FOLOU
D2.2 – Report on available data and information about food loss drivers

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Abbreviations

Abbreviation	Meaning
D	Deliverable
EU	European Union
FL	Food Loss
M	Milestone
T	Task
WP	Work Package

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Executive Summary

The following document presents consolidated results from a systematic literature review, with the aim to identify and characterise the drivers of food losses at the primary production stage in Europe and other regions. The most common behavioural, societal, and environmental drivers associated with food losses are defined based on scientific and grey literature.

The review identified 405 occurrences of 35 drivers, with societal drivers comprising 50%, behavioural drivers 29%, and environmental drivers 20%. The most frequent drivers include marketing and industry standards, inefficient storage and processing infrastructures, inadequate or improper handling of the product, pest and diseases, and unexpected climate and weather events. Between the most frequent drivers, a total of 8 out of 10 directly contribute to food losses, highlighting the pivotal role of primary producers and stakeholders in these occurrences, and underscoring the importance of addressing these drivers for effective food loss reduction strategies.

Key outcomes of the deliverable include the creation of a harmonized dataset comprising main drivers causing food losses in the primary production stage for each commodity group, along with associated literature and technical studies.

The assessment and description of these drivers, to be validated through semi-structured interviews and focus groups with key practitioners in the FOLOU commodity sectors, are crucial for informing local and EU policymakers about the potential impacts of technology development, food supply chain management, and consumer behaviours on food losses.

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1. Introduction

1.1. Rationale and objectives of T2.2 and D.2.2

The main objective of WP2 is to **investigate the direct and indirect drivers as well as the root causes behind food losses at the primary production stage**, for a wide range of the most important commodities produced in the EU with a specific focus on the five commodity sectors studied in FOLOU. T2.2 departing from the framework developed in T2.1[1], reviews scientific and grey literature on food loss drivers in Europe and elsewhere (T2.2.1), as to further classify them into subcategories (e.g., direct and indirect drivers) (T2.2.2).

The current deliverable (D2.2 - *Report on available data and information about food loss drivers*) serves as an inception report of the work carried out up to M14 to fulfil these objectives. The deliverable presents the **consolidated results of a systematic literature review aiming at identifying the variety and frequency of existing behavioural, societal, and environmental drivers of food losses at the primary production stage**.

The assessment and description of the drivers, which will be further validated with semi-structured interviews and focus groups with key practitioners of the five FOLOU commodity sectors, is of paramount importance for local and EU policymakers to envisage how technology development, food supply chain management, and consumers' behaviour and lifestyle may affect food losses in the short and long term.

1.2. Structure of the document

D2.2 is structured in five chapters:

- **Chapter 1** introduces the rationale, main objectives and structure of the deliverable.
- **Chapter 2** presents the research objectives and the methodology followed to systematically review existing knowledge (scientific and technical) on food loss drivers at the primary production stage.
- **Chapter 3** offers a detailed overview of the food loss drivers emerged from the review, their main characteristics, and an assessment regarding whether drivers can be classified as direct and/or indirect, as per the nomenclature outlined in D2.1. The drivers are presented using the division reported in the FOLOU Framework of D2.1.
- **Chapter 4** presents a set of descriptive statistics regarding the drivers contributing to food loss, aiming to emphasize overarching trends.
- **Chapter 5** concludes the deliverable linking its findings to future work to be conducted in the frame of T2.2, focusing on validating and ranking drivers through semi-structured interviews and focus groups (M15-30).

[1] In this work we consider food loss in all the mentioned cases in D2.1, with the exception of the cases in which the food is finally treated in a waste treatment plant with official licence.

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2. Methodology and available data on food loss drivers

In this chapter, we outline the research objectives and discuss the primary methodological decisions made for conducting a systematic review of food loss drivers occurring in the production stage.

2.1. Objectives of the research

The main research questions of D2.2 revolve around identifying and characterizing the drivers of food losses:

- **RQ#1: What factors characterize food losses during the primary production stage in Europe and other regions?**
- **RQ#2: Based on previous scientific and grey literature, what are the most common behavioural, societal, and environmental drivers associated with food losses?**

The main outcomes of the deliverable associated with the abovementioned research questions are:

a) The creation of a **harmonized dataset comprising the main drivers causing food losses in the primary production stage** identified for each commodity group (M2) and its associated literature and technical studies (M1). This dataset is presented and described in Chapter 3 and 4.

b) The identification of the **main (most frequent) drivers across the three domains of the FOLOU framework** (D2.1). This classification is presented and described in Chapter 4 and will be used for the interviews and focus group discussion for further ranking and validation.

c) An **assessment of the drivers' main characteristics**, including their direct or indirect implication for food losses and inter-linkages. These results, presented in Chapter 3, will support the data analysis currently performed in T2.3 (M12-M36).

2.2. Systematic review process and available data

2.2.1 Systematic literature review

The systematic review was carried out in accordance with the guidelines for Systematic Reviews in environmental management (Collaboration for Environmental Evidence, 2013). The primary research question (as outlined in Section 2.1) was deconstructed into its PICO (Population-Intervention-Comparator-Outcomes) components to enhance clarity and define the specific focus of the systematic review. The PICO review framework is a commonly used tool for performing quantitative systematic review in a homogeneous manner. Table 1 presents the PICO components followed in D.2.2.

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Table 1. PICO components of the systematic literature review

Criteria	Implementation in the frame of the study
Population (P)	Food losses in the primary production stage
Intervention (I)	Presence of root-cause drivers of food loss
Comparison (C)	Not relevant for this study
Outcome (O)	Most common behavioural, societal, and environmental drivers associated with food losses

The primary objective was to comprehensively assess and synthesize the **existing literature on food losses at the primary production stage** of the past 10 years. We adopted this time frame because it includes almost all the scientific literature on the topic. A comprehensive search strategy was developed to identify relevant studies *("food loss*" AND "driver" (All Fields) or "food lossAND behav* (All Fields)"*). Electronic databases (Web of Science and Scopus) were systematically queried using a combination of keywords related to food losses and its drivers. Additionally, manual searches of reference lists and grey literature in local languages (ES, NO, NL, FR, IT, and GR) were performed by WP1 and WP2 partners (UVIC, ESPIGOL, NORCE, ACR+, DACC, ARC, UNIVPM, MIO-ECSDE) to include the perspectives of practitioners, food operators, and regional policy centres. The search was conducted between January 2013 and December 2023 yielding 264 individual entries.

2.2.2 Study selection and data extraction

The study selection process comprised a two-step screening procedure. During the initial phase, conducted within the framework of D2.1, titles and abstracts underwent independent review by up to five researchers. The primary aim was to identify potentially eligible studies for further examination. The main inclusion/exclusion criteria focused on two key factors: (i) adherence to the food loss definition outlined in Section 2.1 of D2.1 (Figure 1), and (ii) the presence of root-cause drivers of food loss.

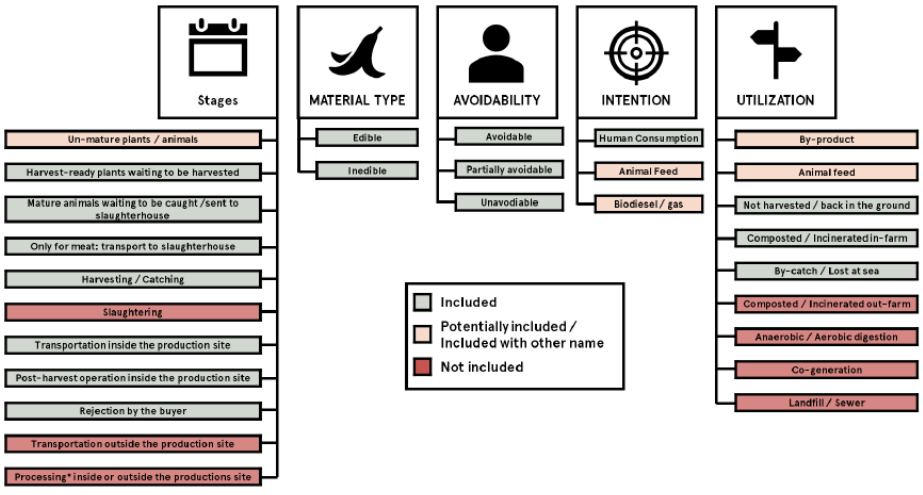

Figure 1. Primary production sector system boundaries. Source: FOLOU Definitional Framework.

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Only studies that achieved consensus as relevant to the eligibility criteria by half or more of the evaluators progressed to the next stage. This reduced the sample to 50 eligible scientific articles. In addition to the scientific articles, an additional 36 grey literature reports provided by local teams in various FOLOU countries, as well as reports obtained from the data collection in collaboration with the FOLOU repository (T1.2) were incorporated into the sample. *Rayyan - AI Powered Tool for Systematic Literature Reviews* was used to collaboratively share the results of the study selections across reviewers. A diagram schematizing the literature review process is provided in Figure 2.

The second step of the review involved conducting full-text assessments on the sample of articles and grey literature reports. During this stage, additional 10 entries were excluded, resulting in a final sample of 76 items. Throughout the full-text assessments, relevant data on food loss drivers was extracted from both articles and grey literature reports.

This encompassed information such as driver identification and description, the country and commodity sector assessed, driver classification (direct vs. indirect), and any available details on the driver magnitude, including its weight as a percentage in relation to overall food losses. Table 2 provides an overview of the key variables extracted during the review. To ensure the accuracy of the data extraction process, three reviewers independently conducted the extraction, and any discrepancies were resolved through consensus or consultation meetings.

Table 2. Variables extracted during the systematic review.

Variables	Description
Unique identifier	An alphanumeric code identifying the individual scientific articles (e.g., SA001) and item of grey literature (e.g., GL001)
Country	The name of the country(ies) studied in the frame of the scientific article/grey literature item.
Commodity	The name of the food commodity(ies) assessed in the frame of the scientific article/grey literature item
Driver ID	An alphanumeric code identifying the individual driver. The code is made of the first three letters of the driver domain (BEH, SOC, ENV) followed by a numeric ID.
Driver name	The name of the food loss driver, following the initial nomenclature presented in D2.1.
Text	An extraction of the text from the article/report describing the driver.
FOLOU 2.1 Classification	The classification of the drivers following the D2.1 FOLOU framework: Behavioural, Societal, Environmental
FOLOU commodity sector	Vegetables and fruits; grain and pulses; roots, tubers and oil crops; aquaculture and fisheries; meat and dairy products
Magnitude	The extent of the impact of the driver, in absolute terms, on food losses can be measured using various units of measurement (If available in the study).
Unit	The units of measurement followed for assessing the driver magnitude.
Weight	The driver weight (in %) in relation to overall food losses
Notes	Eventual notes

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2.2.3 Data analysis

For each article, one or more drivers were identified during the data extraction process. An inductive-deductive approach was used for content analysis. Initially, a deductive set of 23 drivers, further classified into their behavioural, societal, and environmental domains, was extracted from D2.1. The researchers coded the literature based on this initial set; however, during the scrutiny of the literature text, new drivers emerged. Consequently, new drivers were iteratively added to the list while existing ones where reviewed and in certain instances removed or merged. This iterative process resulted in a final list of 33 drivers of food loss at the primary production stage assessed, as reported in Chapters 3 and 4.

