of Tunis, Tunisia (LAPER)

DELIVERABLE

Number: D6.1

Title: Study of the sustainability context of the agri-food supply chain for smallholders

Lead participant: Faculty of Science of Tunis, Tunisia (LAPER)

Other participants: University of Calabria, Italy (UNICAL)

University of Parma, Italy (UNIPR)

University of Extremadura, Spain (UEX)

IMT Mines Ales, France (LSR)

Work package: WP6

Dissemination level: Confidential (CO)

Type: Report (R)

Due date: 2023-04-30

Submission date: 2023-04-30

Contributors: Safa Chabouh (LAPER), Ayla Amamou (LAPER), Siwar Bellahirich (LAPER), Lilia Sidhom (LAPER).

Reviewer(s): IMT Mines Ales, France (LSR) and all

Document revision

Version	Date	Editor	Overview
First release	2023-04-05	Safa Chabouh and Lilia Sidhom	First release of the document
Second Release	2023-25-04	Lilia Sidhom	LAPER and partners Contributions and review
Final release			

Table of Contents

List of Figures

List of Tables

Executive Summary

This document refers to task 6.1 of WP6 of the SMALLDERS project, which is entitled "Multi-indicators based on Multi-capital sustainability approach". WP6 aims to define innovative global and specific multi-capital sustainability indicators and indices related to the economic, social, and environmental pillars. Along with the different tasks (T6.1, T6.2, T6.3, and T6.4) defined in WP6, a global methodology is presented in Figure 1 to define a general framework for defining the multi-capitals sustainability indicators for smallholders in WP6.
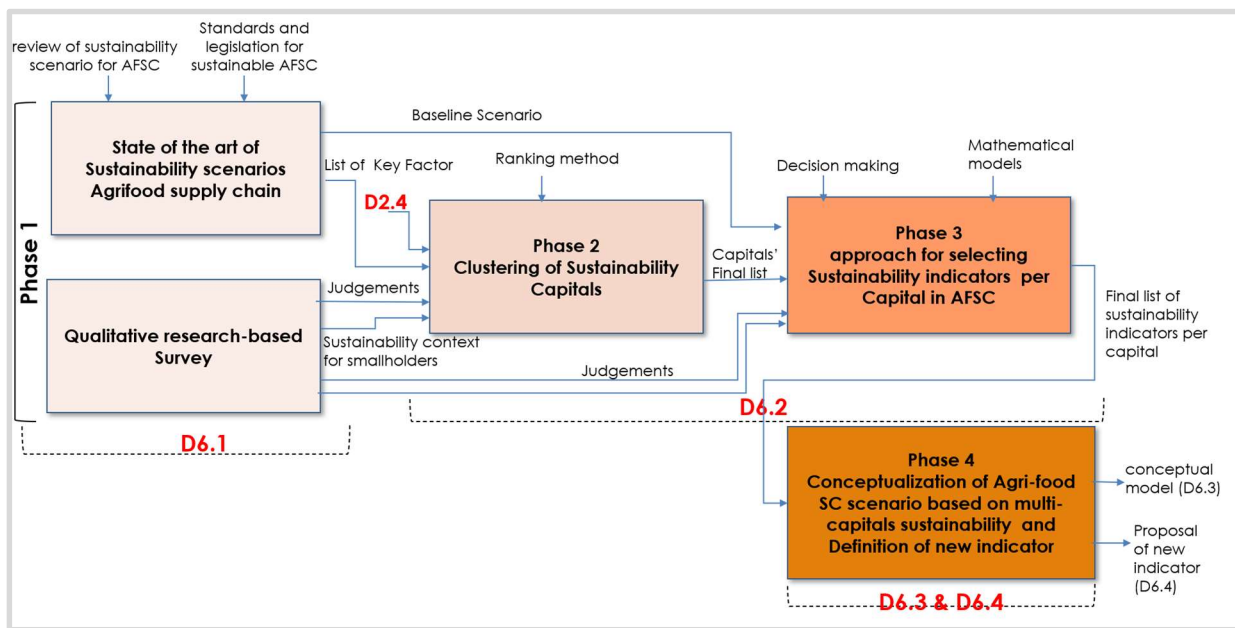
Figure 1 *Methodology of WP6 and its various deliverables*

This methodology is based on a 4-phases approach. The 1st one refers to the study of sustainability context both in scientific literature as well as the legislation and the contributions of the law and international standards. In addition, a review of different sustainability scenarios for the agri-food supply chain (AFSC) context is considered. This review aims at identifying a baseline sustainability scenario for the AFSC. For this, both a qualitative research-based survey with AFSC actors and expert judgment aim at studying the sustainability context for smallholders in Tunisia, Spain, France, and Italy by presenting the key factors for determining sustainability for the AFSC in these countries. Hence, the outputs of Phase 1 will serve for clustering sustainability capitals which is the aim of Phase 2. Once the capitals are selected, phase 3 will be conducted where the set of sustainability indicators per capital will be chosen based on several criteria including measurability (e.g using mathematical models) and using a multi-criteria decision method. Phase 4 is the final

phase of WP6. It consists of: i) conceptualizing the AFSC scenario based on multi-capitals sustainability in the Mediterranean area, and, ii) the defining new indicator(s.

1. Introduction

The SMALLDERS platform represents a new tool to support smallholders in achieving different goals. In this context, the SMALLDERS project envisages the definition of a digital platform to improve sustainability for smallholders by jointly taking into account economic, social, and environmental pillars. That's why; It is necessary to study the sustainability context of the agri-food supply chain (AFSC) for smallholders. To do so, the first step is dedicated to the presentation of the most used and popular sustainability standards in the agro-food context in order to have, thereafter, an idea of the thresholds imposed by these standards for a subsequent evaluation of sustainability (e.g; TBL method). Constraints and compliance with international standards for European Union (EU) countries and Tunisia as well as a study of the context of sustainability via the laws relating to Tunisia and the EU are also presented. This gives an idea about the involvement of countries in relation to the integration of sustainability in the Agri-food sector. This latter can allow us to know if there are any limitations imposed by the government to integrate sustainability in such context. Second, a review of the different sustainability scenarios is given in order to define a baseline scenario for the SMALLDERS project. To define generic key factors of the sustainability scenario of the AFSC both for Tunisia and the European context (French, Italian, and Spanish), we collected data from i) a survey undertaken for the Tunisian case and ii) feedback from the end users through interviews with our external partners (expert judgment). The purpose of this data collection is to validate the assumptions defined for the baseline scenario and to quantify the degree of importance of these factors influencing our scenario.

2. Sustainability context-based standards and legislation for AFSC

The value chain has emerged as one of the main topics for development thinking and practice. This development has been accompanied by an explosion in the number of general and specialized guides devoted to all aspects of value chains. Currently, value chain analysis has been the subject of particular attention by including a three-pillar approach to sustainability by combining three sustainability dimensions: economic, social, and environmental.

To study the sustainability context of the AFSC, it is necessary to have an idea of what exists in terms of legislation, the contributions of laws, and international standards (eg; ISO standards) in such a topic. In this section, these theoretical tools are presented in order to

understand the European Union (EU) and Tunisian legislation/standards context of sustainability.

2.1. Sustainability context-based standards

The sustainability study focuses on the new governance tools for international supply chains called "sustainability standards". These standards are voluntary guidelines that can be used by each actor in the AFSC to have good sustainability practices. According to the literature, there are more than 400 sustainability standards. At the end of the 90s, eco-labels and standards for food and organic products were introduced for the EU, (APC website). For the agriculture sector, developed standards include a set of practices for determining how a farmer should cultivate and harvest his crop or how should optimize the use of natural resources in a sustainable way, (APC website). Another example, standards also concern responsible fishing practices to ensure marine biodiversity. It is crucial that each AFSC stakeholder can select which sustainability standards to use as an important 1st-step in setting objectives.

