FOLOU
D2.1 – Standard Research Protocol for the Data Collection

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Abbreviations

CG: Commodity Group

DPSIR: Drivers-Pressure-State-Impact-Responses

EU: European Union

FAIR: Findable, Accessible, Interoperable, Reusable (data)

GHG: Greenhouse Gases

FL: Food Loss

FSC: Food Supply Chain

WP: Working Package

Glossary

Driver: a driver is considered as any natural or human-induced factor that directly or indirectly generates an output, namely Food Loss.

A *direct* driver is a factor that influences production processes and the consequent generation of Food Loss. Direct drivers can be identified, and their effects measured with differing degrees of accuracy.

An *indirect* driver operates by altering the level or rate of change of one or more direct drivers. According to the Food Loss registry developed in Task 1.1, the causes are the proximate reason for the occurrence of Food Loss, while drivers are the underlying factor that plays a role in creating the cause.

Food Loss: any harvest-mature plant, animal or living being (including inedible parts) that is not successfully harvested, as well as food removed from the supply chain during post-harvest phase that is not donated or does not become animal feed, by-product, or food waste. Food Loss is related to the fraction of production intended for human consumption.

Impact: direct and indirect consequences of Food Loss at the farm level (E.g.: economic costs, environmental costs, reduced profit, decreased customer value, reduced labour productivity and wages).

Response: change in individual behaviour, organizational practices, institutions, and policies induced by Food Loss impacts;

Executive Summary

The generation of Food Loss in the primary production sector is generated by a complex set of interactions between behavioural, environmental, and societal drivers. Those drivers are related with impacts of Food Loss at different levels (social, environmental, and economic) and can lead to a wide set of responses.

The adoption of dedicated qualitative data collection and analysis approaches can help to investigate the interrelations between drivers, impacts, and responses to Food Loss in different Food Supply Chains. This increased knowledge of mechanisms behind the generation of FL can also help to understand the efficacy of Food Loss reduction measures and strategies that are currently adopted, and to design tailored and efficient measures to reduce FL in the future.

This document provides a theoretical framework, adapted from the Drivers-Pressures-State-Impacts-Responses (DPSIR) model, to frame and investigate the Drivers, Impacts, and Responses to Food Loss in different Food Supply Chains at the EU level. Also, it includes guidelines for qualitative data collection, aiming to guide researchers in an efficient and harmonized data collection process.

1. Introduction

Every year a large amount of edible food is lost all along the Food Supply Chain, from primary sector to consumption sector. Food Loss and Waste have several negative impacts on society, from the increase of GHG emission in the atmosphere, to a degradation of the environment and, nevertheless, to consistent economic losses for the actors of the Food Supply Chain (FSC).

Within this context, in the primary sector Food Loss (FL) plays a relevant role in the generation of negative externalities for the society. However, the knowledge and understanding of root causes of FL is still lacking, especially concerning the direct and indirect drivers influencing the exit of still edible products from primary sector in different Commodity Groups.

To fill this gap in knowledge of Food Loss drivers, FOLOU WP2 aims to investigate the direct and indirect drivers and causes behind FL as well as its impacts and the most efficient responses to be adopted for its mitigation. This investigation will be conducted reviewing secondary data currently available and adopting a participatory approach through the inclusion of stakeholders from different CGs in the FOLOU activities.

In the framework of the FOLOU project, a FL definition and boundaries have already been proposed, currently under discussion with field experts. Starting from it, the Data Collection Protocol defines a theoretical framework to investigate Drivers, Impacts and Responses to Food Loss and provide guidelines for qualitative data collection, to be conducted with a wide range of stakeholders involved in the Food Supply Chains investigated within FOLOU.

The document is organized as follows:

Chapter 2 introduces the definitions of Food Loss and system boundaries that will be adopted in the research conducted within the WP2 of FOLOU, that are coherent with the definition proposed in the FOLOU Food Loss Quantification Manual [LINK] and in the FOLOU Food Loss Definitional Framework [LINK].

Chapter 3 defines a behavioural framework for the analysis of drivers, impacts, and responses related to Food Loss. The framework, based on the Drivers-Pressures-State-Impacts-Responses (DPSIR) model, describes Food Loss as a phenomenon generated by Behavioural, Environmental, and Societal drivers, with Impacts on the environment, economy, and society, and Responses that could be adopted to mitigate its effects.

Chapter 4 provides guidelines for the qualitative data collection that will be conducted in WP2. Specifically, it provides guidelines for sampling and conduction of semi-structured interviews with representatives of associations of producers and for focus groups with primary sector producers. This chapter also includes guidelines for harmonized data collection.

Chapter 5: provides guidelines to ensure sharing and comparability of data through a data standardization protocol. This standardization protocol will ensure the compliance of FOLOU research output with the FAIR principles promoted by the EU.

2. Definition of Food Loss and of System boundaries

The definitions of Food Loss and of System boundaries adopted in this Data Collection Protocol rely on those included in the FOLOU Food Loss Quantification Manual [LINK] and in the FOLOU Definitional Framework [LINK], to ensure coherence and comparability of data collection and research findings within the project.

2.1 Definition of Food Loss

According to the definition included in the Definitional Framework document, Food Loss is defined as:

Any harvest-mature plant, animal or living being (including inedible parts) that is not successfully harvested of collected, as well as food removed from the supply chain[1] during post-harvest phase that does not become animal feed, by-product, or food waste.

Given the complexity of the topic, the definition needs to be specified for each Commodity Group investigated in the project. Within FOLOU, Food Loss is specifically defined for 4 food groups: plant-based food, meat and animal products, aquaculture and fisheries, and wild food. Therefore, as each food group has its specific process along the supply chain, *Table 1* includes the definitions of Food Loss considered for each one. The definitions reflect those proposed in the FOLOU Definitional Framework.

Table 1. Food Loss definition for FOLOU Commodity Groups.