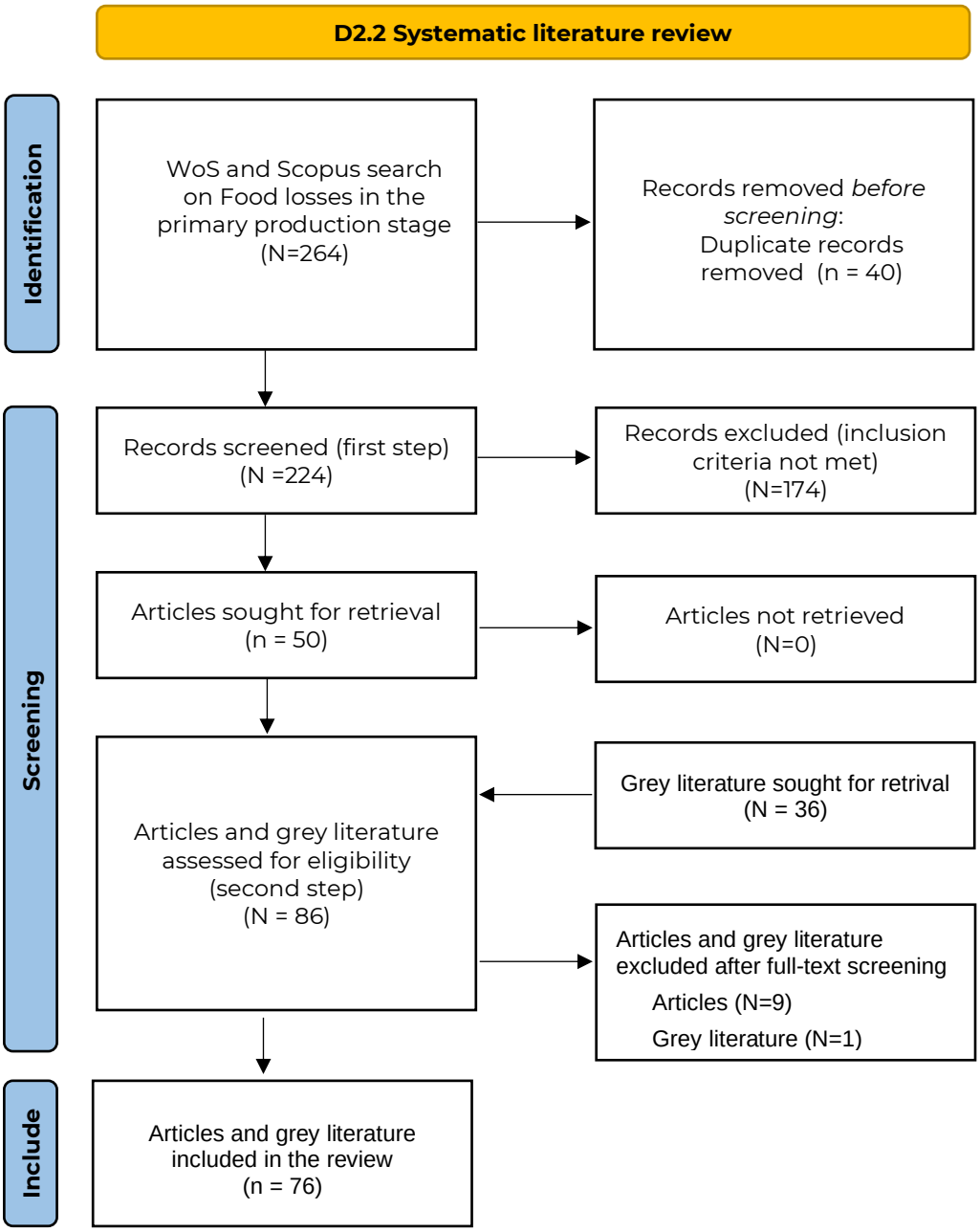

Figure 2. PRISMA diagram flow of the systematic literature review.

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3. Food loss drivers

In this section, we present the compilation of food loss drivers validated through a systematic literature review. For each driver, we provide: **(i) a concise description** sourced from relevant reports and scientific articles, **(ii) an overview of the FOLOU commodity group** in which it is observed (Grain and pulses, Fruits and vegetables, Root tubers and oil crops, Meat and animal derived products; Fish), and **(iii)** an early assessment regarding whether the driver can be classified as **direct and/or indirect for contributing to food losses**, as per the nomenclature outlined in D2.1.

The drivers are presented using the division reported in the FOLOU Framework of D2.1:

- **Behavioural drivers**: Human & individual factors impacting food losses revolving around the individual's motivations, perceptions, beliefs, knowledge, skills and abilities,
- **Environmental drivers**: Environmental factors having consequences on food losses generation
- **Societal drivers**: factors arising from external human sources of socio-cultural, economic, technical, political and regulatory nature.

A list compiling all drivers identified is provided in Annex 1. In Annexes 2 and 3 we provide the list of reviewed scientific articles and grey literature reports.

3.1. Behavioural drivers

3.1.1. Insufficient understanding of market fluctuations and price mechanisms

Driver name	Insufficient understanding of market fluctuations and price mechanisms
Driver code	BEH1
FOLOU commodity sectors	All
Driver key words	Market demand and conditions, price transmission mechanisms, lack of information/knowledge
% of articles/reports in which the driver is reported	29%

Description

This driver highlights the **insufficient information and knowledge among primary producers concerning food market demand changes and market conditions**, including instances of missing markets (where a market fails to emerge or operate efficiently, leading to an absence or inadequate allocation of resources), unclear price transmission mechanisms, and imperfect information (where buyers and/or sellers lack essential information for making informed decisions). The example provided by (Surucu-Balci & Tuna, 2022) illustrates how this driver can impact food losses in the fruit and vegetable commodity sector in Turkey.

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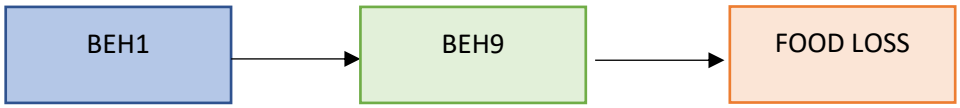
Farmers in Turkey, lacking comprehensive information on the mechanisms behind price formation, often choose to cultivate crops that yielded high income in the previous year. This decision-making process can lead to overproduction, subsequently resulting in losses. Another example from the potato market in Russia show how potato farmers generated food loss due to not properly forecasted demand variations (Filimonau & Ermolaev, 2021). This can also hamper efficient ordering of fresh food markets such as fruits and vegetables.

Classification

This is an indirect driver of food loss. When farmers or producers lack information about the current market demand for their products, they may make decisions that indirectly contribute to food losses. For instance, if farmers are unaware of the specific quantities and varieties of crops in demand, they might overproduce or underproduce certain goods. Overproduction, driven by uncertainty about market demand, can lead to surplus crops that may not find buyers (BEH93), resulting in food losses.



3.1.2. Lack of knowledge of harvest/post-harvest technologies and methods

Driver name	Lack of knowledge of harvest/post-harvest technologies and methods
Driver code	BEH2
FOLOU commodity sectors	All (with a predominance of fruits and vegetables)
Driver key words	Lack of information/knowledge, harvesting processes, post-harvesting technologies, outdated techniques
% of articles/reports in which the driver is reported	28%

Description

This driver highlights the **inadequate or limited knowledge that primary producers possess during specific production cycles, particularly concerning harvesting and post-harvesting processes and technologies**. Challenges in this area encompass: (i) lack of awareness regarding more efficient harvesting or sorting methods for crops (Spang et al., 2019), (ii) uncertainty about the optimal stage of maturity for harvesting certain crops like tomatoes and potatoes (Spang et al., 2019), (iii) lacking standardized harvest and postharvest processes among producers of similar crops leading to structural inefficiencies (Arias Bustos & Moors, 2018a), (iv) reliance on outdated growing techniques and harvesting methods resulting in poor production outputs (Surucu-Balci & Tuna, 2022), (v) a deficiency in the application of scientifically-based methods for harvesting and post-harvesting

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(Anand & Barua, 2022), and finally (vi) a limited understanding of the latest technologies available, particularly for post-harvesting. For the meat sector it was specifically mentioned food losses derived by death during breeding due to poor handling practices(Ishangulyyev et al., 2019).

Classification

This is a direct driver of food loss. When farmers or producers lack information about the harvesting or post-harvesting technologies, they can directly contribute to inefficiencies in the food production system. These inefficiencies can result in avoidable losses during harvesting, handling, and storage processes.

3.1.3. Lack of training

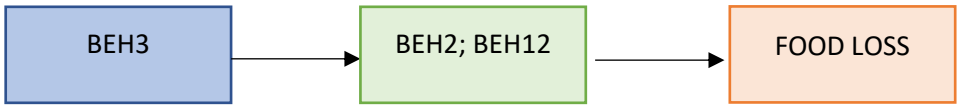
Driver name	Lack of training
Driver code	BEH3
FOLOU commodity sectors	All (with a predominance of fruits and vegetables)
Driver key words	Knowledge exchange, instructions, handling practices
% of articles/reports in which the driver is reported	9%

Description

This driver emphasizes the **inadequate training provided to primary producers concerning production and harvesting methods**, leading to a lack of knowledge in utilizing the latest technology and handling infrastructures. Adequate training, including clear usage instructions and best handling practices for handlers ((Arias Bustos & Moors, 2018b), has the potential to enhance producers' adoption of more efficient methods (see BEH2), thereby having an influence on reducing food losses.

Classification

This is an indirect driver of food loss. The insufficient training of primary producers on production and harvesting methods impacts the level of knowledge regarding the use of the latest technology and handling infrastructures (BEH2). This can lead to inefficiencies in the production and post-harvest processes, ultimately contributing to increased food losses. Moreover, unbalanced training amongst staff can also alter internal personal dynamics (BEH12) with in turn can result in suboptimal harvesting and storage indirectly contributing to food losses



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3.1.4. Lack of investment capacity

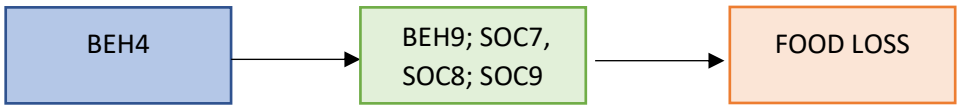
Driver name	Lack of investment capacity
Driver code	BEH4
FOLOU commodity sectors	All
Driver key words	Financial resources, financial investments.
% of articles/reports in which the driver is reported	4%

Description

This driver revolves around the **insufficient financial resources of primary producers to invest in key aspects of their operations** (e.g., sawing, planting, harvesting). This limitation in investment capacity can have various implications such as for instance access to energyand can ultimately generate food losses.