For food and agriculture, many of the international standards have been developed by the food and agriculture organization (FAO) issuing guidelines and guides designed to make agriculture and fisheries more sustainable (FAO, 2015).

According to the ISO 14025 standard, the Product Category Rule (PCR) constitutes the rules for defining a category of products for the development of Product Environmental Profiles (PEP). For food safety, there are also ISO standards whose role is to help organizations identify and control the risks that threaten food safety. Indeed, the ISO 22000 standard is intended for all actors in the food supply chain to offer reliable food to consumers. Published in 2010, the ISO 26000 is the first international standard in terms of social responsibility and respect for the environment by proposing some guidelines. It presents guidelines for all types of organizations focusing on two main pillars: environmental and social, giving great importance to the social aspect. Another standard that can be also cited is ISO 14000 which is focused only on the environmental pillar of sustainability. These guides are specific to some phases of the AFSC. As an example, we can cite the Food Packaging Guide, which paints a portrait of packaging, its roles, and its impact on the environment, (ADIL website).

In France, there is the SD 21000 guide published by AFNOR (French Association for Standardization). This guide supports companies in their sustainable development

approach according to their activities. Recently, new European Sustainability Reporting Standards (ESRS) have been introduced. The ESRS is a series of new standards and indicators that aim to standardize non-financial reporting and end reporting based on national or similar reference frameworks, such as the GRI, the sustainable development goals (SDGs). These standards are intended to be more than just regulations and improve the current situation regarding sustainability reporting. In fact, the ESRS has been put in place to provide a global framework for reporting sustainability performance based on transparency and trust.

According (Meemken et al. 2021), the authors present a comprehensive review on the effects of different sustainability standards involving various actors in the supply chain for different types of products to identify future directions. This research work concludes that, in some cases, standards may well help to improve the sustainability of the AFSC. However, these standards remain insufficient, especially for large supply chains.

Finally, these standards/guidelines focus on helping users to better understand their activities' performance in terms of sustainability and make informed decisions. The most used international Guidance and standards for the agricultural sector are listed following: (Standardsmap website 2021):

- The 2030 Agenda for Sustainable Development (UN SDGs)
- Global Reporting Initiative (GRI)
- Principles for Responsible Investment in Agriculture and Food Systems (CFS-RAI Principles)
- ISO 14000 series (e.g. ISO14001 Environmental management systems)
- Principles for Responsible Agricultural Investment that Respects Rights, Livelihoods and Resources (PRAI)
- OECD-FAO Guidance for Responsible Agricultural Supply Chains
- IFC Performance Standards on Environmental and Social Sustainability
- ISO 26000 Social responsibility

At the end, it can be concluded that there are different international standards/Guidances for sustainable development, while some norms may apply universally to all organizations, others are considered to be organization specific. According to the ESG reporting initiative, the best practice increasingly involves following more than one standard/guidance.

2.2. Sustainability context-based regulations

In this section, a brief review of the European Union (EU) and Tunisian sustainability regulations is presented. The goal is to give an idea of the government's contribution to the sustainability context and specifically in the supply chain and agronomy sector.

2.2.1. EU regulations

For the context of sustainability in the EU, it is important to mention that political decision-makers come together around the same guideline. Since 1962, the Common Agricultural Policy (CAP) of the EU has been launched, the aim of which is to combine social, economic, and environmental approaches in order to establish a sustainable agricultural system in the EU, (EUR-Lex website). Within the EU, many laws have been adopted in order to define the rules imposed in terms of protecting the environment and preserving life quality by also reducing the consequences of climate change.

In February 2022, the European Commission adopted a new directive on respecting human rights and environment by companies in global value chains. Indeed, this directive focuses to promote sustainable and responsible corporate behavior along global value chains by preventing or mitigating the negative human rights impacts of their activities (e.g. child labor) and on the environment. These new regulations will provide legal certainty and fair competition conditions for all players in the value chain, (EUR-Lex website).

Other regulations exist such as the Nitrate Directive considers the protection of water against pollution by nitrates in natural environments. This directive is European and was created on December 12, 1991. The target of this directive is agricultural practices that cause a high concentration of nitrates in waterways. Second example, the packaging laws are quite specific to each country, but the globalization of trade is pushing for the harmonization of local laws with general guidelines. For the EU, a packaging directive has defined the general framework for all member countries. And so, since 1994, the Member States of the European Union such as Tunisia have been able to develop its policy for the prevention management of packaging and waste (94/62/EC). Other requirements (2004/12/EC) were added later such as organic farming. This gave the adoption of Regulation (EU) 2018/848 which establishes the principles of organic production and sets the rules concerning organic production, and the associated certification, (EUR-Lex website).

2.2.2. Tunisian regulations

Currently, sustainable development is increasingly becoming an essential objective for Tunisia. According to (Ferchichi, W and Hammami-Marrakchi, 2021), the new Tunisian constitution of January 2014 clearly announced that it works for the realization of social justice, the balance between the regions, and the rational exploitation of the national wealth while respecting the environmental rules. Consequently, constitutional authority for sustainable development is created to reach the objective of sustainable development considering economic, social, and environmental issues. This has therefore enabled the constitutional text to meet the standards of modern constitutions on the one hand, and Tunisia's international commitments.

Since July 2021, a new law on distribution channels for agricultural products has been proposed. This decree-law was launched to regulate the distribution channels of agricultural and fishing products in Tunisia. Started in early November 2021, this legislation is now in its final phase. In fact, it is a question of digitizing the distribution circuits and guaranteeing the traceability and transparency of transactions. Concretely, the new decree-law will make it possible to better control prices, to limit the activity of speculators, and therefore to ensure the visibility of these circuits and the regular supply of organized markets and consequently price stability. This decree of law will act on different factors influencing sustainability, especially from an economic and social point of view.

During the period 2011 -2021, Tunisia embarked on a process of promoting environmental and development rights through the institutional component. As defined in (Ferchichi, W and Hammami-Marrakchi, 2021), this is the case of Law No. 2018-50 of October 29, 2018, relating to the Human Rights Authority, Law 2017-59 of August 24, 2017, relating to the Authority for Good Governance and the Fight against corruption, and Organic Law No. 2019-60 relating to the Sustainable Development Authority. Other examples can be cited: law n°2018-35 relating to corporate social responsibility, organic law n°. 2019-10 of January 30, 2019, relating to the creation of the "AMEN SOCIAL" program and law no. 2020-30 of June 30, 2020, relating to the social and solidarity economy.
We can conclude that this period was marked by the publication of several texts of a social nature that have a direct impact on the relationship between the environment and human well-being.

In order to establish a precise risk management system for the food chain, Law No. 2019-25 was adopted, (Ferchichi, W and Hammami-Marrakchi, 2021). This law has made it

possible to ensure the sanitary safety of foodstuffs and animal feed and has also made it possible to strengthen biological security. In particular, the period from 2014 to 2021 was marked by the modification of several economic legislations adopted before 2011. Indeed, the adoption of this type of legislation incorporates a different vision of the relationship between the economy and the environment. This has enabled Tunisia to align itself with international agreements on the environment.

Although currently there is more integrated cooperation between industry and agriculture, materialized by the creation of interprofessional groups in the agricultural sector (Ben Becher 2016). In this last one, it is mentioned that Tunisia's overall development model has a lot of progress to make in improving the performance of the agricultural sector and its sustainability. Indeed, the economic and social gap between rural agricultural areas and urban areas has widened. Moreover, the Tunisian smallholder is currently not explained in the legal texts. In addition, there are no specific structures for smallholders, but the Tunisian system is designed to treat all categories of agriculture in the same way. Thus, small farms generally remain on the sidelines and represent a relatively unstructured sector.