Food Group	Commodity Groups	Food Loss Definition
Plant-based food	Fruits and vegetables; Cereals and pulses; Roots, tubers, and oilseeds	Unharvested food, that does not get into the next step of the supply chain due to spoilage during harvesting, transportation, and storage, or due to market frictions. Post-harvest FL includes losses generated during the post-harvest stages of transportation, storage, preparation necessary for storage (e.g., packaging), and food rejected by buyers that return to the production site.
Meat and animal products	Meat[2], dairy, and eggs	*Meat*: FL in meat sector consist in the deaths of animals between the moment in which they are ready to be slaughtered and the actual of slaughtering.
		Milk: post-harvest FL for milk consist of: i) milk removed from cows during the first 6 days of lactation; ii) milk affected by antibiotic contamination; iii) milk discarded due to wrong conservation processes; iv) milk rejected by processors
		Eggs: post-harvest FL for eggs include downgraded eggs not used for human or animal consumption
Fish-based products	Aquaculture and fisheries	*Aquaculture:* FL in this sector is generated from the moment when fish is ready to be collected and the actual catch. It includes fish discarded due to diseases, escaped from the farm, fish left on the boat or not landed for any reason.
		Fisheries: FL in fisheries consists in all the fish left on the boat or not landed for any reason.
Wild foods	Wild foods: wild fish, mushrooms, game, wild plants	FL for wild food includes all food spoiled during harvesting or because of inadequate conservation procedures.

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[1] Donated food is considered part of the Supply Chain and it is excluded from the definition of Food Loss.

[2] Food discarded at the slaughterhouse is considered food waste.

2.2 System boundaries

Within FOLOU project, Food Loss is considered as produced in the primary production sector in pre-harvest, harvest, and first post-harvest phases of food products. Also, FL is related to the fraction of production intended for human consumption.

The FOLOU Definitional Framework defines the starting and ending points of the primary production sector and the phases of pre-harvest, harvest, and post-harvest that are considered in the analysis of Food Loss generated for the different produces. The FOLOU boundaries are shown in the following *Figure 1*:
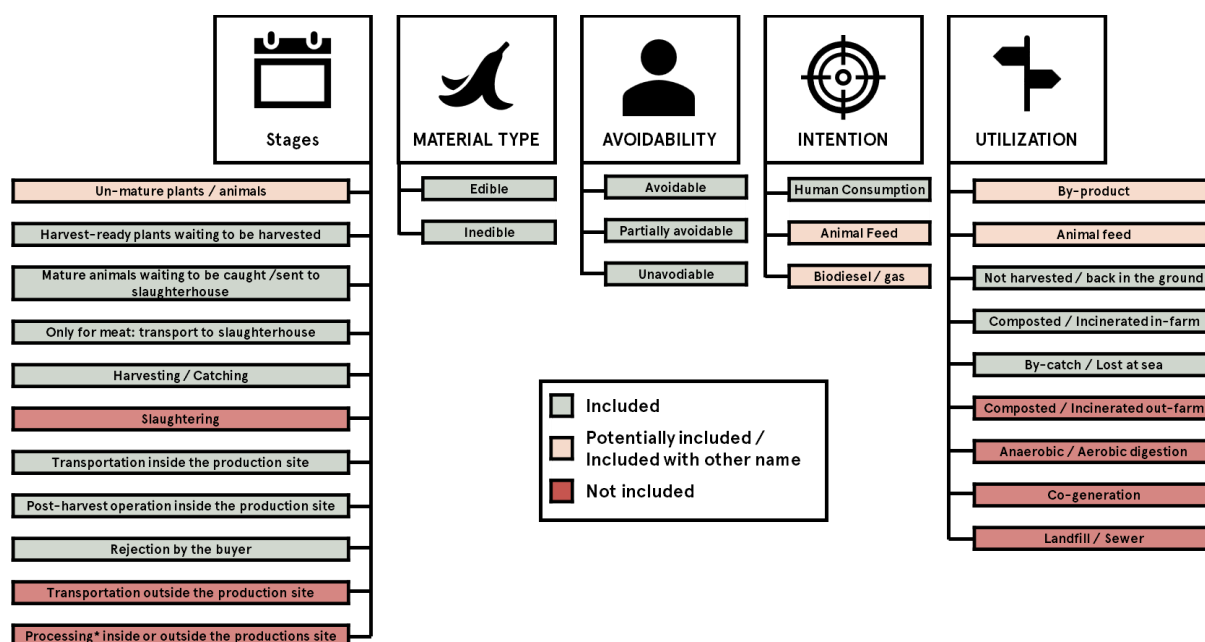
Figure 1. primary production sector system boundaries. Source: FOLOU Definitional Framework [LINK]

2.2.1 Boundaries of primary production sector

FOLOU project follows the definition of primary sector proposed in the FUSIONS European project[3] and by FAO[4] defining the entry point of the primary sector as:

- When crops, fruits, and berries are mature for harvest;
- The harvesting of wild crops, fruits, and berries;
- When animals are ready for slaughter;
- When wild animals are caught or killed;
- The collecting of milk from animals;
- The catching of wild fish;
- When fish from aquaculture is mature in the pond.

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[3] Östergren, K.; Gustavsson, J.; Bos-Brouwers, H.; Timmermans, T.; Hansen, O.J.; Møller, H.; Anderson, G.; O'Connor, C.; Soethoudt, H.; Quested, T. FUSIONS definitional framework for food waste; 2014.

[4] Carola, F.; Alicia, E. Methodological proposal for monitoring SDG Target 12.3. The Global Food Index design, data collection methods and challenges; Rome, 2018.

The ending point of primary sector is considered when:

- Crops, fruits, and berries leave the production site or are processed, regardless which phase comes first;
- Animals are slaughtered (not including slaughtering process);
- Eggs and milk leave the production site or are processed, regardless which phase comes first;
- Wild fish is landed;
- Farmed fish leave the production site or are processed, regardless which phase comes first.

2.2.2 Definition of pre-harvest, harvest, and post-harvest phases

FOLOU considers Food Loss as produced in 3 different stages of the primary production sector: pre-harvest phase, harvest phase, and post-harvest phase of food products.