Classification

This is an indirect driver of food loss. The insufficient investment capacity of primary producers affects other factors such as for instance sub-optimal production outputs (BEH93) and the overall efficiency of the transportation, storage and maintenance infrastructure ((SOC7, and 8).



3.1.5. Inappropriate choice of product varieties

Driver name	Inappropriate choice of product varieties
Driver code	BEH5
FOLOU commodity sectors	All (with a predominance of fruits and vegetables)
Driver key words	Variety, resilience, climate resistant, abiotic and biotic stresses
% of articles/reports in which the driver is reported	9%

Description

This driver refers to the **incorrect or inappropriate choices made by primary producers when defining production lines**. This could encompass decisions related to the selection of varieties, such as seeds, which may be of low quality and

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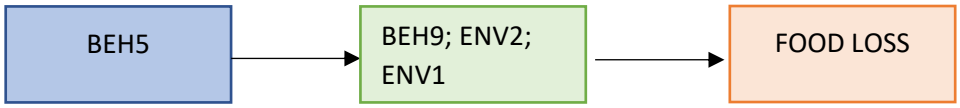
exhibit limited resistance to biotic or abiotic stresses, such as pest invasions, droughts, or strong winds(Blakeney, 2019; Raut et al., 2018). In certain situations, this driver may also be linked to the mindset of producers, including their preferences for specific varieties due to traditions and customs, leading to reluctance towards diversification(Anand & Barua, 2022). In other occasions, food loss can derive from farmers testing new varieties that end up not being successful due to a lack of acceptance from their clients. This also indicate the role of clients and food distributors on the correct choice of product varieties.

Classification

This is an indirect driver of food loss. The inappropriate choices made by primary producers in defining production lines (e.g., selecting low-quality seed lines) can result in inappropriate yields (BEH09) and increased vulnerability to losses (ENV1, ENV2). Similarly, a reluctance towards diversification, driven by producers' mindsets, may limit the resilience of the agricultural system and increase the overall risk of food losses.



3.1.6. Inadequate or improper handling of the product

Driver name	Inadequate or improper handling of the product
Driver code	BEH6
FOLOU commodity sectors	All
Driver key words	Careless handling, death, damage, poor living condition, multiple handling.
% of articles/reports in which the driver is reported	46%

Description

This driver refers to the **lack of care adopted when handling the food product, leading to potential damage that hinders commercialization**. Issues may arise during transportation, including on-site transportation, often attributed to inadequate transport infrastructure or careless handling practices, during harvesting and often attributed to the wrong us of machinery or inappropiate handling of crops, or during early storage (e.g., vegetables knocked onto the floor; Kor et al., 2021). The negative impacts of multiple handling are particularly severe for fresh and perishable products, such as fruits and vegetables, and may extend to animals and livestock, resulting in health issues, diseases, or conflicts due to poor living and breeding conditions(Blakeney, 2019). Damaged products, often failing to

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meet stringent regulatory and marketing standards, become unsuitable for commercialization and are consequently recorded as losses.

Classification

This is a direct driver of food loss. The lack of proper care during the handling of food products directly contributes to damage, making them unsuitable for commercialization. The direct impact is evident in the diminished quality and market value of the products, leading to tangible food losses.

3.1.7. Wrong collecting time

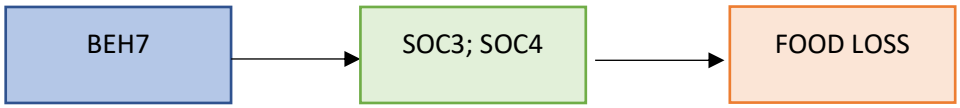
Driver name	Wrong collecting time
Driver code	BEH7
FOLOU commodity sectors	All (with a predominance of fruits and vegetables)
Driver key words	Maturity, premature harvesting, harvesting time targets
% of articles/reports in which the driver is reported	11%

Description

This driver describes situations where **food is harvested and collected at an inappropriate time**, potentially leading to increased food losses. Harvesting fruits and vegetables at the wrong stage of maturity can compromise their quality, vitamin content, and suitability for transport and storage, ultimately impacting their conformity to marketing and industry requirements and resulting in food losses(Blakeney, 2019). Additionally, in some instances, products are either harvested prematurely or left unharvested. In the case of the New Zeeland tomato market, the implementation of harvesting time targets, led to elevated levels of unharvested products(Thorsen et al., 2021).

Classification

This is an indirect driver of food loss. Harvesting at the wrong stage of maturity affects the quality and suitability of the product, impacting its ability to meet market and industry requirements (SOC3 and 4).



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3.1.8. Lack of knowledge on fiscal aid tools and bureaucracy

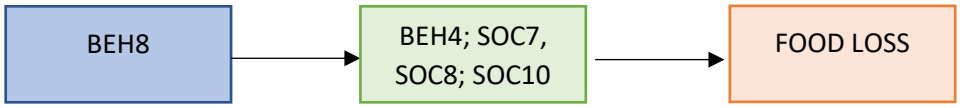
Driver name	Lack of knowledge on fiscal aid tools and bureaucracy
Driver code	BEH8
FOLOU commodity sectors	Fruits and vegetables
Driver key words	Tax credit, administrative procedures, inefficiency.
% of articles/reports in which the driver is reported	1%

Description

This driver describes situations where **primary producers lack awareness or understanding of fiscal aid tools and encounter challenges related to bureaucratic processes**. This can hinder their ability to access tax credit or navigate administrative procedures effectively (Soma et al., 2021)

Classification

This is an indirect driver of food loss. The lack of knowledge on fiscal aid tools and challenges with bureaucracy may indirectly affect the financial stability of primary producers, potentially limiting their ability to invest in technologies (BEH4), infrastructure, or practices that could reduce food losses (SOC7 and 8).



3.1.9. Excess production to ensure fulfilment of contracts

Driver name	Excess production to ensure fulfilment of contracts
Driver code	BEH9
FOLOU commodity sectors	All (with a predominance of fruits and vegetables)
Driver key words	Overproduction, contractual obligations, risk mitigation, market price
% of articles/reports in which the driver is reported	13%

Description

This driver describes practices where **primary producers overproduce goods to guarantee the fulfilment of contractual agreements**. This strategy is often

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employed to account for uncertainties in production, ensuring that contractual obligations with upstream stakeholders can be met even if unexpected challenges or disruptions occur. Disruptions can take the form of: adverse climatic/weather conditions (Kör et al., 2022), pest outbreaks (Ishangulyyev et al., 2019), market uncertainties and/or inaccurate market forecasting(Magalhães et al., 2021). Overproduction can decrease the market price leading to products left unharvested.

Classification

This is a direct driver of food loss. This driver is a direct contributor to losses, as the excess production undertaken to fulfil contracts can create situations where a significant portion of the produced food goes unconsumed or becomes unsuitable for consumption.

3.1.10. Mistrust versus central administration/institutions

Driver name	Mistrust versus central administration/institutions
Driver code	BEH10
FOLOU commodity sectors	All
Driver key words	Mistrust, food value chain, transparency, cooperation
% of articles/reports in which the driver is reported	1%

Description

A situation where primary producers build **lack of trust towards centralized administrations (e.g., regional, national or supranational regulatory bodies) or institutions involved in the food production and distribution system**. This mistrust can manifest in various ways and may hinder collaborations and cooperation across the food value chain, potentially resulting in increased food losses.

Classification

This is an indirect driver of food loss. Mistrust towards centralized institutions might deteriorate collaborations across the food value chains (SOC5), which in turn can impact production levels and increase food losses.

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3.1.11. Inappropriate planting scale

Driver name	Inappropriate planting scale
Driver code	BEH11
FOLOU commodity sectors	Cereals and Pulses
Driver key words	Planting, overproduction.
% of articles/reports in which the driver is reported	1%

Description

This driver refers to situations where the **scale of planting or agricultural activities is not well-suited to the specific conditions, resources, or market demands**. This can result in suboptimal outcomes and may contribute to excess of production or product degradation increasing food losses. This might also occur with leafy vegetables (lettuces, spinach…) when weather changes take place, which favour the growth of these crops and thus contribute to excess of production.

Classification

This is a direct driver of food loss. Unappropriated planting scales can generate overproduction, contributing to post-harvest food losses.

3.1.12. Interpersonal dynamics altering the supply chain efficiency

Driver name	Interpersonal dynamics altering the supply chain efficiency
Driver code	BEH12
FOLOU commodity sectors	All
Driver key words	Conflicts, ineffective managerial interventions, disputes
% of articles/reports in which the driver is reported	3%

Description

This driver refers to **interpersonal or personal factors that disrupt the smooth functioning of the supply chain in the agricultural sector**. These dynamics could involve conflicts, disputes, personal agendas, or ineffective managerial interventions that hinder cooperation and collaboration among stakeholders in the supply chain. Resource limitations and/or conflicts within SMEs can result in the

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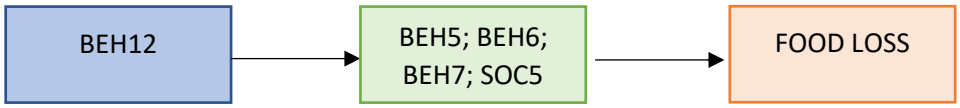
deprioritization of waste and loss management within the company's priorities (Jacob-John et al., 2023).

Classification

This is an indirect driver of food loss. Personal dynamics can in turn impact cooperation and collaboration practices amongst stakeholders (SOC5), with in turn can result in suboptimal harvesting and storage (BEH5, 6,7) indirectly contributing to food losses.



3.1.13. Bycatch

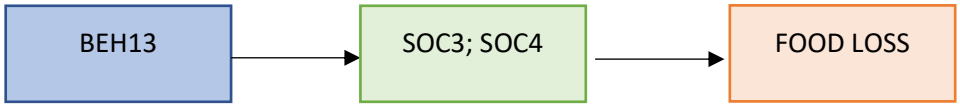
Driver name	Bycatch
Driver code	BEH13
FOLOU commodity sectors	Aquaculture and fisheries
Driver key words	Non targeted fish species, undersize fish
% of articles/reports in which the driver is reported	1%

Description

This driver describes the **unintentional capture of non-target or undersized marine species during fishing activities**. This occurs when fishing gear intended for a specific species unintentionally captures other species that are not suitable for sale or consumption.

Classification

This is an indirect driver of food loss. Bycatching becomes a food loss driver when the market does not recognize the potential of the non-targeted fish species for food consumption (SOC3, and 4).