Finally, the EU has made progress in terms of legislation for sustainable development regarding the Tunisian country. However, Tunisia has started to integrate sustainability regulations based on the three dimensions: economic, natural, and social in the agricultural sector since 2011 in order to align with its European partner's sustainability aims. This can cause some gaps between the sustainability key factors for the EU and Tunisia context.

3. Review of some sustainability scenarios for the AFSC context

"Scenarios are consistent and coherent descriptions of alternative hypothetical futures that reflect different perspectives on past, present, and future developments, which can serve as a basis for action" (Van Notten 2006). In the context of AFSC sustainability, and according to FAO, scenario identification serves for defining a realistic vision for the value chain and a basic strategy for achieving that vision to which AFSC stakeholders adhere (FAO, 2015).

In the following, the methodology for scenario creation is presented, then a review of sustainability scenarios for AFSC is proposed. Finally, a first proposal for a baseline scenario for the SMALLDERS project is defined.

3.1. Methodology for scenario development

In the state of the art, almost the same logic was used to define a sustainability scenario (Voglhuber-Slavinsky et al. 2021; Melkonyan et al. 2019; Moller et al. 2020). Inspired from these studies, a 4-step methodology is defined, for creating sustainability scenarios for AFSC (c.f Figure 2). In the following, each step presented in Figure 2 will be explained.

1 System /Trend analysis	
1.1 Identify the factors that influence AFSC sustainability	1.2 Select key factors

2 Scenario pre-development	
2.1 Identify features/ aspects for each key factor	2.2 Identify possible options for each aspect within each key factor

3 Scenarios development	
3.1 Consistency check of options pair-matching from different key factors	3.2 Identify possible scenarios (matching of options from all the key factors)

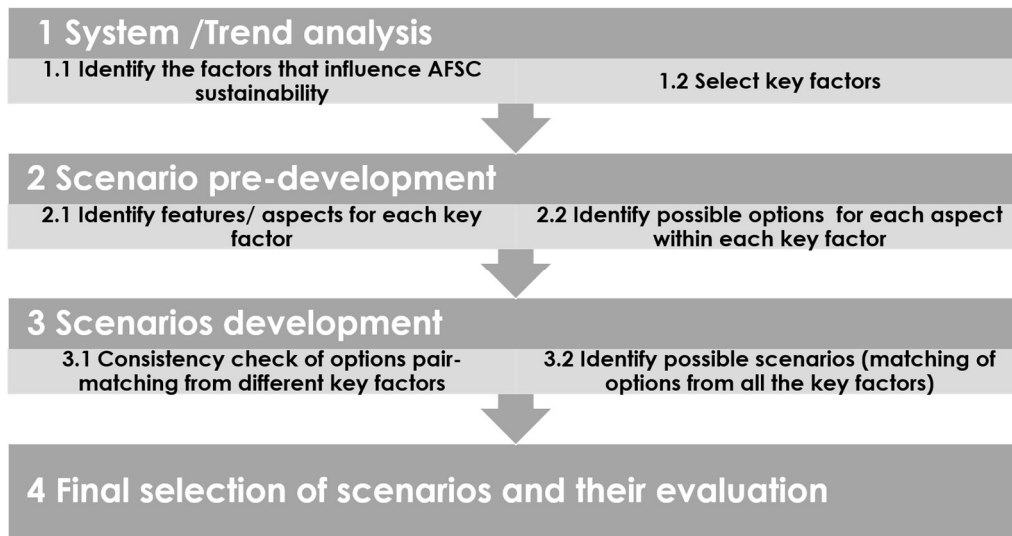| 4 Final selection of scenarios and their evaluation |
|---|

Figure 2 *The proposed methodology for AFSC sustainability scenarios development*

As mentioned in Figure 2, the first step consists of analyzing the AFSC and its trends. In fact, system and trend analysis aims at identifying the main factors that impact the development of sustainable AFSC (today and in the future). It is the starting point for scenario creation. The influencing factors are relevant not only for assessing the sustainability of AFSC but also for paving potential solutions for integrating them in a practical way (Voglhuber-Slavinsky et al. 2021; Melkonyan et al. 2019). They could be of different types: ecological, socioeconomic, technological, and political. In order to define the complete list of influencing factors within the AFSC, many issues should be considered. For instance, the focus should be on a particular region of the world (Melkonyan et al. 2019) (for example European region, Mediterranean, North Africa, or a specific country within a region). In fact, each region has its specificities regarding climate, natural resources (such as water, land, and soil quality), policies, regulations, governance, consumer behavior and preferences, and food culture. Moreover, the implementation of sustainable AFSCs is driven by consumer demand as well as the alignment with corporate strategy, and government concerns regarding environmental and social issues (Luo et al. 2018) which also depend on the region. Therefore, existing studies in the literature that

define sustainability scenarios for AFSC have been applied to specific regions (Germany in Melkonyan et al. 2019; European region in Moller et al. 2020; Austria in Voglhuber-Slavinsky et al. 2021; China in Jiang et al. 2023).

For the SMALLDERS project, the idea is to identify global sustainability factors influencing the Mediterranean countries and actors specific to each country. Four sets of specific factors could be identified, one per Mediterranean country partner of the project (Tunisia, Italy, France, and Spain). Hence a baseline scenario should be developed in order to take into consideration their global context (e.g, reglementation).

Other essential components to consider in the definition of sustainability scenario are the type and dynamic nature of AFSC which are of great importance also. In fact, AFSC can be differentiated by the type of product and agrifood sector (dairy sector is totally different from the olive sector, etc.). Also, we distinguish two main types of AFSC regarding the type of agrifood products (Van der Vorst et al. 2007) : " fresh agricultural products" (like fresh vegetables) and " processed food products" (like snacks, desserts etc).

So, the diversity of AFSC and the continuous evolution of the environmental context as well as stakeholders' needs and priorities affect the trends and key factors to be considered in scenario creation. That is why sustainability scenarios are supposed to be dynamic scenarios even if we consider only one agri-food sector.

Once an extensive list of the potential factors is created, key factors with the greater influence are selected, see Figure 2. Here, several tools could be applied: a cross-impact matrix (Melkonyan et al. 2019), workshops, and surveys with AFSC actors and stakeholders (Moller et al. 2020). Finally, it is worth noting that AFSC actors and stakeholders should be actively involved from the beginning in setting the influencing factors. According to Melkonyan et al. (2019),the entire AFSC should be considered (not only the agricultural production systems) in order to build scenarios of AFSC in a holistic way. Therefore, ASCF actors and stakeholders should be involved in scenarios' identification.

The second step consists of scenario pre-development which aims at developing the future options per key factor required for scenario creation. An option is a possible future state or scenario of a key factor. A way to conduct step 2 could be found in (Melkonyan et al. 2019). Stakeholders could be involved in this step too as each option could be discussed with them or proposed by them.

Once the key factors are selected and their options described in detail, the next step is dedicated to scenario development itself. Optional future states of each key factor defined in the last step should be validated with AFSC actors. A consistency check could

be also conducted (i.e., defined options for each key factor is checked pairwise with the future states of all the other key factors)(Moller et al. 2020, Melkonyan et al. 2019). The last step of the methodology refers to the final selection of scenarios and their evaluation (cf Figure 2). Scenario evaluation could be carried out by mapping the identified and retained scenarios.

3.2 Review of AFSC sustainability scenarios developed in literature

Two main studies developed AFSC sustainability scenarios for the implementation of a local and sustainable food supply chain in Germany (Melkonyan et al. 2019) and in the European region (Moller et al. 2020).