- Pre-harvest phase: Food Loss generated in this phase of the primary production includes FL occurring from the moment when the food is ready for collecting (harvesting, slaughtering, and catch), to the actual moment of collecting.
- Harvest phase: FL in this phase is due to mechanical damage and spilling occurring during the collecting operations. It does not include losses from slaughtering, that is considered as processing stage.
- Post-harvest phase: Food Loos generated in this phase includes losses occurring during transportation, storage, or preparation for storage (e.g., sorting, basic packing) and until food leaves production site. FL in this phase also includes food rejected by buyers that return to the production site.

3. Definitions and scope of the Protocol

3.1 The FOLOU framework for the investigation of FL drivers

This section describes the theoretical framework adopted for the analysis of FL drivers and responses. The FOLOU framework has its theoretical roots in the Drivers-Pressure-State-Impact-Responses (DPSIR) framework.

The DPSIR framework is a Framework methodology to describe the interactions between society and the environment through 5 categories of elements: Driving forces, Pressures, States, Impacts and Responses. It has also been adopted to investigate dynamics of the agrifood systems, including the generation of food waste[5].

In particular, Driving Forces are macroeconomic, sociocultural, technological, policy factors that shape the activities of the actors of the considered sector, for example, labour markets dynamics, technological innovation, cultural change.

Pressures are individual and institutional aspects endogenous to the system. Examples related to the agrifood system are e.g., farmers' choices about land, fertilizer, and use of water, retailers' choices, market demand.

The element State describes the by current conditions in parameters of interest, for example quantity of food materials discarded, regional food loss patterns, environmental footprint.

Finally, Impacts include the economic, social, and environmental side-effects and costs of a phenomenon, while Responses describe changes in behaviour, practices, institutions, and policies induced by the considered phenomenon.

To better understand the peculiarities of the Food Loss phenomenon, the DPSIR framework has been modified and adapted to the FL domain. The result of this process is a new behavioural framework specifically designed for the research activities on Drivers, Impacts, and Responses to Food Loss to be conducted in FOLOU.

The FOLOU framework, represented in *Figure 2*, conceptualizes Food Loss drivers and responses through 5 categories of elements: Behavioural, Societal, and Environmental drivers (deriving respectively from Driving Forces, Pressures, and State elements of the DPSIR framework), Impacts, and Responses. The framework will be validated and eventually expanded through the research conducted within FOLOU.

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[5] Cristóbal Garcia, J., Vila, M., Giavini, M., Torres de Matos, C., Manfredi, S., 2016. Prevention of Waste in the Circular Economy: Analysis of Strategies and Identification of Sustainable Targets - The food waste example. https://doi.org/10.2760/256208
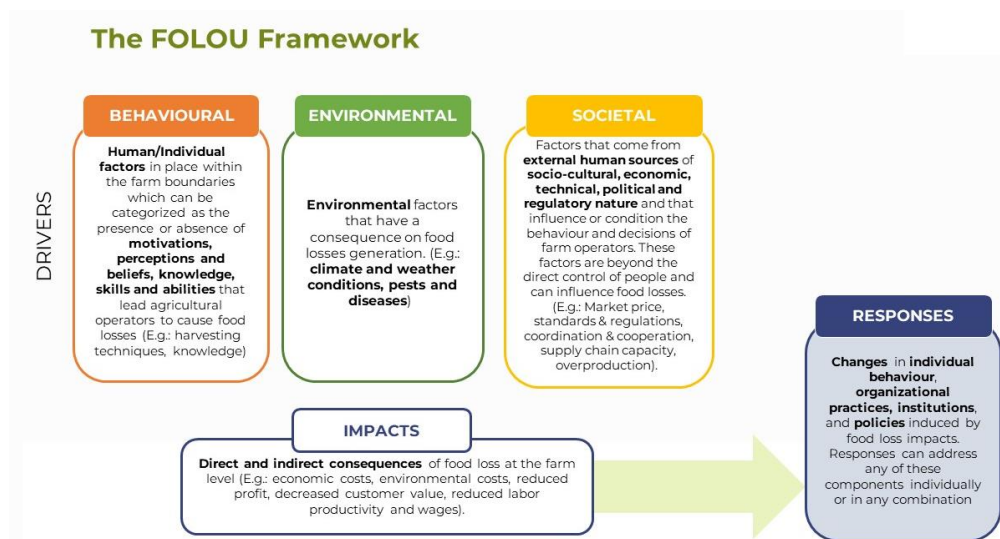
Figure 2. The FOLOU framework.

Elements included in each of those 5 categories are peculiar for each CG included in the FOLOU activities and, consequently, in data collection.

The next subsections describe the elements of the FOLOU framework for each Commodity Group investigated in FOLOU:

- Fruit and Vegetables
- Cereals and Pulses
- Roots, Tubers, and Oilseeds
- Meat and Animal products
- Aquaculture and Fisheries

The elements of the framework for each CG to be investigated in FOLOU were selected through a 2-steps process. First, a collaborative literature review was conducted by the members of the Consortium to identify drivers, impacts and responses to Food Loss investigated in the scientific and grey literature produced in the last 10 years.
Then the list of elements identified in literature has been validated and expanded through a process of expert consultation conducted both with members of FOLOU consortium and through a survey submitted to a wide range of producer and experts operating in the supply chains of Commodity Groups considered in the project activities.

3.1.1 Behavioural drivers

Within FOLOU, behavioural drivers are considered as human factors in place within the farm boundaries which can be categorized as the presence or absence of motivations, perceptions and beliefs, knowledge, skills, and abilities that lead agricultural operators to cause Food Loss.

Behavioural drivers identified for the 5 FOLOU Commodity Groups are presented in *Table 2*.

Table 2. Behavioural drivers identified for the 5 FOLOU Commodity Groups.