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3.2 Societal drivers

3.2.1. Low market price of food products

Driver name	Low market price of food products
Driver code	SOC1
FOLOU commodity sectors	All
Driver key words	Market price, harvest period, low income, farmers
% of articles/reports in which the driver is reported	29%

Description

This factor highlights **the challenges that farmers may face when they try to sell their products on the market. For certain products and at certain times of the year, prices for some commodities may be low.** This may lead to food losses during the harvesting process. If the price is too low, it may be more practical for some farmers to throw away the food rather than sell it. The example in the paper analysed illustrates how this factor can periodically affect food losses: producers may choose to leave the crop unharvested if demand is low or supply too high at that moment and the returns from the harvest are insufficient to cover the costs of harvesting and transport (Spang et al., 2019; Ishangulyyev et al., 2019). Food production does not reach the market, resulting in food loss.

Classification

This is a direct driver of food loss. The fear of financial losses is a major driver of food waste. If farmers or producers believe they won't make enough money from selling a product, they may choose to avoid harvesting it or, if harvested, not bring it to the market. This results in the direct disposal of the product by farmers or producers, preventing it from reaching the market.

3.2.2. Low market power of farmers due to unfair contracts

Driver name	Low market power of farmers due to unfair contracts
Driver code	SOC2
FOLOU commodity sectors	All
Driver key words	Power market, contracts, farmers
% of articles/reports in which the driver is reported	16%

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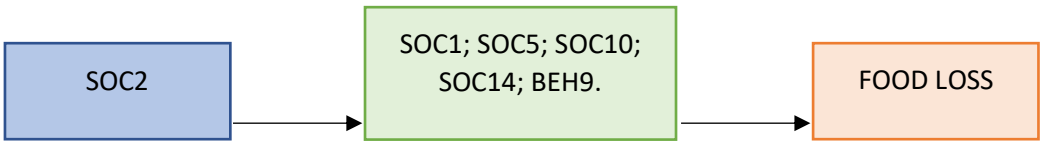
Description

This driver underlines the **importance of contracts that provide legal and economical protection for farmers**. Without such safeguards, farmers may have limited market power. This may lead them to produce goods for which there is no strong market demand, which can cause low prices, or can lead farmers to decide not to harvest or sell what they produce. Food waste is not only due to technological shortcomings. It is also influenced by social dynamics and power imbalances within the agricultural supply chain and can become a tool for negotiating economic power (Kor et al., 2022). The unequal distribution of market power between farmers, processors, distributors and retailers can place the responsibility for food waste and loss on farmers. The social position of farmers in the supply chain is a key determinant of the extent of food loss (Bustos et al., 2019). Minimising food loss in the wider agricultural ecosystem can be achieved by addressing these power imbalances and improving the contractual framework for farmers.

An important factor in this driver is international concurrence. The internalisation of resources and skills appears asymmetric, and often small producers receive fewer economic and social benefits than other FSC participants. The **competition between different production models** makes small-scale producers more vulnerable to price fluctuations and less able to penetrate the industrial market. For this reason, food losscan be a strategy to increase farm income.

Classification

This constitutes an **indirect driver of food loss**, as the contractual situation of farmers holds sway over their decision-making processes, not only in terms of selecting the products to cultivate but also in ensuring a successful harvest and effectively presenting their produce in the market. The intricacies of contractual agreements significantly shape the choices made by farmers throughout the agricultural supply chain, ultimately influencing the outcomes related to food loss.



3.2.3. Marketing and industry standards (weight, aesthetic standards, size, shape, quality)

Driver name	Marketing and industry standards (weight, aesthetic standards, size, shape, quality)
Driver code	SOC3
FOLOU commodity sectors	All
Driver key words	Food shape, food color, food quality, food size, “food cosmetic”
% of articles/reports in which the driver is reported	58%

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Description

Stringent quality, aesthetic and weight standards play a key role in contributing to food loss. During the harvest of fruit and vegetable crops, a significant proportion of the produce is discarded if it is not up to market quality standards (Vittuari et al., 2019; Willersinn et al., 2015). These specifications can cover purely cosmetic aspects such as colour, shape and size, and are crucial in determining the ability of a product to be sold on the industrial market (McKinzie et al., 2017; Thorsen et al., 2022), or quality characteristics of the harvested products. If they don't meet these standards, crops are often left to rot in the fields or are discarded during the post-harvest selection process. In the context of fruit and vegetables, this problem seems to be most pronounced.

Classification

This constitutes a **direct driver of food** loss. In fact, the exclusion from the market of food that does not meet the aesthetic standards of the agro-industrial cycle creates a significant waste dilemma. This inflexibility within industrial criteria not only leads to the discarding or non-harvesting of such products, but also exacerbates the overall problem of food waste by preventing these products from reaching consumers who might otherwise find them perfectly edible and nutritious. The impact of rigid aesthetic criteria on the food supply chain has a social origin and has a strong impact on the priorities of producers and retailers.

3.2.4. Food safety regulations and standards

Driver name	Food safety regulations and standards
Driver code	SOC4
FOLOU commodity sectors	All
Driver key words	Quality standards, food safety
% of articles/reports in which the driver is reported	18%

Description

This driver shares some similarities with the previous one (SOC3 "Marketing and industry standards"), but it diverges significantly. While SOC3 pertains to quality standards related to aesthetics or "food cosmetics," this driver is concerned with **food safety, nutritional parameters, and health.** The key stages of the production chain associated with this driver are storage and agricultural production. The use of pesticides and fertilizers in agriculture can influence food safety, with regulations governing their application varying geographically and historically (Herzberg et al., 2022; Pietrangeli et al., 2023). Additionally, storage conditions play a crucial role, as

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inadequate quality in these conditions may lead to bacterial growth, the presence of microorganisms, or food spoilage (Spang et al., 2019).

Classification

This is a **direct driver of food loss**. Food that does not meet local food safety standards is directly rejected from any distribution channel. In order to avoid food losses, it is important to be aware of the chemical products used in agricultural production and to control the reliability of any infrastructure used for food storage, processing and transport. If safety standards are not met, the food cannot be consumed. This leads to food losses.

3.2.5. Lack of coordination and communication among actors and territories

Driver name	Lack of coordination and communication among actors and territories
Driver code	SOC5
FOLOU commodity sectors	All
Driver key words	Food supply chain, cooperation, communication, actors, territories, connections
% of articles/reports in which the driver is reported	28%

Description

This driver carries a significant social dimension and exerts a substantial impact on food loss (FL). It revolves around missed opportunities stemming from **inadequate cooperation and coordination among stakeholders and territories** within individual supply chains and across different supply chains. FL often results from a lack of communication among actors regarding their needs, practices, or production (Fan et al., 2019; Raut et al., 2018). Failures in communication, such as insufficient information sharing or inaccuracies, can disrupt the ability to make optimal decisions, and if a supply chain lacks overall management responsibility, no one can be held accountable for food losses. This fragmentation fosters a lack of trust and hostile behaviour among different levels of the supply chain (Magalhaes et al., 2021).

This driver can be analysed at various stages of the supply chain. In the production phase, a lack of coordination and information exchange between producers and retailers may lead to failures in production priorities and farmers' growing schedules, contributing to overstocking and FL (Maegher et al., 2020.) In the logistics of supply, coordination issues between actors globally and at different stages of the supply chain can result in misunderstandings, leading to inaccurate supply/demand forecasts and subsequent food losses (Yan et al., 2021). The institutional capacity to encourage cooperation among actors is another dimension of this driver, linking it to SOC 11 “Market organization” as institutions

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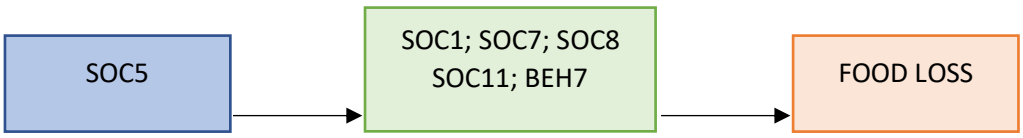
play a role in facilitating integration and information exchange between private and public actors to reduce food loss (An et al., 2022). Additionally, the driver is connected to the problem of missing the traceability of products, as accurate information needs to be collected and shared for effective traceability in the supply chain (Magalhaes et al., 2021). Lastly, the infrastructure dimension is crucial to this driver, emphasizing that connectivity between territories is fundamental for reducing food loss (Principato et al., 2019; Surucu-Balci et al, 2021). This connectivity allows farmers and retailers access to markets and helps diminish inefficiencies in logistics systems.

Classification

This is an **indirect driver of food loss**. In fact, the lack of communication between actors and territories does not directly cause food loss, but rather creates the conditions for it to occur. The wrong timing of planting and harvesting (BEH7), the lack of information between the stages of the supply chain, the lack of communication between territories and the inability to define common strategies for the transport, handling or consumption of food (SOC 7 and 8) can lead to changes in prices (SOC1), quality, quantity and supply (SOC11) that cause food loss.



3.2.6. Lack of adequate supply chain capacity

Driver name	Lack of adequate supply chain capacity
Driver code	SOC6
FOLOU commodity sectors	All
Driver key words	Workers' formation, infrastructure, lack of supply chain development
% of articles/reports in which the driver is reported	3%

Description

This driver highlights a **deficiency in the development of the supply chain**, which can manifest as either a social or an infrastructural inadequacy. On the social front, a lack of capacity among supply chain workers to self-train, receive training, cooperate effectively, and organize their work to leverage the supply chain structure efficiently can result in food loss (Filimonau et al., 2021). In this scenario, the supply chain is not managed optimally by its participants. On the other hand, the deficiency in supply chain development may point to a lack of structural functionality. This could encompass the absence of critical infrastructures,

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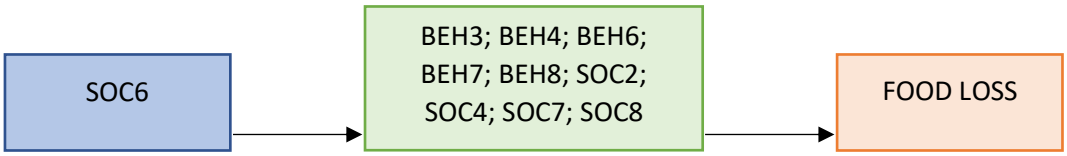
inadequate machinery, or poorly maintained silos and other containers, among other issues (Garcia-Flores et al., 2019). In such cases, the overall functionality of the supply chain is compromised, contributing to the occurrence of food loss.

Classification

This is an **indirect driver of food loss**, acting as an overarching factor that can give rise to other more specific drivers with distinct impacts. While it may not have a direct effect, it is crucial because supply chain issues can be systemic, influencing multiple stages rather than pointing to a single isolated problem. Addressing this systemic dimension is essential to comprehensively tackle and mitigate the various specific drivers contributing to food loss.



3.2.7. Inefficient storage and processing infrastructure

Driver name	Inefficient storage and processing infrastructure
Driver code	SOC7
FOLOU commodity sectors	All
Driver key words	Silos, cold chain/ dry chain maintenance, food processing
% of articles/reports in which the driver is reported	51%

Description

This is one of the most crucial societal drivers, intricately linked with BEH2 "Lack of knowledge of harvest/post-harvest technologies and methods," as storage and processing procedures fall under post-harvest methods.