Regarding (Melkonyan et al. 2019), four scenarios were proposed for a specific region (Germany) to investigate the local food supply chain as a sustainability scenario. The first one called "New Supply Concepts for Consumers Based on Digital Innovations" is the "desired scenario". In fact, environmental sustainability here is targeted through the use of new transportation concepts to reduce emissions. The social dimension is addressed through consumer behavior (healthy and sustainable lifestyle). While the economic pillar is illustrated by legally regulated markets that encourage and support digital innovations (which implies new business models and ways of economic growth). The second scenario addressed the reduction of food waste for both food processors or companies and consumers. Food waste is an environmental issue of great importance. This second scenario proposes a food-sharing platform which belongs to sharing economy solutions for matching supply and demand(consumer needs) efficiently. It represents a win-win situation: the consumer has access to edible food at no or less cost, and food companies realize savings from food waste reduction. It is noted that the consumer has an active role as a volunteer in creating, maintaining, and enhancing the sharing platform. The third scenario is "Business as usual": the actual situation where sustainability is not yet addressed (e.g., low environmental awareness among consumers, unhealthy lifestyle, overpopulation, etc). Also ,the focus of society in this scenario is mainly on economic growth. Finally, the fourth scenario "prospective urbanization" encourages the digitized economy and recourse to new agile business models. New consumption patterns are addressed like increasing online retailing. However, it still claims a high degree of urbanization which impacts environmental sustainability. The details of how these scenarios were developed by setting options for the defined key factors are presented in

Table 1. In this study, consumers, food companies, policymakers, and transportation companies were involved in the sustainability scenario.

Table 1 below presents the different scenarios discussed by (Melkonyan et al. 2019) and the corresponding key factors options considered. (Melkonyan et al. 2019) highlights the importance of incorporating consumer behavior and awareness (into environmental and social issues) to achieve sustainability objectives.

Table 1 *AFSC sustainability scenarios developed in*(Melkonyan et al. 2019)

Key Factors	Scenario 1 New Supply Concepts for Consumers Based on Digital Innovations	Scenario 2 Sharing society	Scenario 3 Business as usual	Scenario 4 Prospective urbanisation
Globalization	Local market with increased competition and low sales prices	- International Market with increased competition and low sales prices - Locally regulated market with high subsidies		
Digitalization				Digitized economy with high transparency
Policy regulations				No market failure
Resource availability	High resource scarcity as a chance to switch towards sustainable economy			
Climate change and air pollution	New mobility concepts but expansion of logistics infrastructures			

Innovation in agriculture (New business models)		High level of sharing society, potentially regulated	Strategic alliances	Strategic alliances
Social trends			Overpopulation	Overurbanization
Consumption trends	Lifestyle of Health and sustainability		Ignorance towards environment because of low income	

Moller et al. (2020) developed 3 scenarios for "Europe's food sector in 2035 ("pictures of the future")" as alternatives for the food sector along its entire value chain. The European food sector, its policies, industries, and research were the focus of the considered scenarios. In the first scenario, entitled "Policy secures sustainability", sustainable agriculture is recognized by politicians to be vital for food security. Hence, many policy regulations favor AFSC sustainability (cf Table 3 below). The states have a central role in owning and managing agricultural land; producing food according to local conditions; Influencing citizens' choices (e.g., labels) and caring for their well-being as well as access to data along the whole AFSC and data sovereignty. In the second scenario, society drives sustainability where consumer behavior and awareness toward food quality, loss, and security as well as health and sustainability are the core ideas. Contrary to the first scenario, the role of the state is limited and society has the major and central role in developing and spreading a sustainable behavior and searching for a healthy lifestyle in harmony with nature. Moreover, local communities have a crucial role in reaching high levels of self-sufficiency in food production. In Scenario 3, entitled "A CO2-currency and retailers dominate trade and consumption", the role of retailers is emphasized. In this scenario, global trade has a central role on the variety and prices of food as well as on its security. It is as central as CO2-prices, the large-scale industrial processing of food, and the use of side streams. In this case, hiighly specialized global markets instead of local ones are widespread. Economic growth and production efficiency are the main focus in this scenario contrary to the second one. Environmental impacts (like the effects on land and biodiversity) are considered of minor importance.

Table 2 below presents the different scenarios discussed by (Moller et al. 2020) and the corresponding key factors options considered. (Moller et al. 2020) underlines the different

facets of sustainability consideration according to the perspective from which it was considered (policy maker, stakeholders, and consumer/ society).

Table 2 *AFSC sustainability scenarios for Europe's food sector in 2035, (Moller et al. 2020)*

Key factor	Scenario 1 Policy Secures Sustainability	Scenario 2 Society Drives Sustainability	Scenario 3 A CO2 Currency and Retailers Dominate Trade and Consumption
Appreciation of products promoting ecosystem services	No awareness or intentional disregard of ecosystem services	Market for products promoting ecosystem services exists	Products promoting specific compensation payments preserving ecosystem services
Degree of centralisation of food production	Centralized agriculture in each country	Almost all food is produced within a 1-mile radius of the final customer or place of consumption	Centralisation and specialization of agriculture
Purchasing behavior related to food	Price driven purchasing	Health and self-optimisation is the key driver for consumer decisions.	Smaller in-between meals: "snackification".
Measures to reduce climate change in the food sector	Internalization of external effects: CO2-intensive products are charged with high prices by application of certain CO2-taxes.	Society triggers production with low CO2-emission	CO2-emission is new currency (Both prices, the usual one and the emission price have to be paid when purchasing a product or service). There are no climate change mitigation measures in place.
Public and private investment in food and agriculture	Sustainable public investment	Sustainable mainly private investment	Profit driven private investments
Artificial Intelligence in the value chain	Intelligent Value Chain	Use of AI at specific stages of the value chain	Retailers have most information and are the players that can use AI most efficiently.
Resource availability	Equitable distribution of resources by the state	Resource use as individual responsibility	Resources managed by the industry
Measures for sustainability issues: food losses and wastes, food security	***Regulation policy promotes sustainability*** - Regulations to avoid food losses and waste - High level of policy regulation for food security	***Consumer awareness*** - High food safety and security through responsible consumption -Sustainability through consumer decision	***Retailer perception*** -Sustainability as business model for retailer - No food losses due to specialization and reuse -Low food safety and

	and safety -Sustainability through regulation	-Less food waste by consumers' conviction and technological improvement	security due to global exchange and focus on very cheap food
Balance of power within the value chain	Regulations ensure an equal distribution of power	Digitalisation empowers consumers	Market power of retailers: Large retail stores and discounters have mostly replaced the traditional offer structure of small food retailers
Packaging of Food	Food packaging still in place	Bulk stores on- and offline: Consumers prefer to buy products with no or just few packaging.	Packaging only where absolutely necessary : materials such as plastic are replaced by more sustainable alternatives. Bulk stores
Quality and quantity of labels	Strict state regulation for fewer labels	Sustainability labels on the rise	Labels made by retailers
E-commerce, Platforms and "Product as a service" in the food sector	- Governmental platforms to serve information on food and health - E-commerce on local or regional level implemented	- Platforms to support sustainable and efficient food -E-commerce stores dominate the sale	- Food service platforms as a booming business - Pervasive e-commerce in the hands of the big box retailers.

As can be seen, the chosen factors could be related to sustainability requirements and goals defined for AFSC. For this reason; in our project, a definition of the key factors on the basis of multidimensional sustainability as well as the project proposal must be undertaken. Then, this list will be adjusted based on the surveys and/or interviews conducted with AFSC actors within each country partner of the SMALLDERS project (see, section 4). Thus, the surveys and/or interviews serve for choosing the specific Key factors for each country and also identifying the generic key factors that help us define a baseline sustainability scenario for AFSC.