Fruit & Vegetables	Cereals & Pulses	Roots, Tubers, Oilseeds	Meat & animal products	Aquaculture & fisheries
Lack of knowledge of market demand	Lack of knowledge of market demand	Lack of knowledge of market demand	Lack of knowledge of market demand	Lack of knowledge of market demand
Lack of knowledge of harvest/post-harvest technologies	Lack of knowledge of harvest/post-harvest technologies	Lack of knowledge of harvest/post-harvest technologies	Lack of knowledge of harvest/post-harvest technologies	Lack of knowledge of harvest/post-harvest technologies
Lack of training	Lack of training	Lack of training	Lack of training	Lack of training
Lack of investment capacity	Lack of investment capacity	Lack of investment capacity	Lack of investment capacity	Lack of investment capacity
Inappropriate choice of product varieties (e.g., crops, breed…)	Inappropriate choice of product varieties (e.g., crops, breed…)	Inappropriate choice of product varieties (e.g., crops, breed…)	Inadequate or improper handling of the product	Inappropriate choice of product varieties (e.g., crops, breed…)
Inadequate or improper handling of the product	Inadequate or improper handling of the product	Inadequate or improper handling of the product	Wrong collecting time (harvesting, catching…)	Inadequate or improper handling of the product
Wrong collecting time (harvesting, catching…)	Wrong collecting time (harvesting, catching…)	Wrong collecting time (harvesting, catching…)	Wrong communication strategies by producers	Wrong collecting time (harvesting, catching…)

3.1.2 Societal drivers

In the FOLOU framework, Societal Drivers are defined as factors deriving from external human sources of socio-cultural, economic, technical, political and regulatory nature that influence or condition the behaviour and decisions of farm operators. These factors are beyond the direct control of producers and can influence Food Loss. Examples of Societal drivers are market price, standards and regulations, coordination and cooperation within the FSC, FSC capacity, overproduction.

Societal drivers identified for the 5 FOLOU Commodity Groups are presented in *Table 3*.

Table 3. Societal drivers identified for the 5 FOLOU Commodity Groups.

Fruit & Vegetables	Cereals & Pulses	Roots, Tubers, Oilseeds	Meat & animal products	Aquaculture & fisheries
Low market price of food products	Low market price of food products	Low market price of food products	Low market power of farmers due to unfair contracts	Low market power of producers due to unfair contracts
Low market power of farmers due to unfair contracts	Low market power of farmers due to unfair contracts	Low market power of farmers due to unfair contracts	Marketing and industry standards (weight, aesthetic standards, size, and shape)	Marketing and industry standards (weight, aesthetic standards, size, and shape)
Marketing and industry standards (weight, aesthetic standards, size, and shape)	Marketing and industry standards (weight, aesthetic standards, size, and shape)	Marketing and industry standards (weight, aesthetic standards, size, and shape)	Food safety regulations and standards	Food safety regulations and standards
Food safety regulations and standards	Food safety regulations and standards	Food safety regulations and standards	Lack of coordination and communication among the supply chain actors	Lack of coordination and communication among the supply chain actors
Lack of coordination and communication among the supply chain actors	Lack of coordination and communication among the supply chain actors	Lack of coordination and communication among the supply chain actors	Lack of skilled labour availability	Lack of skilled labour availability
Supply chain cannot absorb all the production	Supply chain cannot absorb all the production	Supply chain cannot absorb all the production	Inefficient cold chain maintenance	Inefficient cold chain maintenance
Lack of skilled labour availability	Lack of skilled labour availability	Lack of skilled labour availability		Inadequate or lacking traceability
Inefficient storage infrastructure	Inefficient storage infrastructure	Inefficient cold chain maintenance		
Inefficient cold chain maintenance	Inefficient cold chain maintenance	Inefficient transportation infrastructure		
Inefficient transportation infrastructure	Inefficient transportation infrastructure	Inadequate or lacking traceability		
Inadequate or lacking traceability	Inadequate or lacking traceability			

3.1.3 Environmental drivers

The FOLOU Framework considers Environmental Drivers as environmental factors that have a consequence on Food Loss generation. Examples of Environmental Drivers are climate and weather conditions, pests and diseases.

Environmental drivers identified for the 5 FOLOU Commodity Groups are presented in *Table 4*.

Table 4. Environmental drivers identified for the 5 FOLOU Commodity Groups.

Fruit & Vegetables	Cereals & Pulses	Roots, Tubers, Oilseeds	Meat & animal products	Aquaculture & fisheries
Unexpected climate and weather events	Unexpected climate and weather events	Unexpected climate and weather events	Unexpected climate and weather events	Unexpected climate and weather events
Pests and diseases	Pests and diseases	Pests and diseases	Pests and diseases	Pests and diseases
Phytosanitary issues	Phytosanitary issues	Phytosanitary issues	Phytosanitary issues	Consumption or damage by insects, rodents, birds, or microbes (e.g., molds, bacteria)
Soil deterioration	Soil deterioration	Soil deterioration	Soil deterioration	
Consumption or damage by insects, rodents, birds, or microbes (e.g., molds, bacteria)	Consumption or damage by insects, rodents, birds, or microbes (e.g., molds, bacteria)	Consumption or damage by insects, rodents, birds, or microbes (e.g., molds, bacteria)	Consumption or damage by insects, rodents, birds, or microbes (e.g., molds, bacteria)	

3.1.4 Impacts

Within FOLOU Impacts of Food Loss are defined as direct and indirect consequences of FL at the farm level. Examples include economic costs, environmental costs, reduced profit, decreased customer value, reduced labour productivity and lower wages. This definition of Impact is coherent with the one proposed by the DPSIR framework.

Impacts of FL identified for the 5 FOLOU Commodity Groups are presented in *Table 5*.

Table 5. Impacts of Food Loss for the 5 FOLOU Commodity Groups.