This driver encompasses various issues. On one hand, it concerns the **quantity, state of deterioration, and technological advancement of storage infrastructures**. They may be insufficient for the necessary production quantity, malfunctioning, or incapable of preserving products optimally. This inevitably leads to food loss, as the product becomes spoiled or is discarded even before being stored. Issues can also arise during the food processing phase. If those working in the supply chain lack adequate training, if the machines are old and inefficient, or if there are disruptions or errors in the processing processes, food is wasted (Suruci-Balci et al., 2022; Blakeney, 2019; Magalheas, 2021).

Another aspect of this problem is the **maintenance of the cold chain.** Especially for fruits and vegetables, the failure to maintain this type of preservation condemns

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the products to a very short shelf life or prevents the saving of overproduction. The cold chain can be interrupted due to the staff's inability to use machinery effectively, technological insufficiency, or machine deterioration and lack of technical supervision. Maintaining the cold chain is also connected to the SOC8 driver "Inefficient transportation infrastructure," as it often occurs during the transportation phases. Moreover, another aspect is the supply chain's ability to ensure appropriate product drying operations. When this does not happen, the phytosanitary quality of the products is compromised, resulting in a total loss of production (Duran et al., 2023; Sprang et al., 2019).

Due to the direct link between storage methods, processing, food preservation, and the phytosanitary conditions of food, this driver is also interconnected with SOC4 "Food safety regulations and standards," ENV3 "Phytosanitary issues," and ENV5 "Consumption or damage by insects, rodents, birds, or microbes (e.g., molds, bacteria)".

Classification

This is a **direct driver of food loss**. When challenges arise in the storage, processing, or maintenance phases of products, food undergoes deterioration, rendering it unsuitable for market access. This deterioration not only affects the quality and safety of the food but also hinders its viability within the market.

3.2.8. Inefficient transportation infrastructure

Driver name	Inefficient transportation infrastructure
Driver code	SOC8
FOLOU commodity sectors	All
Driver key words	Transport, cold chain, packaging
% of articles/reports in which the driver is reported	14%

Description

This driver often relates to food waste, emphasizing the significance of losses incurred due to the **inefficiency of transporting** produce to sales sites. However, in some cases, the importance of inefficient food transportation, the use of inappropriate means of transportation, and prolonged transit times to processing sites or within production facilities have also been highlighted (Surucu-Balci et al., 2018). The failure to maintain the cold chain or the inefficiency of packaging methods is central to the issue of food damage. In certain contexts, the lack of infrastructure connecting production sites with storage or processing facilities is a problem (Blakeney, 2019). Additional transportation costs pose another widespread issue for producers. This structural deficiency results in delays that lead to food

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spoilage, making it impossible to integrate production into market and production cycles (Magalheas et al., 2021)

Classification

This is a **direct driver of food loss**. Inefficiencies in maintaining products in an intact and healthy state during transportation directly lead to food loss, rendering the food unsafe or deteriorated.

3.2.9. Direct subsidies on production

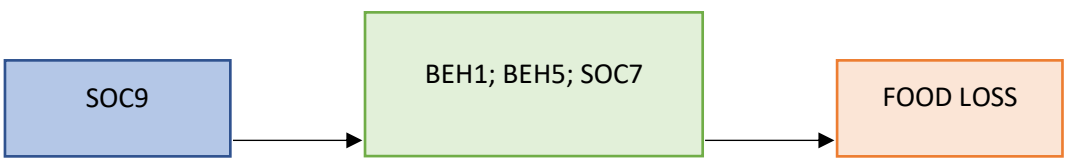
Driver name	Direct subsidies on production
Driver code	SOC9
FOLOU commodity sectors	All
Driver key words	Subside, government, market
% of articles/reports in which the driver is reported	1%

Description

This driver, although less frequently discussed in the literature, is highly relevant in shaping farmers' tendencies to produce beyond the actual demand. **Subsidy structures designed to regulate food prices through supply management and support agricultural activities can lead to overproduction**. Consequently, this overproduction may result in waste if the products lack access to the market and effective methods of storage, processing, and preservation (Vittuari et al., 2019).

Classification

This is an **indirect driver of food loss**. Indeed, subsidies significantly influence the behavior of actors within the food supply chain and play an indirect role in contributing to food waste. As actors navigate their activities based on subsidy structures, unintended consequences may arise, leading to food loss at various stages of the supply chain.



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3.2.10. Market organization

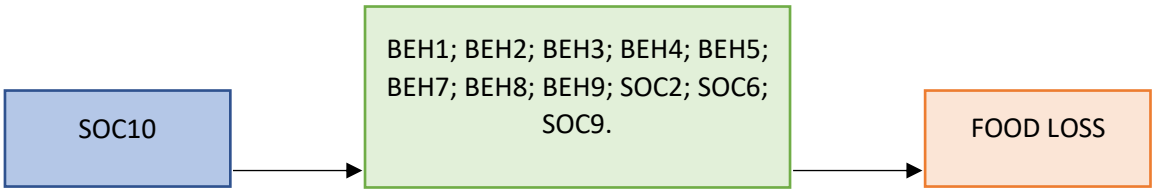
Driver name	Market organization
Driver code	SOC10
FOLOU commodity sectors	All
Driver key words	Structural inefficiencies, priorities definition, governmental gaps
% of articles/reports in which the driver is reported	11%

Description

This driver may seem very general, but it is structurally relevant. The ability to avoid inefficiencies arising from the market's configuration and the way it is constructed through **government incentives** is central to preventing food loss (Bustos et al., 2018). Environmental regulations, rules to limit food loss, and fiscal instruments to alter market operations are particularly relevant for guiding the actions of stakeholders (Abaultaher et al., 2018). Structural inefficiencies along FSCs arise especially due to inadequate managerial decisions, commitments, incentives, and human relationships along FSCs resulting, among others, from the lack of information exchange, incentives alignment, effective partnerships, or the inadequate use of technology among FSC participants (Raut et al., 2018). Policymakers play a critical 'umbrella' role in the framework as collaboration promoters, capacity builders, feasibility demonstrators, legal guarantors, financial support providers, and monitoring agents (Filimonau et al., 2021). Another important part of this driver concerns the overproduction due to supply agreements with retail, and the lack of vertical integration between farmers and consumers (Raut et al., 2018)

Classification

This is an **indirect driver of food loss**. The ineffective organization of the agri-food market leads to production inefficiencies, restricted market access, and behaviours not aligned with actual demand. These inefficiencies also manifest in the management of harvesting and post-harvest phases, contributing to the issue of food loss.



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3.2.11. Marketing strategies

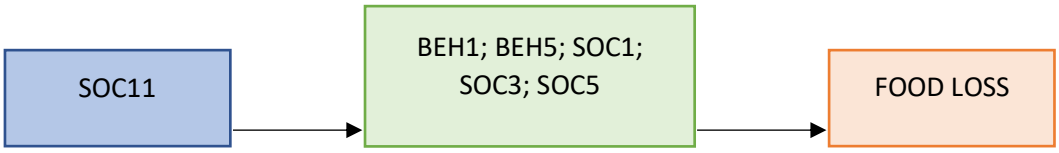
Driver name	Marketing strategies
Driver code	SOC11
FOLOU commodity sectors	All
Driver key words	Industrial standards; coordination between supply chain's phase; market priorities
% of articles/reports in which the driver is reported	4%

Description

This driver is relevant in shaping how production interacts with the market. **Marketing strategies** can impact how mismatches between supply and demand contribute to food waste. Market strategies refer to how producers organize themselves to enter the market and influence the pricing of agricultural products(Bustos et al., 2018). Another crucial aspect of this driver is its connection with the traceability process and how the construction of new markets intersects with food loss (Coderoni et al., 2021)

Classification

This is an **indirect driver of food loss**. Marketing strategies indeed influence overproduction, the relationship between supply and demand, the definition of industrial standards, etc. Due to its ability to guide actors toward practices that directly result in food loss, this driver has been identified as an indirect one.



3.2.12. Lack of efficiency of equipment

Driver name	Lack of efficiency of equipment
Driver code	SOC12
FOLOU commodity sectors	All
Driver key words	Technical knowledge; machinery degradation; harvesting practices
% of articles/reports in which the driver is reported	8%

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Description

This driver is connected both to BEH2 "Lack of knowledge of harvest/post-harvest technologies and methods" and SOC7 "Inefficient storage and processing infrastructure." However, it has been chosen to be a standalone driver because various texts have highlighted food damage due to issues related to the **operation and deterioration of machinery** as a specific problem (Spang et al., 2018; Magalhaes et al., 2021).

Classification

This is a **direct driver of food loss**. In fact, the mishandling of food in these cases directly leads to food loss.

3.2.13. Adoption of a paradigm that produce losses and waste

Driver name	Adoption of a paradigm that produce losses and waste
Driver code	SOC13
FOLOU commodity sectors	All
Driver key words	Ideas on food structure; governance; priority definition
% of articles/reports in which the driver is reported	8%

Description

This driver allows indicating how the issue of food loss is considered in structuring the agri-food production and consumption system. The way data is constructed and monitored, the priorities recognized by the actors in the supply chains, the legal lack of tools to reduce food loss, the absence of a stringent inventory policy to prioritize reducing food loss, and the low effectiveness and efficiency in the internal organization of supply chains: all contribute to the **inability to reduce food loss** (Abualtaher et al., 2020; Yan et al., 2021; Surucu-Balci et al.,2021).

Classification

This is an **indirect driver of food loss**. Adopting a paradigm that does not recognize the reduction of food loss as a priority leads to actions that directly impact food loss. Making direct reference to the paradigms governing the actions of stakeholders is crucial because it is precisely from the failure to recognize the urgency of changing the production and market organization structure that practices generating food loss emerge.

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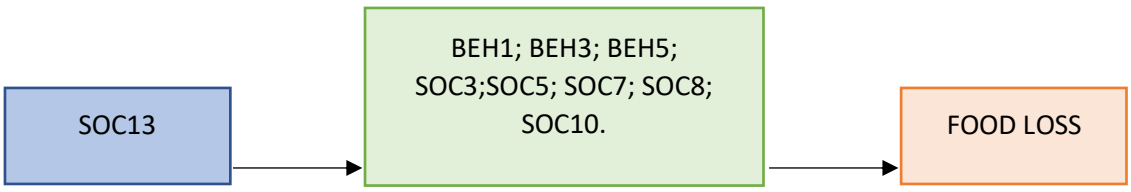


3.2.14. Missed application of technological advances

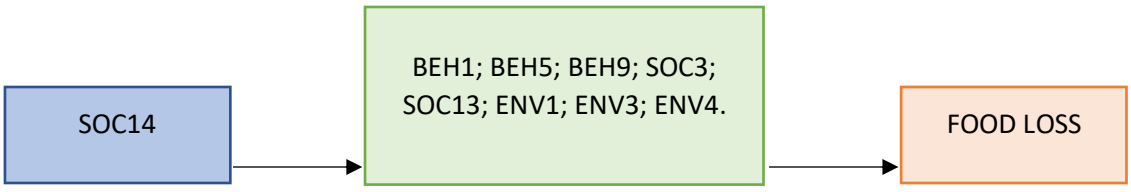
Driver name	Missed application of technological advances
Driver code	SOC14
FOLOU commodity sectors	All
Driver key words	Technical advancement, worker's training, change
% of articles/reports in which the driver is reported	3%

Description

This driver highlights the **lack of implementation of technological innovations**. To address food loss, technologies have been developed to reduce damage to food during harvesting, post-harvesting, storage, processing, and transportation (McKinzie et al., 2017; Jacob-Jhon et al., 2022). However, when these technologies are not adopted, a significant amount of avoidable food loss occurs.