3.3 Baseline sustainability scenario for SMALLDERS project

In this subsection, a first proposal for the baseline scenario of AFSC for the SMALLDERS project is developed. This proposal is defined based on the methodology described in subsection 3.1. As mentioned earlier, the development of a scenario starts by defining the influencing factors and then selecting the key ones. In the SMALLDERS project, influencing factors are extracted from the proposal of the project where the expected impacts of the SMALLDERS platform for AFSC actors were described. These impacts were presented as SMALLDERS's objectives.

In order to design the baseline scenario for the SMALLDERS project, the list of key factors should be also identified while involving AFSC actors and project partners. Figure 3 below illustrates the process of determining the list of key factors. We note that the final list of key factors is obtained after the feedback of AFSC actors and experts. That is why, a preliminary list of key factors is selected to develop a preliminary baseline scenario. This latter will be refined based on the involvement of the actors/experts which can be realized through the study of sustainability context (in section 4).
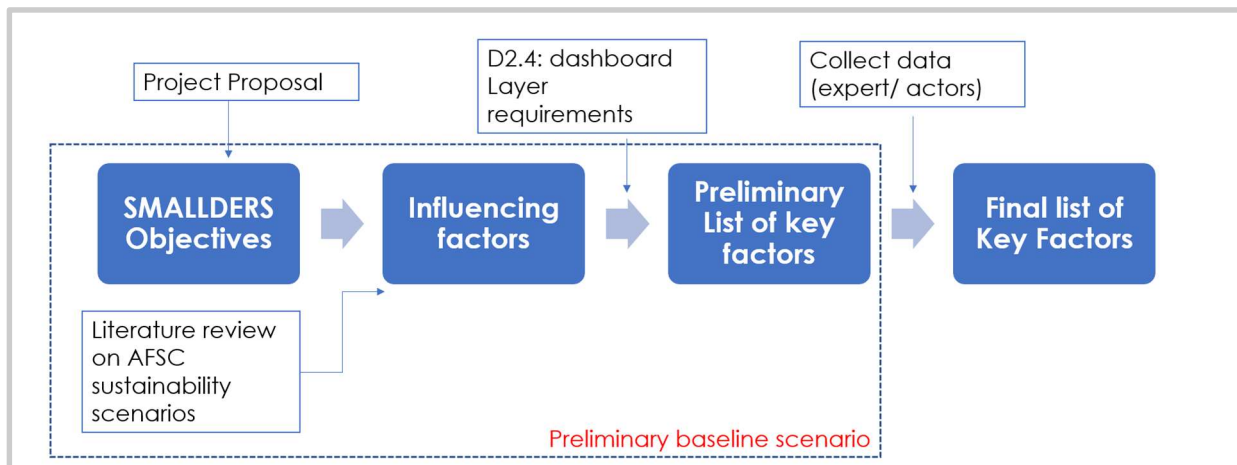

Figure 3 Steps for setting the final list of key factors required to develop the baseline scenario.

In Table 3, the preliminary baseline sustainability scenario "Innovative SMALLDERS Platform for Sustainable Agrifood Local vaLue chain" is presented through describing each key factor option. Preliminary key factors were identified from the review of AFSC sustainability scenarios in subsection 3.2, SMALLDERS objectives, and W2.

Table 3 *Baseline scenario " Innovative "SMALLDERS" Platform for Sustainable Agrifood Local VaLue Chain"*

Key factor	Option description
Mobile and web application, Virtual shops, e-commerce	- all AFSC actors have internet access (Long Range Wide Area Network (LoRaWAN), Wi-Fi; mobile communication (e.g., 4G/5G)) - all AFSC players use digital tools (smartphone, digital tablet, etc.)

Digital technologies	Use of blockchain technology to ensure high traceability of agri-food products by: ● certify the origin of different products to be monitored through IoT networks on the field; ● certify the use of different monitored resources (e.g., water) inside the involved farms; ● certify the traceability of products involving an interaction among multiple actors cooperating in the SMALLDERS platform. Use Sensors and IoT services: ● Plant health sensors, providing information about the smallholders' crops health. ● Flowmeters or water consumption sensors to monitor the water consumption on the field ● Environmental sensors data, aiming at collecting information about the status of the environment around the crops (e.g., a weather station, pressure, wind, humidity, temperature levels, temperature, and pressure of food). ● Use QR code inventories monitoring ● Use QR code for production tracking ● Fuel consumption sensors ● Localization sensors (e.g., based on GPS) to track shipments, whether automatic tracking systems are not available from freight transport companies.
Artificial intelligence in value chain	- Smart assistant to be used in rural e-commerce system (assistant vocal intelligent) - Use AI navigator
Sustainability-based multi-capitals (indicators: pollution, Resources availability / Use...)	Sustainability-based multi-capital with the number of sustainability capitals as defined in KPI-O5-1(O5-1:"Increasing the Multi-Capital Sustainability of Smallholders processes"). So, the number of sustainability capitals is defined between 8 to 12: natural capital, social capital, financial capital, shareholders' capital, image capital, ethical capital, human capital, intellectual capital, relational capital, stakeholders capital and material capital.

	Different indicators are defined per capita for each actor (see D2.4) in order to be assessed. For example the environmental capital comprises specifically for the smallholders: Global warming potential, Acidification potential Eutrophication potential, Photochemical oxidant formation potential, Abiotic depletion potential – Fossil fuels, Water Scarcity Footprint, Impacts of land use and land use change.
New business model	e-marketplace
Decision-making integration	- Digital twin - sustainability indicators number

4. Study of the sustainability context of the AFSC for smallholders

This section is dedicated to studying and evaluating the sustainability context for smallholders within each Mediterranean country partner in the SMALLDERS project. Therefore, two contexts are distinguished : the Tunisian context (as Tunisia is the north-Africa country partner of SMALLDERS) and the European context involving France, Italy, and Spain. Moreover, it aims at refining and validating the key factors as well as their options previously defined for the development of the baseline sustainability scenario in section 3. To do so, a questionnaire and conducted interviews with experts are elaborated. The objective was to collect their feedback about the key factors considered for defining the baseline scenario as well as their options. Moreover, based on the collected data, the level of applicability of each key factor's option will be refined. Figure 4 below illustrates the aforementioned steps.
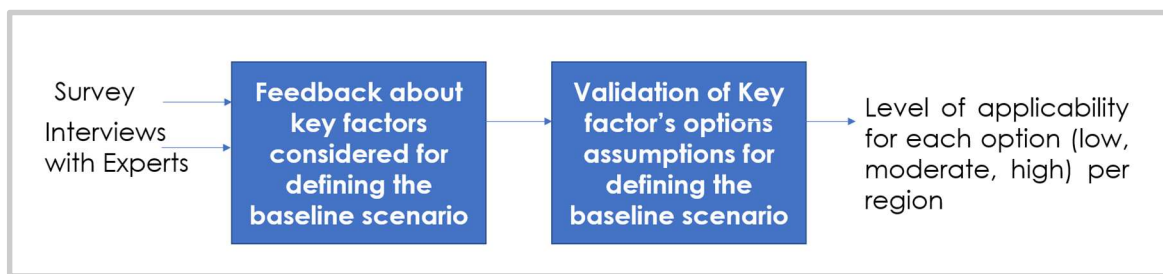

Figure 4 *The process of validating and refining key-factors options for the Tunisian and European context (Italy, France, Spain) to define the baseline scenario*

The questionnaire, that was designed for the survey and interviews with experts, consisted of 4 main parts:

- Q1: Use of digital tools and internet accessibility for smallholders,
- Q2: E-commerce use, market access
- Q3: Digital and new technologies (IoT, AI) applied to agriculture
- Q4: Sustainability capitals and their degree of importance

In the following, the sustainability context for Smallholders in Tunisia as well as European countries (based on the results of the questionnaire) will be presented.