Fruit & Vegetables	Cereals & Pulses	Roots, Tubers, Oilseeds	Meat & animal products	Aquaculture & fisheries
Low availability of food in the market (food scarcity)	Low availability of food in the market (food scarcity)	Low availability of food in the market (food scarcity)	Low availability of food in the market (food scarcity)	Low availability of food in the market (food scarcity)
Decreased financial resources for investment in other sectors	Decreased financial resources for investment in other sectors	Decreased financial resources for investment in other sectors	Decreased financial resources for investment in other sectors	Decreased financial resources for investment in other sectors
Reputation damage to the company	Reputation damage to the company	Reputation damage to the company	Reputation damage to the company	Reputation damage to the company
Decreased overall supply chain performance	Decreased overall supply chain performance	Decreased overall supply chain performance	Decreased overall supply chain performance	Waste of non-renewable energy
Waste of non-renewable energy	Waste of non-renewable energy	Waste of non-renewable energy	Waste of non-renewable energy	Loss of nutrients in aquaculture
Waste of water	Waste of water	Waste of water	Waste of water	Reduced efficiency of catches
Waste of other resources	Waste of other resources	Waste of other resources		
Increased GHG Emissions	Increased GHG Emissions	Increased GHG Emissions		
Social impacts related to the scarcity of food	Social impacts related to the scarcity of food	Social impacts related to the scarcity of food		

3.1.5 Responses

The FOLOU Framework considers Responses to Food Loss as changes in individual behaviour, organizational practices, institutions, and policies induced by FL impacts. Responses can address any of these components individually or in any combination. This definition of Responses is coherent with the one proposed by the DPSIR framework.

Responses to FL identified for the 5 FOLOU Commodity Groups are presented in *Table 6*.

Table 6. Responses to Food Loss identified for the 5 FOLOU Commodity Groups.

Fruit & Vegetables	Cereals & Pulses	Roots, Tubers, Oilseeds	Meat & animal products	Aquaculture & fisheries
Activities to raise awareness of supply chain actors	Activities to raise awareness of supply chain actors	Activities to raise awareness of supply chain actors	Activities to raise awareness of supply chain actors	Activities to raise awareness of supply chain actors
Education and communication campaigns with consumers	Education and communication campaigns with consumers	Education and communication campaigns with consumers	Technical innovation (e.g. new production and collection techniques, ICT solutions)	Technical innovation (e.g. new production and collection techniques, ICT solutions)
Identification of alternative markets for food products	Identification of alternative markets for food products	Identification of alternative markets for food products		
Reformulation of market standards	Shorten the supply chain	Shorten the supply chain		
Shorten the supply chain	Reformulation of market standards	Reformulation of market standards		
Investments in research and training	Investments in research and training	Investments in research and training		
Technical innovation (e.g., new production and collection techniques, ICT solutions)	Technical innovation (e.g., new production and collection techniques, ICT solutions)	Technical innovation (e.g., new production and collection techniques, ICT solutions)		

3.2 Aims of the qualitative data collection

Data collected will be used to reach the goals of FOLOU WP2. Qualitative data collected will allow to validate and expand the FOLOU framework, with the aim of unravel hidden interactions between direct and indirect drivers of FL for each of the Commodity Groups included in the project.

Also, results of the qualitative data collection will be a crucial tool to gauge the effectiveness of responses that are already put in place to reduce Food Loss and to design new policies and interventions to reduce FL that are tailored on the specific characteristics and peculiarities of the different case studies.

4. Guidelines for data collection and sampling

In this section, guidelines on data collection methods and sampling are outlined. Data collection structured in the FOLOU project consists of two main phases: the first step envisages holding semi-structured interviews with experts from different Commodity Groups (4.1) and the second step includes focus groups with key stakeholders at the primary sector production level (4.2). Integrating these approaches, a Mixed Methods Research (MMR) methodology is adopted. In line with the overall objective, in the following paragraphs, the methodologies to be employed, the sampling criteria, the types of data to be collected and the expected results for each phase will be illustrated. *Table 7* summarises the planned data collection phases and the identified timeline for conducting the activities. Furthermore, to provide more detailed indications on the specific structure and execution of the planned activities, a training workshop will be organised with that partners involved in data collection and invited to follow. Before the data collection starts, the materials with the detailed guidelines for properly carrying out the semi structured interviews and focus groups as well as the documents for the collected data reporting phase will be provided.

Table 7. Activities and timeline for the data collection.

Activity	Date
→ Detailed guidelines for conducting the interviews and focus groups and material for reporting the data collected are shared with partners involved in data collection.	**M16 (April '24)**
→ Partners attend training workshop for data collection.	**M16 (April '24)**
→ Partners conduct semi-structured interviews.	**M17 – M22 (May to October '24)**
→ Semi-structured interviews reports completed.	**M23 (November '24)**
→ Partners conduct focus groups.	**M24 – M29 (December '24 to May '25)**
→ Focus groups reports completed.	**M30 (June '25)**

4.1 Guidelines for semi-structured interviews

In the semi-structured interviews, the interviewer follows a set of predetermined questions, but has the flexibility to adapt and focus on specific topics according to the answers of the interviewee. Therefore, semi-structured interviews allow for greater exploration of themes and can adapt to the specific context of the interview.

In this context, starting from the FOLOU framework described in Section 3, semi-structured interviews are conducted with the aim of exploring the drivers, impacts and responses associated with Food Loss in different categories of Food Supply Chains involving experts in the fields.

4.1.1 Sampling for semi-structured interviews

To meet the objectives of the semi-structured interviews, the target group selected is the representative organizations of primary sector producers in the five countries: one targeting large producers and the other targeting small-medium producers covering different categories of Commodity Groups as indicated in *Table 8*. It might happen that in some countries representative organization of primary sector producers are not strictly connected to one CG only (e.g. In Spain organisation of producers of vegetables also cover tubers and roots). If this situation occurs, the best option is to choose two different representatives, one for each group within the same organisation. Also, the definition of small, medium and large producer is based on country specific definition for the food supply chain to be investigated. This approach will provide a proxy of the data needed. Considering four interviews for the five countries, a total of 20 interviews will therefore be conducted and reported.

Table 8. Sampling criteria for semi-structured interviews.