Classification

This is a **direct driver of food loss**, as the failure to adopt and appropriately utilize modern technologies designed to reduce damage during harvesting, post-harvesting, storage, processing, and transportation leads directly to avoidable instances of food loss.



3.2.15. Inability to cope with unexpected external changes

Driver name	Inability to cope with unexpected external changes
Driver code	SOC15

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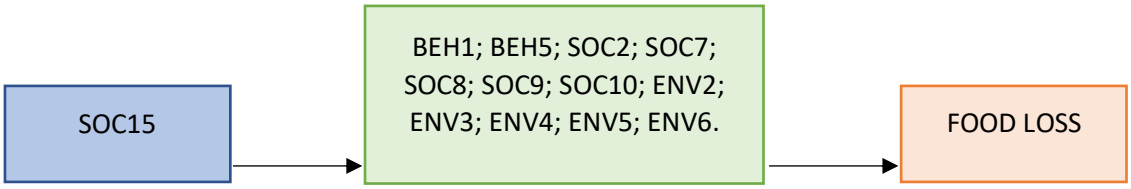
FOLOU commodity sectors	All
Driver key words	Covid-19 pandemic, climate change, change in power relationships, technological transformation
% of articles/reports in which the driver is reported	9%

Description

This driver involves unexpected and unaccounted-for situations, such as the Covid-19 pandemic, environmental events, changes in internal supply chain relations, etc., which can cause food loss (Jacob-Jhon et al., 2022). The inability of productive, infrastructural, economic, and administrative organizations to react flexibly and quickly to changes can indeed result in the loss of food products or the production of foods not demanded by the market (Bustos et al., 2018; Thorsen et al., 2022). Additionally, this driver is connected to SOC13 "Missed application of technological advances" due to the inability to apply new technologies in the agro-industrial supply chain.

Classification

This is an **indirect driver**. The inability to incorporate external changes into production and distribution chains reflects on other phases of the supply chains and influences how actors determine their actions and choices.



3.2.16. Lack of skilled labour availability

Driver name	Lack of skilled labour availability
Driver code	SOC16
FOLOU commodity sectors	All
Driver key words	Availability of trained workers
% of articles/reports in which the driver is reported	7%

Description

This driver stems from the **scarcity of skilled labour in the market**. Ensuring the optimal utilization of machinery, storage and processing infrastructure, harvest

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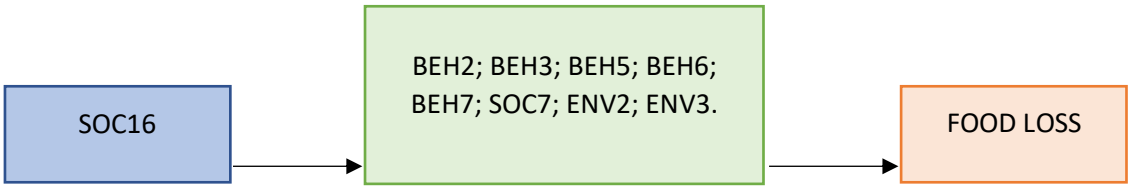
practices, and production organization hinges significantly on the proficiency of individuals working in the fields and agroindustry. The deficiency in their efficiency emerges as a noteworthy factor contributing to food loss (Backer et al., 2020).

Classification

This is an **indirect driver**. The incorrect utilization of machinery, inadequate **management** of storage and processing infrastructure, or improper handling of the product, indeed, is a major contributor to food loss, leading to inefficiencies in the agricultural and agro-industrial processes.



3.3 Environmental drivers

3.3.1. Unexpected climate and weather events

Driver name	Unexpected climate and weather events
Driver code	ENV1
FOLOU commodity sectors	All (with a predominance of fruits and vegetables)
Driver key words	Extreme weather events, climate changes, damage to crops
% of articles/reports in which the driver is reported	33%

Description

This driver highlights that climate changes and weather variability can have an obvious effect upon yield and can also lead to crop losses in the field. Indeed, extreme weather events may cause visible cosmetic damage to crops, leading to their rejection because of retail specifications (Beausang et al., 2017).

Some authors underline that the amount of loss during harvesting can be influenced by natural conditions such as the occurrence of abnormal weather, in some cases, for instance, temperature extremes predispose crops to fungal attacks rendering food unsafe and requiring it to be discarded (Dorner, et al, 1989).

Furthermore, extreme weather events such as sudden frost, heavy rain, hailstorms, drought, excess wind, ext. can lead to damage to crops, causing them to fall prematurely to the ground or causing damage that makes them unharvestable.

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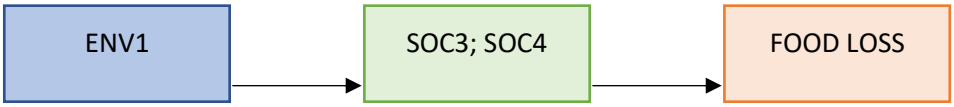
Classification

This is both a direct and indirect driver of food loss. When extreme weather events and climate changes cause falls to the ground or significant damage to products, we can consider this a direct driver. When extreme weather events cause visible aesthetic damage to crops, making them unmarketable (SOC3), or making them vulnerable to disease and pest attacks, causing food safety issues (SOC4), we can consider it an indirect factor.



3.3.2. Pests, diseases and phytosanitary issues

Driver name	Pests and diseases and phytosanitary issues
Driver code	ENV2
FOLOU commodity sectors	All (with a predominance of fruits and vegetables)
Driver key words	Pest infestations, diseases, parasite infestation, epidemics, reduced production, damage to the product
% of articles/reports in which the driver is reported	37%

Description

This driver emphasizes that pest infestations and crop diseases are among the primary factors leading to food losses during both the ripening and post-harvest stages, especially for fruits and vegetables. Several authors underline that parasite infestations pose a greater threat when they occur during the pre-harvest phase, resulting in significant losses during subsequent handling and conservation stages.

Other authors emphasize how products harvested under excellent conditions can still be vulnerable to attacks by parasites and diseases during storage, leading to food losses.

Food losses due to diseases and parasites can also occur in animal products. For instance, milk may be lost when dairy cattle fall ill and require treatment with antibiotics. One of the most significant diseases in dairy farming is mastitis, an inflammation of breast tissue that is widespread and results in reduced milk production. Additionally, certain epidemics may result in food losses as infected animals are removed from the supply chain to safeguard consumers and aid in the eradication of specific diseases (Jaja et al., 2018).

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Classification

This is a direct driver of food loss. Parasite attacks and diseases either result in reduced production or damage to the product, rendering it inedible. In other cases, they make food products unsafe for human consumption and are consequently removed from the food supply chain.

3.3.3. Consumption or damage by insects, rodents, birds or microbes (e.g., molds, bacteria)

Driver name	Consumption or damage by insects, rodents, birds or microbes (e.g., molds, bacteria)
Driver code	ENV3
FOLOU commodity sectors	All
Driver key words	Insects, rodents, birds, microbes, production destroyed, damaged, or consumed
% of articles/reports in which the driver is reported	16%

Description

This driver highlights how agricultural production can be destroyed, damaged, or consumed by insects, rodents, birds, or microbes, both before and after harvesting. Such damage can significantly impact the rate of sensory or microbiological deterioration associated with the natural degradation of the physiological, biochemical, and microbiological properties of the products (Mena et al., 2014; Emana et al., 2017).

Some authors also note that the amount of cereal loss during harvesting can be influenced not only by natural conditions such as abnormal weather, by insect populations, and field humidity but also by the presence of rodents, birds, and harmful microbes.

Classification

This is a direct driver of food loss. When insects, rodents, birds, or microbes attack food production before or after harvesting, they result in the destruction, damage, or consumption of crops, leading to losses.

3.3.4. Natural weather/meteorological conditions

Driver name	Natural weather/meteorological conditions
Driver code	ENV4

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FOLOU commodity sectors	All
Driver key words	Normal climatic and meteorological conditions, temperature, precipitation, humidity, wind, favorable weather
% of articles/reports in which the driver is reported	17%

Description

This driver highlights that normal climatic and meteorological conditions can lead to losses both in the different phases of plant development and in the pre-harvest and post-harvest ones, if they deviate from those optimal for the development of the plant. Climatic conditions, such as temperature, precipitation, humidity, and wind, play a crucial role in influencing both the quality and quantity of the harvest. For instance, seasons with limited rainfall can lead to reduced yields, while excessively high temperatures can shorten the shelf life of goods during post-harvest phases.

Some authors emphasize that exceptionally favorable weather conditions can result in losses, as excessive production may not find a market and consequently must be destroyed. For example, periods of higher temperatures than those expected during winter, cause an overproduction of certain crops (mainly leafy vegetables) that, unable to be put on the market, are discarded.

Classification

This is both a direct and indirect driver of food loss. This is a direct driver when normal climatic and meteorological conditions can lead to losses, in terms of decreases in the quantities produced, if they deviate from those optimal for the development of the plant.

This is an indirect factor when exceptionally favorable weather conditions lead to excess production that fails to find a market.

3.3.5. Old plantations

Driver name	Old plantations
Driver code	ENV5
FOLOU commodity sectors	Fruits and vegetables
Driver key words	Old orchard, lower yield, new varieties low market demand
% of articles/reports in which the driver is reported	5%

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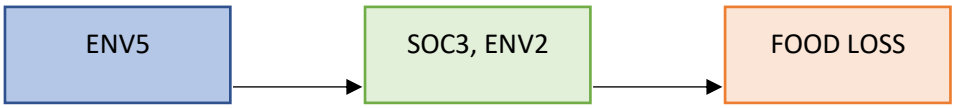
Description

The aging of orchards has been identified as one of the drivers contributing to food losses in primary production. Older orchards typically have lower yields, reduced product quality, and increased susceptibility to pests and diseases. Therefore, this factor can lead to losses on farms compared to newer varieties specifically designed to produce fruits that align with market demands.

Classification

This is both a direct and indirect driver of food loss. It directly contributes to food loss as an aging orchard experiences a decrease in its natural production capacity. Additionally, it indirectly influences food loss as older orchards are more vulnerable to pests and diseases, which further exacerbate production losses.