4.1 Sustainability study of Tunisian context

To collect data and key factors options for the Tunisian context, we conducted both i) interviews with experts from CRDA (Regional Commissariat for Agricultural Development, Ministry of Agriculture, Water Resources and Fisheries of Tunisia) of Nabeul and ii) survey with smallholders with lands' surface area less than 5 hectares.

Regarding the interviews with experts, the policymaker's perspective is taken into account. And, regarding the survey, the questionnaire was developed in the online system "Survey Solution" to help signatories answer a series of questions and provide related data. In this survey, demographic characteristics of the smallholders are also identified (e.g., age, gender, education level, etc) and their agricultural activities (type of crops, type of agricultural activity (milk, vegetables…). The questions were about the 2020-2021 agricultural season. At the beginning, a face-to-face questionnaire was launched in the beginning of December. A sample of 200 smallholders is considered in the region of Nabeul (Tunisia). Also, survey meetings and face-to-face interviews were conducted whenever required.

Most of the respondents were men (94%), have a low education level (11,3% university 43,8% High school level, and 40% primary school level,) and are mostly aged between 40 and 60 (54%) against 20% between 25 and 40 and 24% over 60 years. Therefore, it is noted that for 81% of the participants, agriculture represented their main activity for a living.

For the use of digital tools and internet access, the survey with smallholders showed that:

➢ 40% of farms are supplied with the internet;
➢ only 23% of farmers use the internet within their agricultural activities showing that the use of the internet is still limited for smallholders in Tunisia.
➢ 43% of farmers are connected to social networks (so they are using digital tools).
➢ 41% of smallholders are interested in using new production techniques and monitoring tools and 36% have concept knowledge about it.

Regarding e-commerce and market access, 97% of respondents do not use online sales techniques, figures 5 and 6 below show respectively the type or location of market where the farmer sells directly its products and the share of direct sales in the total sales of the smallholder's farm. These results highlight the potential of using e-commerce and online sales techniques to increase direct sales of the smallholder in Tunisia.
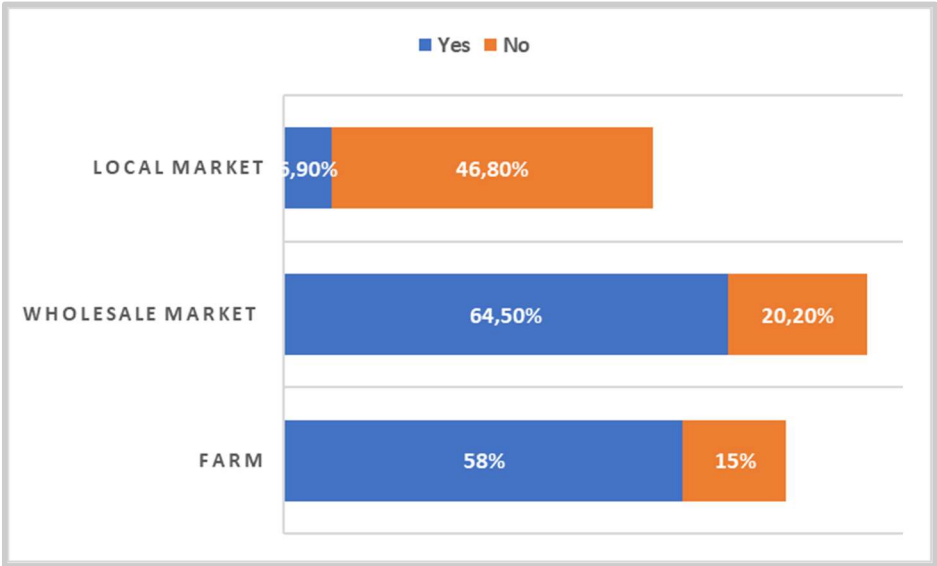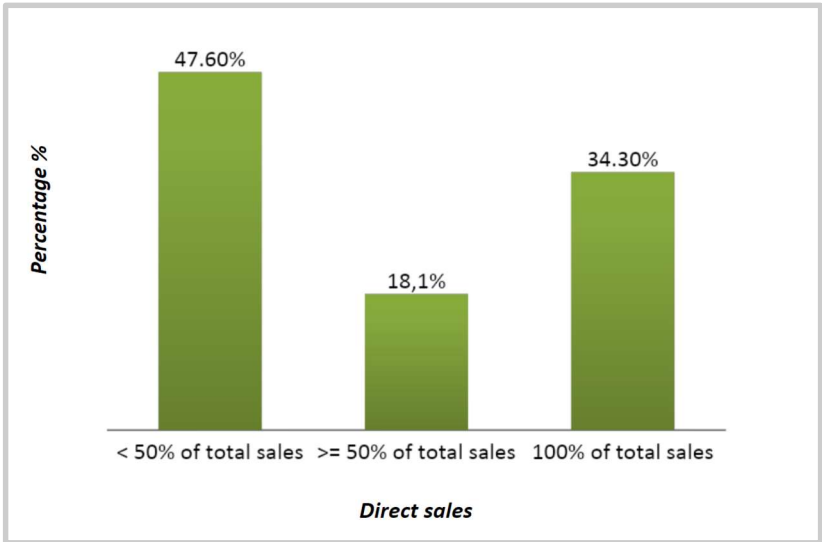

Figure 5 *Sale location repartition*

Figure 6 *The proportion of direct sale to the customer in the total sales*

Regarding the sustainability capitals, the response of smallholders as well as the policy maker are collected. Figure 7 below shows some statistics regarding sustainability-related knowledge and participation desire to sustainable development. As we can see, smallholders showed interest in sustainability considerations in their agricultural activity.
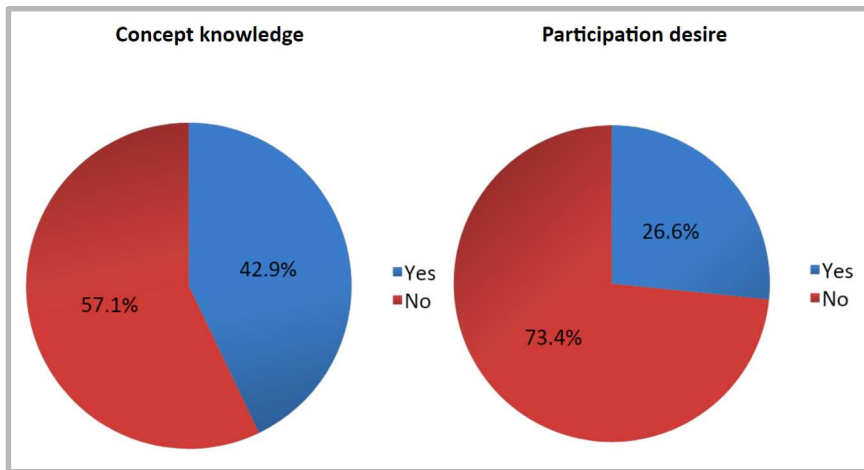
Figure 7 *Interest of smallholders into sustainability concept*