Country	Reference code	Interviewee	Commodity Group
Country 1:	A.1	Representative organization of primary sector producers (large producers)	**Vegetables**
	A.2	Representative organization of primary sector producers (small-medium producers)	**Vegetables**
	B.1	Representative organization of primary sector producers (large producers)	**Fruit**
	B.2	Representative organization of primary sector producers (small-medium producers)	**Fruit**
Country 2:	C.1	Representative organization of primary sector producers (large producers)	**Grains and cereals**
	C.2	Representative organization of primary sector producers (small-medium producers)	**Grains and cereals**
	D.1	Representative organization of primary sector producers (large producers)	**Pulses**
	D.2	Representative organization of primary sector producers (small-medium producers)	**Pulses**
Country 3:	E.1	Representative organization of primary sector producers (large producers)	**Aquaculture (farmed fish)**
	E.2	Representative organization of primary sector producers (small-medium producers)	**Aquaculture (farmed fish)**
	F.1	Representative organization of primary sector producers (large producers)	**Fishery (wild fish)**
	F.2	Representative organization of primary sector producers (small-medium producers)	**Fishery (wild fish)**

Country 4:	G.1	Representative organization of primary sector producers (large producers)	**Roots and tubers**
	G.2	Representative organization of primary sector producers (small-medium producers)	**Roots and tubers**
	H.1	Representative organization of primary sector producers (large producers)	**Oil crops**
	H.2	Representative organization of primary sector producers (small-medium producers)	**Oil crops**
Country 5:	I.1	Representative organization of primary sector producers (large producers)	**Meat**
	I.2	Representative organization of primary sector producers (small-medium producers)	**Meat**
	L.1	Representative organization of primary sector producers (large producers)	**Dairy/Milk**
	L.2	Representative organization of primary sector producers (small-medium producers)	**Dairy/Milk**
		Tot: **20 interviews**	

4.1.2 Data collection in the semi-structured interviews

The data collection for each semi-structured interview (from A.1 to L.2, *Table 8*) follows a structure organized in four distinct phases:

- Step 1: Respondents will be firstly provided with a list of FL drivers specifically referring to the food supply chain they are involved in. The list of drivers has been identified through a literature review for the development of the FOLOU framework in the previous steps and has been validated through the distribution of a survey to the experts engaged with support of the project partners. The objective of step 1 is the validation of the list of the previously selected drivers. The interviewees will be asked to contribute by expressing doubts or possible mistakes, or by adding the missing drivers which they consider to be relevant and not yet included in the presented list. The strategy suggested is to circulate the list of the drivers among respondents before the interview to give time to properly prepare for the activity. The time foreseen for step 1 is about 20 minutes.

- Step 2: At this stage, each driver (both those on the presented list and the potentially new ones added) will be rated by the respondent on a Likert scale from 1 to 7, where 1 indicates that the driver is not relevant at all for Food Loss and 7 indicates that its relevance for their specific case is very high. When rating the drivers' relevance, both the frequency at which Food Loss takes place and the quantity of food lost will be considered. Respondents will be asked to provide their motivation for the assigned rating and to give insights about the reasons behind them. The time allocated for this activity is approximately 20 minutes.

- <u>Step 3:</u> In the third step the respondents will be asked about the different impacts caused by FL in their farm or food enterprise. In this sense, impacts are considered the economic, social, and environmental side effects and costs at the different stages of the supply chain in which individual farmers are involved. The time allocated for this activity is approximately 20 minutes.

- <u>Step 4:</u> Starting from the results of the discussion about the drivers and impacts of Food Loss, respondents will be asked to identify what are the responses to Food Loss they are aware of. The FOLOU framework outlines responses as "changes in behaviour, practices, institutions, and policies induced by Food Loss impacts; responses can address any of the preceding components individually or in combination" (3.1). To systematically classify the identified responses, interviewees will need to specify; the actors responsible for their implementation (by whom), the level and stakeholders to which they are directed (to whom), and any potential barrier identified to their implementation. The time allocated for this phase is 30 minutes. to their implementation. The time allocated for this phase is 30 minutes.

The data expected to be obtained from these steps are:

→ A list of validated Food Loss drivers for each category of food supply chain considered, weighted and classified according to their relevance in Food Loss.
→ A list of environmental, social, and economic impacts resulting from Food Loss of each category of food supply chain considered identified by experts.
→ A list of responses to the impacts of Food Loss of each category of food supply chain considered identified by the experts.

4.1.3 How to report data collected through semi-structured interviews

To conduct the interviews and to report the collected data, the interviewers will be provided with an Excel file with a template designed by the University of Bologna (*Table 7*). The document is structured in two sheets: one describing the instructions for conducting the semi-structured interview and another with the data recording matrix. Once the interviews have been conducted and the data reported, it is asked to the interviewers to share the documents by uploading them in the appropriate folder in the FOLOU shared folder. It will be required to fill out one document for each semi-structured interview conducted, so in total, each interviewer will have to submit four documents (*Table 8*).

4.2 Guidelines for focus groups

A focus group is a qualitative research methodology in which a small group of representative stakeholder participants is brought together to discuss and share their opinions, experiences and perceptions on a given topic. For this purpose, one or more moderators are identified to guide the discussion, asking targeted questions to obtain detailed and in-depth information.

In this context, focus groups aim at obtaining a deeper understanding and validating the results of the semi-structured interviews. Through the involvement of experts, it is possible to obtain an in-depth understanding of the complex dynamics and connections between drivers, impacts, and responses.

4.2.1 Sampling for focus groups

To validate the results of the semi-structured interviews, a total of 10 focus groups will be conducted, corresponding to two focus groups for each food supply chain identified for the five reference countries (*Table 9*). In each focus group, from 6 to 8 producers from the reference production sector will be invited to participate. To ensure diversity and representation, half of the producers involved will come from small and medium-sized food enterprise, while the other half will represent producers with large food enterprise. The definition of small, medium and large primary sector producer is based on country specific definition for the food supply chain to be investigated. The ideal goal is to include primary sector producers from different geographical areas of each reference country. To facilitate producers' participation, focus groups could be conducted online.

Table 9. Sampling criteria for focus groups.