3.3.6. Soil deterioration

Driver name	Soil deterioration
Driver code	ENV6
FOLOU commodity sectors	Fruits and vegetables
Driver key words	Wear, erosion insufficient rotation, soil degradation, loss of the fertility
% of articles/reports in which the driver is reported	1%

Description

Erosion means "wear" and is one of the major causes of soil degradation. Erosion causes the loss of the most superficial and fertile part of the soil, making the land less suitable for growing crops. Many agricultural practices contribute to soil "wear" because they are not carried out in a sustainable way, failing to conserve the soil resource. Among these practices, the authors of the report include the insufficient rotation of crops.

Classification

This is a direct driver of food loss. When the soil loses its fertility due to excessive exploitation of the land associated with monoculture, it also loses some of its nutritional capacity, resulting in less productive crops.

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4. Descriptive statistics

In this section we provide a set of descriptive statistics on the most frequent drivers contributing to food loss identified in the review. Moreover, their coverage is analysed by commodity group, country and data available. The aim of this is to derive overarching trends characterizing the drivers behind food losses.

4.1. Most frequent drivers of food loss and commodity sector

In total, our review identified **405 occurrences of 35 societal, behavioural, and environmental drivers of food losses** during the primary production stage. Of these, 204 (50%) are related to drivers of societal nature, 118 (29%) are behavioural drivers, while 83 (20%) are drivers of environmental nature (Figure 3).

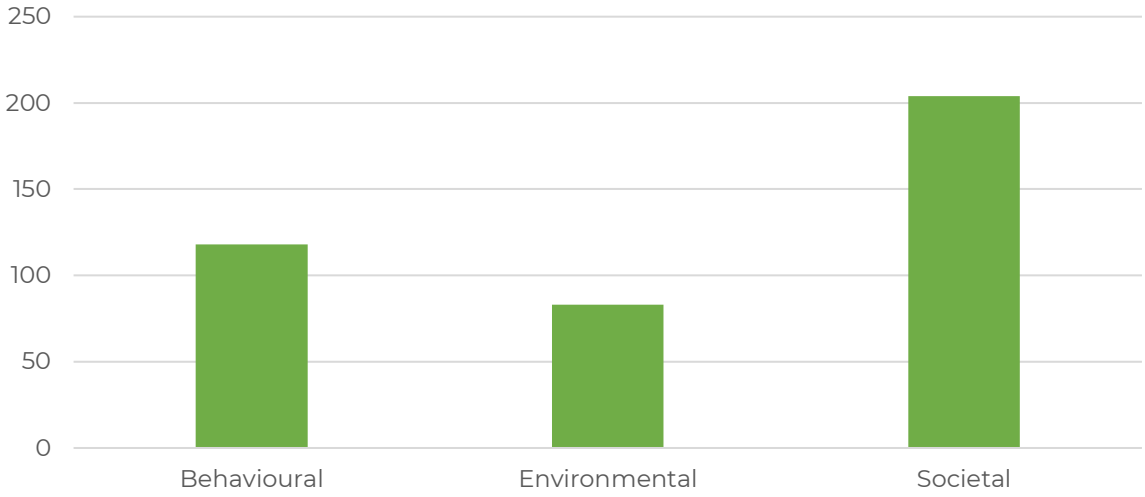

Figure 3. Drivers' occurrence by type.

Figure 4 reports the most frequent drivers identified while performing the review. **Five of the ten most frequent drivers are of societal nature, while three of behavioural nature and two of environmental nature**. Overall, these drivers account for about 67% of the total occurrences reported in Figure 3.

The most frequent societal drivers are:

I. SOC3: Marketing and industry standards (identified in 58% of the studies reviewed)

II. SOC7: Inefficient storage and processing infrastructures (51% of the studies)

III. SOC1: Low market price of food products (29%)

IV. SOC5: Lack of coordination and communication among actors and territories (28%)

V. SOC4; Food safety regulations and standards (18%)

The most frequent behavioural drivers are:

I. BEH6: Inadequate or improper handling of the product (46%)

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II. BEH1: Insufficient understanding of market fluctuations and price mechanisms (29%)

III. BEH2: Lack of knowledge of harvest/post-harvest technologies and methods (28%)

Finally, the most frequent drivers of environmental nature are:

I. ENV2: Pest, diseases, and phytosanitary issues (37%)

II. ENV1: Unexpected climate and weather events (33%)

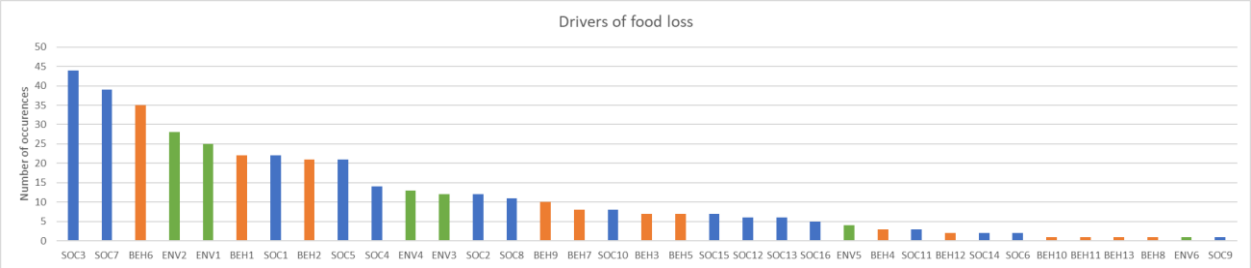

Figure 4. Driver occurrence in the review.

Interestingly, among the ten most frequently reviewed drivers, **the majority (8) directly contribute to food losses, while only two (SOC5 and BEH1) have been identified as indirect drivers**. This emphasizes the significant role that direct actions of primary producers and related stakeholders play in the generation of food losses.

When looking at the food commodity sector coverage, **most of the reviewed articles and reports (56%) refer to the fruit and vegetable commodity sector**. About 8% of the studies refers to the meat and animal derived products sector, 6% refers to the fish and fisheries product sector, 5% to the grain and pulses, and 4% to the root tubers and oil crops sectors. About 41 % of the studies deal with the general primary production sector, without specifying the food products they are referring to when discussing about food loss drivers. Finally, 7% of the articles cover multiple sectors.

4.2 Country coverage and available data on food losses

The sample reviewed includes 76 items, comprising 41 scientific publications and 35 grey literature reports. The average number of drivers reported for each item is 5.3 ± 0.15. The article with the highest number of drivers reported has 14 drivers, while the minimum is 1.

Figure 5 provides an overview of the countries assessed in our review. **Most of the drivers of food loss are found in articles and reports that do not specifically focus on particular countries, providing general overviews** (36%). The best surveyed countries are Spain (23%), Belgium (6%), Europe in general (5%), and Turkey (5%).

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When appraising the articles and reports regarding data and available statistics on the magnitude and weight of food losses by drivers, we found that **only 28% of the studies provide some kind of estimation of food loss drivers weight, while only 14% provides information on the driver magnitude.** This is either due to their qualitative nature of the study (e.g., interviews with primary producers), or because they offer quantification of food losses by sector and production phase (on-farm vs. off-farm) rather than by individual drivers. **This suggests that further work on assessing the weights of the most frequent drivers of food losses, using both quantitative and qualitative methods, is a relevant analysis not yet conducted**.

The most frequent drivers for which the literature reports information on their weight and magnitude are:

- SOC7: Inefficient storage and processing infrastructure
- ENV2: Pests, diseases and phytosanitary issues
- BEH6: Inadequate or improper handling of the product.

As reported in 4.1, these are also the most frequent and important drivers of food losses overall.

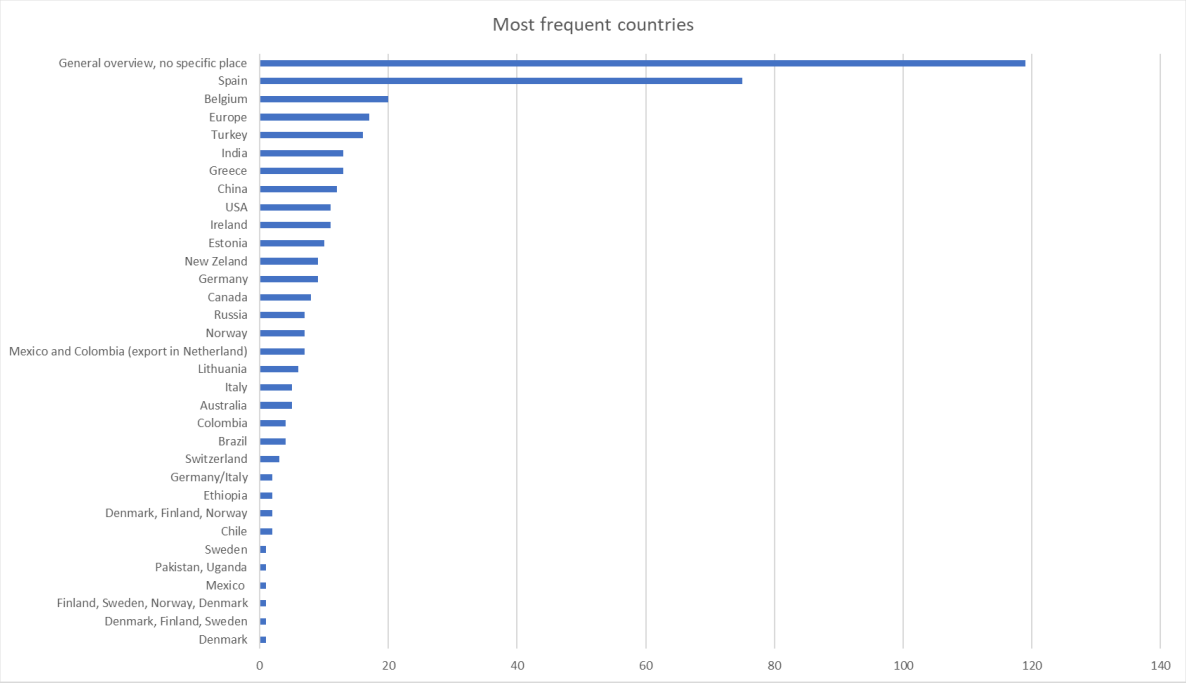

Figure 5. Country coverage

4.3 Linking drivers' effect on food losses

In Figure 6, we present a preliminary combined visualization of the drivers' connections, considering their direct or indirect effects on food losses at the primary production stage. These relationships will serve as the background information for the stakeholder engagement process, which will start from M14. This process will concentrate on validating the data gathered through systematic

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review via semi-structured interviews (aimed at prioritizing and evaluating the drivers identified) and focus groups (targeting the identification of interconnections among drivers, as illustrated in Figure 6).