The degree of importance of sustainability capitals from both perspectives (smallholder and policy maker) is illustrated in Figures 8 and 9 respectively. Although the policy maker's response was more accurate than the smallholders' one, some correlation in capital's importance from both actors is noted. For instance, the ethical capital is not important for both smallholders and policymakers. It is also valid for image and intellectual capitals. The main difference is noted for the environmental capital: neutral for policy makers and important for smallholders. In fact, the response of the policy maker was about the actual consideration of environmental issues by smallholders which is very low (e.g., the use of green energy). However, they demonstrated a willingness and a great interest in defining strategies to integrate the environmental dimension in agricultural activity while we were conducting interviews with them.
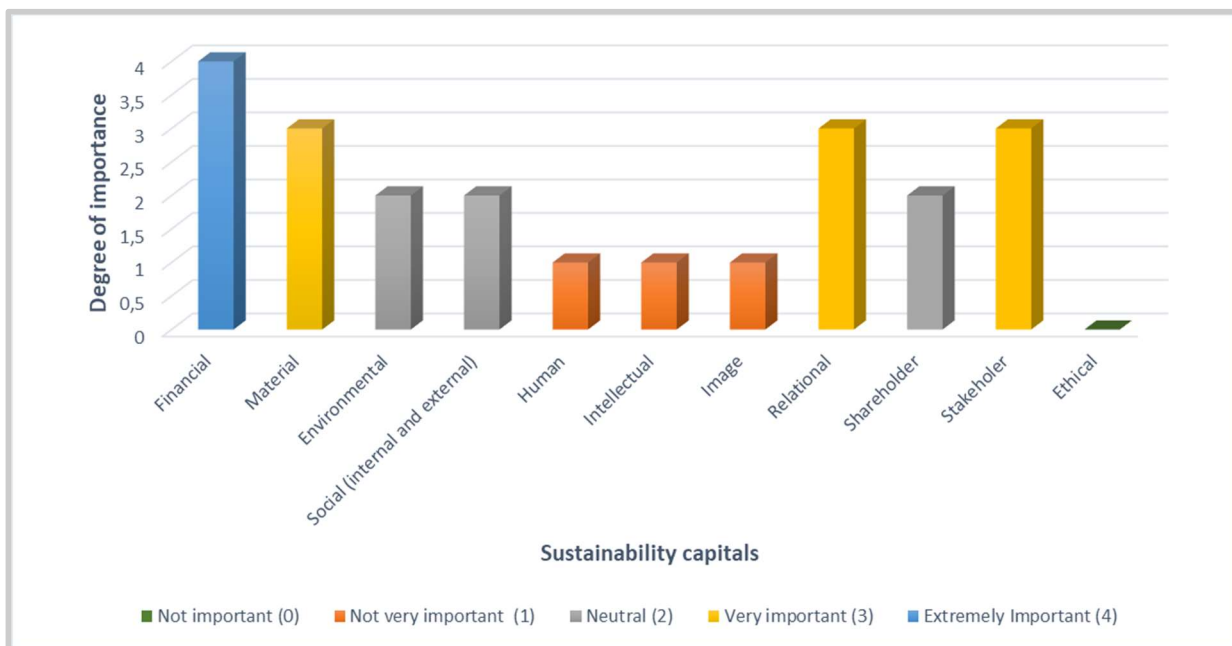
Figure 8 *Degree of the importance of sustainability capital from the policy maker's perspective: Tunisian context*
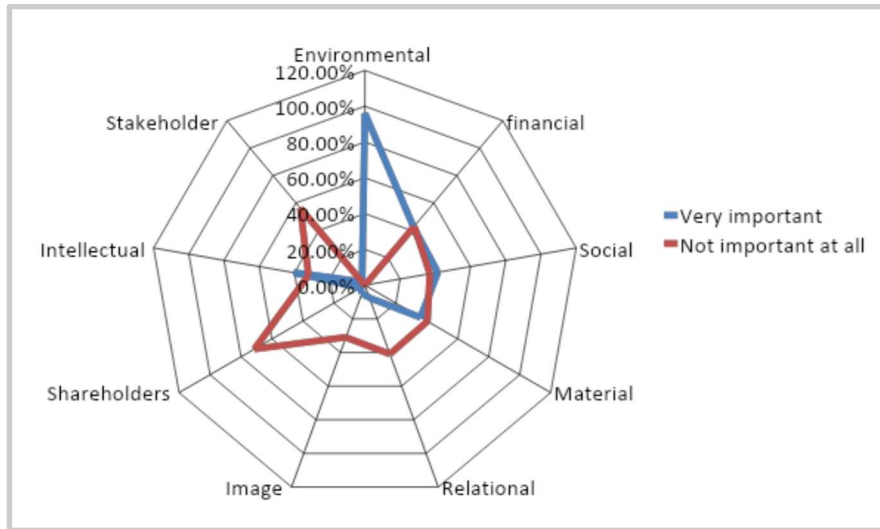

Figure 9 *Degree of the importance of sustainability capital from the smallholder's perspective: Tunisian context*

From all these results, we can better describe the options for the first four key factors through defining the level of applicability of each option. The values for the Tunisian context are presented in the following Table.

Table 4 *Level of applicability of the options within the key factor for Tunisian context*

Key factor's options	Level of applicability in the Tunisian context for Smallholders
- all AFSC actors have internet access (Long Range Wide Area Network (LoRaWAN), Wi-Fi; mobile communication (e.g., 4G/5G)	Low
- all AFSC players use digital tools (smartphone, digital tablet, etc.	Moderate
Use of blockchain technology to ensure high traceability of agri-food products Use Sensors and IoT services	Low to moderate (there is an interest from

- Smart assistant to be used in rural e-commerce system (assistant vocal intelligent) - Use AI navigator	smallholders to their use)
- Sustainability capitals	The first 8 sustainability capitals that could be retained (sorted in decreasing order of importance) are: Financial, Relational, stakeholders, shareholders, environmental, Social (internal and external), Material, intellectual.

4.2 Sustainability study of EU context (French, Italian, Spanish)

To collect data and key factor options for the European context, interviews with external partners or experts of each country (French, Italian, Spanish) are conducted. On the side of the Spanish study, experts from the Fruit Growers Association from Extremadura (AFUREX) (which represents the smallholder's perspective) were interviewed. From France, interviews with Le Mas des Agriculteurs (a company that offers healthy products from local agriculture, in the south of France, without intermediaries) were conducted . An Italian expert in AFSC was also interviewed.

From the collected responses, the key factor options and its level of applicability are grouped in Table 5. We can see that access to the internet in the three contexts is high in farms (contrary to the Tunisian context) as well as the use of mobile as a digital tool. However, there is not a strong use of e-commerce (digital platform) in agricultural activity for the Italian context. The use of sensors to track and monitor the production (through tracking daily production, inventory level and yield and productivity) and storage (temperature, quantity) is high in the three countries with some differences in the parameters to be tracked (see Table 5). The use of blockchain technology is not well defined for the italian and french contexts. Instead, they propose "connection with sensors on the field" as platform features that could improve production tracking contrary to the Spanish partner. Finally, regarding the sustainability capitals, a sustainable strategy is already adopted by the association of smallholders in Spain. The degree of importance of sustainability capitals for the European countries is illustrated in Figure 10. From these results, it is noteworthy that for the Spanish context, sustainability capitals that could be retained (sorted in decreasing order of importance) are: Human, intellectual, shareholders, Financial, social, environmental, Relational,.. However, for France and Italy,

financial, social, environmental and Human capitals were chosen as very important and neutral positions were chosen for all the remaining capitals.