Country	Reference code	Categories of participants		Commodity Group
Country 1:	A.3	3 to 4 Primary sector producers (large)	TOT of 6 to 8 participants	**Vegetables**
		3 to 4 Primary sector producers (small-medium)		
	B.3	3 to 4 Primary sector producers (large)	TOT of 6 to 8 participants	**Fruit**
		3 to 4 Primary sector producers (small-medium)		
Country 2:	C.3	3 to 4 Primary sector producers (large)	TOT of 6 to 8 participants	**Grains and cereals**
		3 to 4 Primary sector producers (small-medium)		
	D.3	3 to 4 Primary sector producers (large)	TOT of 6 to 8 participants	**Pulses**
		3 to 4 Primary sector producers (small-medium)		
Country 3:	E.3	3 to 4 Primary sector producers (large)	TOT of 6 to 8 participants	**Aquaculture (farmed fish)**
		3 to 4 Primary sector producers (small-medium)		
	F.3	3 to 4 Primary sector producers (large)	TOT of 6 to 8 participants	**Fisheries (wild fish)**
		3 to 4 Primary sector producers (small-medium)		
Country 4:	G.3	3 to 4 Primary sector producers (large)	TOT of 6 to 8 participants	**Roots and tubers**
		3 to 4 Primary sector producers (small-medium)		
	H.3	3 to 4 Primary sector producers (large)	TOT of 6 to 8 participants	**Oil crops**

		3 to 4 Primary sector producers (small-medium)		
Country 5:	I.3	3 to 4 Primary sector producers (large)	TOT of 6 to 8 participants	**Meat**
		3 to 4 Primary sector producers (small-medium)		
	L.3	3 to 4 Primary sector producers (large)	TOT of 6 to 8 participants	**Dairy/Milk**
		3 to 4 Primary sector producers (small-medium)		
Tot: **10 Focus groups**				

4.2.2 Data collection in the focus groups

The data collection for each focus group (from A.3 to L.3, *Table 9*) follows a process organized in four distinct phases:

- Step 1: In this phase, the results of the semi-structured interviews will be presented to the primary sector producers who participate in the focus group. The objective of this phase is the validation of the drivers and their relevance in determining FL according to the participants, guided by the moderator.
- Step 2: Based on the results of step 1, in step 2 participants, guided by the moderator, will be asked to identify connections and hierarchies between the drivers of FL. The activity will result in a conceptual map of the drivers.
- Step 3: Starting from the conceptual map of drivers, participants will validate the responses identified during the interviews and allocate them on the map connected to the drivers' flow.

The data expected to be collected in these steps are:

- → A list of FL drivers validated by the participants for each category of food supply chain considered.
- → A conceptual map of drivers that describes connections and hierarchies designed by the participants or each category of food supply chain considered.
- → A conceptual map of drivers and responses that describes connections and hierarchies designed by the participants or each category of food supply chain considered.

4.2.3 How to report data collected through focus groups

To conduct the focus groups and to report the collected data, interviewers will receive a document with the guidelines, supporting materials and tools (*Table 7*). Once the focus groups have been conducted and the data reported, the documents will be shared and uploaded by the interviewers to the appropriate folder in the FOLOU project repository. It will be required to fill out one document for each focus group conducted, so in total, each interviewer will have to submit two documents (*Table 9*).

5. Data standardization protocol

5.1 The need for a standardization protocol

The sharing of data collected within and across Work Packages is a crucial aspect for the reaching of FOLOU goals and is considered at EU level as a fundamental step for every research project. As recognized by the European Commission Directorate-General for Research and Innovation (DGRI) in the *Guidelines on FAIR Data Management in Horizon 2020*[6], an effective structure of data management ensures a reduction of risks of misunderstanding of data, especially when information is managed by researchers not involved in data collection and on the original design of the research. Also, effective data management is associated with a reduction of costs in terms of time and financial resources related to data manipulation.

In the *Guidelines on FAIR Data Management in Horizon 2020*, the EU commission stresses on the need for a data management plan describing, for each set of data that will be collected, a set of standard requirements: naming of datasets, description of the datasets, description of metadata and standards, description on how data will be shared and eventual limitations (embargos, repositories, etc.), and description of how data will be stored. These aspects, as well as the concept of FAIR data, will be addressed for the data collected in WP2 of FOLOU in the following sections.

5.2 Producing FAIR data: Findable, Accessible, Interoperable, and Reusable

According to EU guidelines, data collected in Horizon Europe projects must comply with the FAIR principles, being Findable, Accessible, Interoperable and Reusable (FAIR), to ensure effective management and replicability of research. Compliance with FAIR principles is not intended only as a goal of the project itself, but rather a key tool to promote research and dissemination, as well as data and knowledge sharing, integration, interoperability, and reuse.

FAIR data and datasets present specific characteristics[7]:

- Findable data requires that they are easy to find, both for humans and for automated research algorithms. In this regard, the elements that describe the information included in datasets and data itself should harmonized and readable by the largest possible number of subjects;
- Accessible data should be easily accessible by researchers, even after authorization/authentication processes;
- Interoperable data: The data usually need to be integrated with other data. In addition, the data need to interoperate with applications or workflows for analysis, storage, and processing;
- Reusable data: metadata and data should be well-described so that they can be replicated and/or combined in different settings. This is fundamental to allow data to be adapted and combined in different research settings.

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[6] https://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-data-mgt_en.pdf
[7] https://www.go-fair.org/fair-principles/

These principles have been also considered in the Project Data Management Plan document of the FOLOU project. The deliverable defines the key elements to ensure open access to data but also as closed as necessary for commercial and exploitation purposes. It will be updated twice all along the duration of the project.

5.3 Format and naming of datasets

To promote sharing and comparability of data collected through FOLOU activities, a common format for datasets resulting from data collection must be defined.

First, datasets should be saved with formats that are easily accessible for the largest share of researchers, both involved in the FOLOU data collection activities and in other project partners and institutions.

Given the qualitative nature of data collected in FOLOU WP2, dataset should be saved in formats that could be operable with Microsoft Office package, in particular with MS Word and MS Excel, and with comparable open-source packages, as OpenOffice. Thus, formats that should be adopted for FOLOU WP2 datasets are ".doc", ".docx", ".odt", ".xls", ".xlsx", and ".ods".

Naming of files also help to promote sharing of results and their accessibility to researchers not directly involved in the data collection process. In particular, file names should be self-explicative of the content of the document and should have a structure that allows to categorize results in an efficient and accessible way. In this regard, files including results of interviews and focus groups conducted in FOLOU WP2 should present a common structure of the file name, e.g. [name of product]_[country]_[interview of focus group]_[number of interview or of focus group].[extension].

D2.1 – Standard Research Protocol for the Data Collection

Annex 1

Questionnaire for the experts' consultation to validate the FOLOU framework

Questionnaire for FOLOU framework validation

FOLOU - Bringing knowledge and consensus to prevent and reduce Food Loss at the primary production stage (https://www.folou.eu/) is a research project funded by the European Union's Horizon Europe Research and Innovation program under Grant Agreement n° 101084106. This project aims to set up all the necessary mechanisms to: (i) measure and estimate (robust and harmonized methodology), (ii) monitor and report (national and EU Food Loss registries), and (iii) assess the magnitude and impact of Food Loss at EU level.

This survey aims to collect expert insights to identify and validate the most relevant drivers, impacts and responses to Food Loss in the primary production sector. Once you've successfully submitted your responses, you're welcome to request the survey results and to participate in the subsequent discussion on framework building.

The questionnaire is divided into two sections and the time required to complete it is about 15 minutes. Data collected will be treated confidentially and anonymously and you are free to leave the questionnaire in any moment.

Many thanks for your contribution!

Section 1 - Socio-demographics

1. Location (country and region)

2. Food supply chain you are engaged in (multiple choice):
   o Fruit, Vegetables
   o Cereals
   o Meat and animal products (excluding fish)
   o Aquaculture and fisheries
   o Wild Food
   o None of the above (end questionnaire)
3. What is your role within the supply chain (multiple choice):
   o Production sector
   o Advisor
   o Researcher/Expert
   o Other: ___

3b. If you are involved in the production sector, how many employees work in your company: _____

Section 2 drivers, impacts and responses to Food Loss

This section aims to investigate what are the drivers and impacts of Food Loss in the food supply chain and the most relevant responses that are put in place to mitigate those impacts. Food loss is defined as:

"Food Loss is any harvest-mature plant, animal or living being (including inedible parts) that is not successfully harvested, as well as food removed from the supply chain during post-harvest phase that is not donated or does not become animal feed, by-product or food waste."

[QUESTIONS]

- BEHAVIOURAL DRIVERS are human factors in place within the farm boundaries which can be categorized as the presence or absence of **motivations**, **perceptions and beliefs**, **knowledge, skills and abilities** that could lead agricultural operators to experience Food Loss (E.g.: *harvesting techniques, knowledge*)

4) Among the following behavioral drivers, which ones do you think are relevant for those products that do not end up in the market nor are donated in the supply chain stage you are involved in? (multiple choice):

- o Lack of knowledge of market demand
- o Lack of knowledge of harvest/post-harvest technologies
- o Lack of training
- o Lack of investment capacity
- o Inappropriate choice of product varieties (e.g. crops, breed...)
- o Inadequate or improper handling of the product
- o Wrong collecting time (harvesting, catching...)
- o Other _____

4a) According to your expertise, what are other potential BEHAVIOURAL DRIVERS of Food Loss in the food supply chain in which you are involved? [Open question]

- SOCIETAL DRIVERS are factors that come from external human sources of **socio-cultural, economic, technical, political and regulatory** nature and that influence or condition the behavior and decisions of farm operators. These factors are beyond the direct control of people and can influence Food Loss. (E.g.: *Market price, standards & regulations, coordination & cooperation, supply chain capacity, overproduction*).

5) Among the following societal drivers, which ones do you think are relevant for those produces that do not end up in the market, especially in the supply chain stage you are involved in (multiple choice):

- o Low market price of food products
- o Low market power of farmers due to unfair contracts
- o Marketing/industry standards (weight, aesthetic standards, size and shape)
- o Food safety regulations and standards
- o Lack of coordination and communication among the supply chain actors
- o Lack of adequate supply chain capacity
- o Lack of skilled labour availability
- o Inefficient storage infrastructure
- o Inefficient cold chain maintenance
- o Inefficient transportation infrastructure
- o Inadequate/lack of treaceability

5a) According to your expertise, what are other potential SOCIETAL DRIVERS of Food Loss in the food supply chain in which you are involved? [Open question]

- ENVIRONMENTAL DRIVERS are **environmental factors** that have a consequence on Food Loss generation. (E.g.: *climate and weather conditions, pests and diseases*)

6) Among the following environmental drivers, which ones do you think are relevant for those produces that do not end up in the market, especially in the supply chain stage you are involved in (multiple choice):

- o Unexpected climate and weather events
- o Pests and diseases
- o Phytosanitary issues
- o Soil deterioration
- o Consumption or damage by insects, rodents, birds or microbes (e.g., molds, bacteria)

6a) According to your expertise, what are other potential ENVIRONMENTAL DRIVERS of Food Loss in the food supply chain in which you are involved? [Open question]

- IMPACTS are the direct and indirect consequences of Food Loss at the farm level *(E.g.: economic costs, environmental costs, reduced profit, decreased customer value, reduced labor productivity and wages)*.

7) Among the following impacts, which ones do you think are relevant for those produces that do not end up in the market, especially in the supply chain stage you are involved in (multiple choice):

- o Low availability of food in the market (food scarcity)
- o Decreased financial resources for investment in other sectors
- o Reputation damage to the company
- o Decreased overall supply chain performance
- o Waste of non-renewable energy
- o Waste of water

7a) According to your expertise, what are other potential IMPACTS of Food Loss in the food supply chain in which you are involved? [Open question]

- RESPONSES are **resulted changes** in individual behaviour, organizational practices, institutions, and policies induced by Food Loss impacts; responses can address any of the preceding components individually or in combination.

(if answer to question 2 NOT =" production sector") 8) Which are the main responses to Food Loss implemented by the actors of the supply chain in which you are involved [Open question]

(if answer to question 2 =" production sector") 8) Which are the main responses to Food Loss implemented by your company [Open question]

Are you available to be contacted for the next stages of this research?

Yes) Indicate your email address

No)