In conclusion, even for the European context, a baseline scenario per country should be defined. This could be explained by the differences between key factors options for each partner although there are some similarities. These similarities include: the access to internet; the use of sensors, the importance of human, environmental, financial and social capitals and the neutral position toward the stakeholder, ethical and material capitals. The differences are attributed to the use or not of a platform, the kind of parameters that could be tracked by sensors as well as the importance of the intellectual and shareholders capitals (crucial for the Spanish association and neutral for experts from Italy and France).
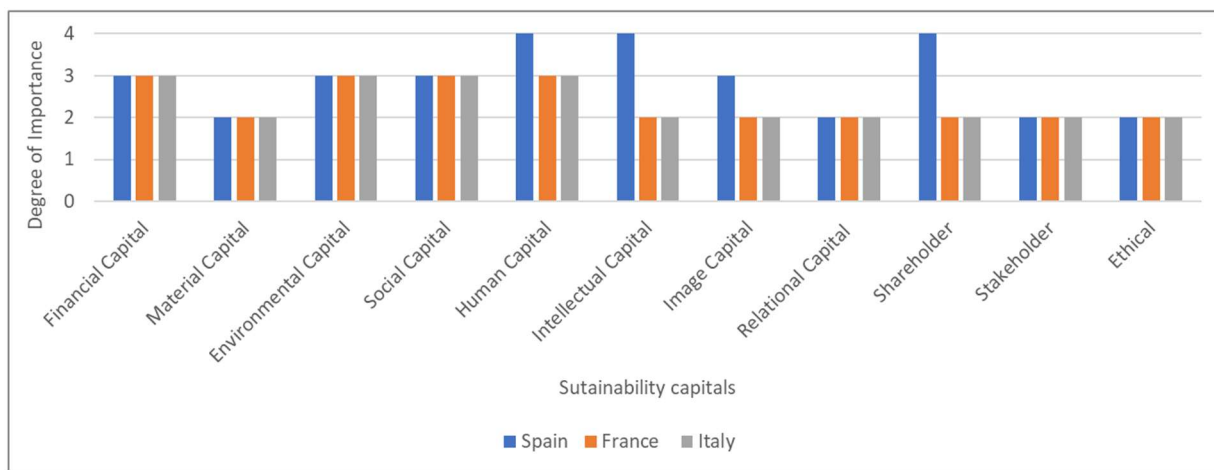

Figure 10 *Degree of the importance of sustainability capitals from expert judgements in the EU context*

Table 5 *Level of applicability of the options within the key factor for EU context for smallholders based on expert judgment*

Key factor's options	Level of applicability in the Spanish context	Level of applicability in the French context	Level of applicability in Italian context
- all AFSC actors have internet access (Long Range Wide Area Network (LoRaWAN), Wi-Fi; mobile communication (e.g., 4G/5G)	High	High	High
- all AFSC players use digital tools (smartphone, digital tablet, etc.)	High	High Use of a platform	Moderate : do not use a platform nor e-commerce
Use of blockchain technology to ensure high traceability of agri-food products Use Sensors and IoT services	- High - use of sensors to track the daily production, Inventory level, Yield and Productivity, and to monitor storage		

		Parameters to track Water Consumption, Stock temperatures, Product location in the warehouse, Humidity	Parameters to track Operators working per day, Food waste, Water Consumption, Stock temperatures, Product quantity, Product location in the warehouse
- Smart assistant to be used in rural e-commerce system (assistant vocal intelligent) - Use AI navigator	High	low	low
- Sustainability capitals	The first 8 Sustainability capitals that could be retained (sorted in decreasing order of importance) are: Human, intellectual, shareholders, Financial, social, environmental, Relational, image.	The first 8 Sustainability capitals that could be retained (sorted in decreasing order of importance) are: Financial, Environmental, Social, Human, intellectual, shareholders, Relational, image. (The first four are very important, the remaining capitals : neutral)	

5. Conclusion

In this deliverable, a study of the sustainability context of the agri-food supply chain for smallholders was presented. It was conducted on three steps. The first one consisted of studying the legislative context and standards related to AFSC sustainability topics. The Tunisian and European related regulations were briefly analyzed in order to understand the difference in the regulatory framework of each country. Then, a review of sustainability scenarios for the AFSC was conducted where the methodology for scenario development was identified as well as main key factors required for AFSC scenarios development in literature. This allowed us to define a preliminary set of key factors, from which a preliminary baseline scenario for the SMALLDERS project is developed. In order to validate these latter, a study of the sustainability context for smallholders in each country partner of the SMALLDERS project was presented. This study was based on questionnaires with smallholders and interviews with experts in AFSC. The study of sustainability context showed that there are some disparities in sustainability consideration in AFSC especially regarding the options for the defined key factors. It suggests the identification of four baseline scenarios, one per country in order to consider the specificities.

In order to better define specific scenarios for each country, questionnaires/interviews with AFSC actors for each country will be carried out and their results will be provided in future deliverables. Regarding the Tunisian context, a Workshop will be held on May 03, 2023, where the different actors of the Tunisian AFSC will be present in order to make roundtables to specify more the options for the Tunisian baseline scenario.

References

APC website, https://agriculture.ec.europa.eu/sustainability/environmental-sustainability_en, last update 2022, consulted the Mars 28th, 2023

FAO (2015). Developing sustainable food value chains – Guiding principles. Rome.

FAO (2019). Sustainability assessment of food and agriculture systems. Rome, Italie.

ESG & Sustainability Reporting Guidance, 2015

ALDI website, https://www.aldi-nord.de/en/sustainability-report/2017/key-topics/sustainable-standards-in-the-non-food-supply-chain.html, latest update 2018

Standardsmap website. https://www.standardsmap.org/fr/identify, last updated August 2021, consulted the Mars 27th, 2023

Meemken, EM., Barrett, C.B., Michelson, H.C. et al. Sustainability standards in global agrifood supply chains. Nat Food 2, 758–765 (2021). https://doi.org/10.1038/s43016-021-00360-3

EUR-Lex website. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=legissum:4314872, last update May, 3rd 2022, consulted the Mars 28th, 2023

Ben Becher, L. Tunisia: a new agricultural policy to meet the challenges of sustainability Report, International Center for Advanced Mediterranean Agronomic Studies (CIHEAM), September 2016

Ferchichi, W and Hammami-Marrakchi, A. "Ten Years of Environmental Legislation 2011-2021 Legislative Overview". A Report published by the office of the Heinrich Böll Foundation in Tunis, Tunisia, November 2021

Jiang, S., Chen, H., Yang, S. et al. Assessment and scenario hypothesis of food waste in China based on material flow analysis. npj Urban Sustain 3, 2 (2023). https://doi.org/10.1038/s42949-022-00081-x

Luo J, Ji C, Qiu C, Jia F. Agri-Food Supply Chain Management: Bibliometric and Content Analyses. Sustainability. 2018; 10(5):1573. https://doi.org/10.3390/su10051573

Melkonyan, A., Gruchmann, T., Huerta, A., Krumme, K. (2019). Scenario Planning for Sustainable Food Supply Chains. In: Melkonyan, A., Krumme, K. (eds) Innovative Logistics Services and Sustainable Lifestyles. Springer, Cham. https://doi.org/10.1007/978-3-319-98467-4_10

Moller, B.; Voglhuber-Slavinsky, A.; Dönitz, E. Three Scenarios for Europe's Food Sector in 2035; Fraunhofer ISI: Karlsruhe, Germany, 2020.

Van der Vorst, J.; Da Silva, C.; Trienekens, J.;. Agro-industrial supply chain management: concepts and applications. FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS.Rome, 2007

Van Notten, P. (2006). Scenario development: A typology of approaches. ICIS, NL.

Voglhuber-Slavinsky, A.; Derler, H.; Moller, B.; Dönitz, E.; Bahrs, E.; Berner, S. Measures to Increase Local Food Supply in the Context of European Framework Scenarios for the Agri-Food Sector. Sustainability 2021, 13, 10019. https:// doi.org/10.3390/su131810019