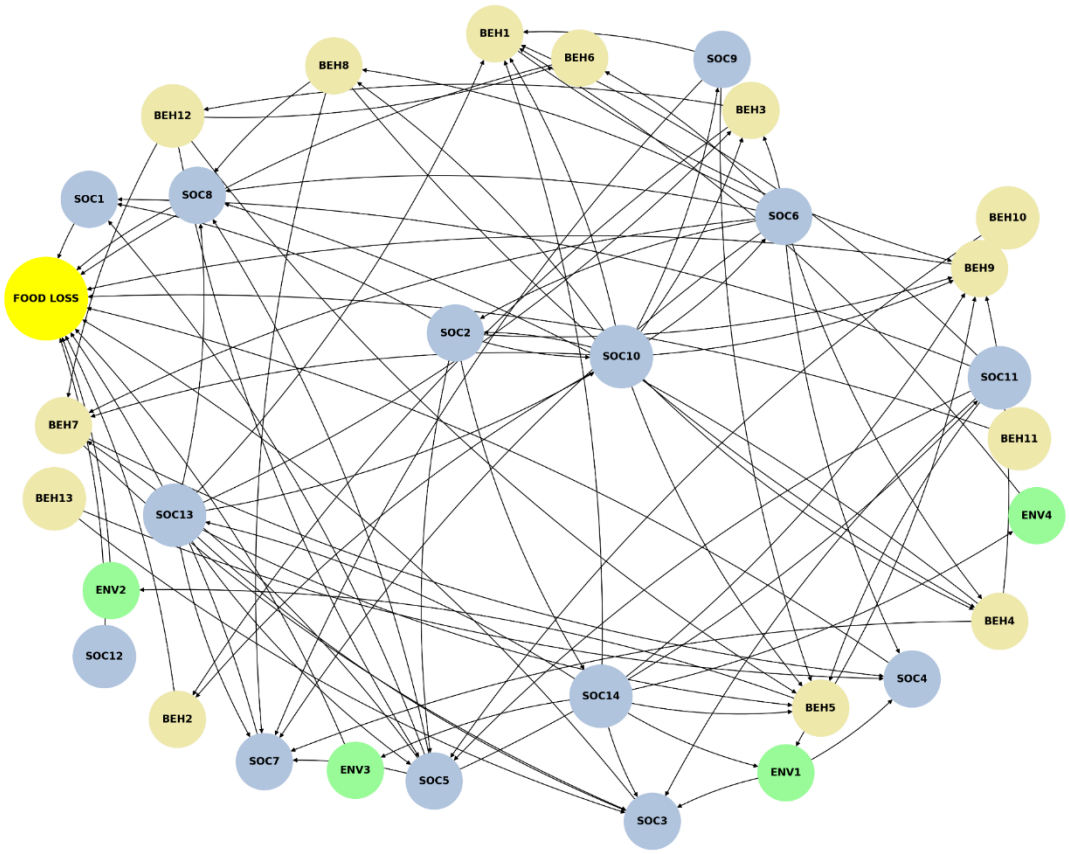

Figure 6. Direct and indirect drivers of food losses: an initial visualization of existing linkages.

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5. Conclusions and next steps

This study sheds light on the factors characterizing food losses during the primary production stage. By reviewing 76 items of literature on food losses worldwide, we identified the most common behavioural, societal, and environmental drivers associated with food losses. These are primarily direct drivers related to market standards, inefficient storage and processing infrastructure, improper handling, pest diseases, and unexpected climate events.

Despite the relevance of these findings, further work will be conducted in the frame of WP2 to validate the findings of this systematic review. On one hand, we plan to validate the list of identified drivers with practitioners from the primary production sector (T2.2 and T2.3). Additionally, we aim to prioritize and rank drivers through semi-structured interviews and focus groups. These activities are scheduled for M15-30 of the project and will lay the groundwork for data analysis in D2.3. This analysis aims to unravel connections among drivers and derive suitable interventions to mitigate their impact.

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D2.2 – Report on available data and information about food loss drivers

Annex 1

List of drivers of food loss

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Table 3. List compiling all drivers identified in the literature review.

Driver code	Driver name	Category as in D2.1	Direct/Indirect
BEH1	Insufficient understanding of market fluctuations and price mechanisms	Behavioural	Indirect
BEH2	Lack of knowledge of harvest/post-harvest technologies and methods	Behavioural	Direct
BEH3	Lack of training	Behavioural	Indirect
BEH4	Lack of investment capacity	Behavioural	Indirect
BEH5	Inappropriate choice of product varieties (e.g., crops, breed…)	Behavioural	Indirect
BEH6	Inadequate or improper handling of the product	Behavioural	Direct
BEH7	Wrong collecting time (harvesting, catching…)	Behavioural	Indirect
BEH8	Lack of knowledge on fiscal aid tools and bureocracy	Behavioural	Indirect
BEH9	Excess production to ensure fulfillment of contracts	Behavioural	Direct
BEH10	Mistrust versus central administration/institutions	Behavioural	Indirect
BEH11	Inappropriate planting scale	Behavioural	Direct
BEH12	Interpersonal dynamics altering the supply chain efficiency	Behavioural	Indirect
BEH13	Bycatch	Behavioural	Indirect
SOC1	Low market price of food products	Societal	Direct
SOC2	Low market power of farmers due to unfair contracts and competition	Societal	Indirect
SOC3	Marketing and industry standards (weight, aesthetic standards, size, shape, quality)	Societal	Direct
SOC4	Food safety regulations and standards	Societal	Direct
SOC5	Lack of coordination and communication among actors and territories	Societal	Indirect
SOC6	Lack of adequate supply chain capacity	Societal	Indirect
SOC7	Inefficient storage and processing infrastructure	Societal	Direct
SOC8	Inefficient transportation infrastructure	Societal	Direct
SOC9	Direct subsidies on production	Societal	Indirect
SOC10	Market organization	Societal	Indirect
SOC11	Marketing strategies	Societal	Indirect
SOC12	Lack of efficiency of equipment	Societal	Direct
SOC13	Adoption of a paradigm that produce losses and waste	Societal	Indirect
SOC14	Missed application of technological advances	Societal	Direct
SOC15	Inability to cope with unexpected external changes	Societal	Indirect
SOC16	Lack of skilled labour availability	Societal	Indirect
ENV1	Unexpected climate and weather events	Environmental	Indirect/Direct
ENV2	Pests, diseases and phytosanitary issues	Environmental	Direct
ENV3	Consumption or damage by insects, rodents, birds or microbes (e.g., molds, bacteria), or predators	Environmental	Direct
ENV4	Natural weather/meteorological conditions	Environmental	Indirect/Direct
ENV5	Old plantations	Environmental	Indirect/Direct
ENV6	Soil deterioration	Environmental	Direct

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D2.2 – Report on available data and information about food loss drivers

Annex 2

List of scientific articles reviewed

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Table 4. List of scientific articles reviewed.

ID	Title	Year	Journal	Vol.	Issue	Authors	DOI	Included in the review?
1	Addressing food loss and waste prevention	2022	British Food Journal	124	8	Kor, Burcu and Krawczyk, Adriana and Wakkee, Ingrid	10.1108/BFJ-05-2021-0571	yes
2	Mitigation of food loss and waste in primary production of a transition economy via stakeholder collaboration: A perspective of independent farmers in Russia	2021	Sustainable Production and Consumption	28		Filimonau, Viachaslau and Ermolaev, Vladimir A.	10.1016/j.spc.2021.06.002	yes
3	Using a methodological approach to model causes of food loss and waste in fruit and vegetable supply chains	2021	Journal Of Cleaner Production	283		Magalhaes, Vanessa S. M. and Ferreira, Luis Miguel D. F. and Silva, Cristovao	10.1016/j.jclepro.2020.124574	yes
4	Understanding Food Loss and Waste-Why Are We Losing and Wasting Food?	2019	Foods	8	8	Ishangulyyev, Shen and Kim, Sanghyo and Lee, Sang Hyeon	10.3390/foods8080297	yes
5	A systematic review of food loss and waste in China: Quantity, impacts and mediators	2022	Journal Of Environmental Management	303		Li, Charlene and Bremer, Phil and Harder, Marie K. and Lee, Michael S. W. and Parker, Kate and Gaugler, Evamaria C. and Mirosa, Mir and a	10.1016/j.jenvman.2021.114092	yes
6	A critical review of on-farm food loss and waste: future research and policy recommendations	2023	Renewable Agriculture and Food Systems	38		O'Connor, Jessica and Skeaff, Sheila and Bremer, Phil and Lucci, Gina and Mirosa, Mir and a	10.1017/S1742170523000169	yes
7	How can food loss and waste management achieve sustainable development goals?	2019	Journal Of Cleaner Production	234		Lemaire, Anais and Limbourg, Sabine	10.1016/j.jclepro.2019.06.226	yes
8	Investigating logistics-related food loss drivers: A study on fresh fruit and vegetable supply chain	2021	Journal Of Cleaner Production	318		Surucu-Balci, Ebru and Tuna, Okan	10.1016/j.jclepro.2021.128561	yes
9	Systems Engineering Approach to Food Loss Reduction in Norwegian Farmed Salmon Post-Harvest Processing	2020	Systems	8	1	Abualtaher, Mohd and Bar, Eirin Skjondal	10.3390/systems8010004	yes
10	Tilling food under: Barriers and opportunities to address the loss of edible food at the farm-level in British Columbia, Canada	2021	Resources Conservation and Recycling	170		Soma, Tammara and Kozhikode, Rajiv and Krishnan, Rekha	10.1016/j.resconrec.2021.105571	yes
11	Quantity and quality of food losses along the Swiss potato supply chain: Stepwise investigation and the influence of quality standards on losses	2015	Waste Management	46		Willersinn, Christian and Mack, Gabriele and Mouron, Patrik and Keiser, Andreas and Siegrist, Michael	10.1016/j.wasman.2015.08.033	yes
12	The role of collaboration in tackling food loss and waste: Salient stakeholder perspective	2022	Journal Of Cleaner Production	367		Surucu-Balci, Ebru and Tuna, Okan	10.1016/j.jclepro.2022.133126	yes
13	Importance of sustainable operations in food loss: evidence from the Belgian food processing industry	2020	Annals Of Operations Research	290	1	Dora, Manoj and Wesana, Joshua and Gellynck, Xavier and Seth, Nitin and Dey, Bidit and De Steur, Hans	10.1007/s10479-019-03134-0	no
14	Causes and mitigation strategies of food loss and waste: A systematic literature review and framework development	2021	Sustainable Production and Consumption	28		Magalhaes, Vanessa S. M. and Ferreira, Luis Miguel D. F. and Silva, Cristovao	10.1016/j.spc.2021.08.004	yes

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ID	Title	Year	Journal	Vol.	Issue	Authors	DOI	Included in the review?
15	Adopting the circular economy approach on food loss and waste: The case of Italian pasta production	2019	Resources Conservation and Recycling	144		Principato, Ludovica and Ruini, Luca and Guidi, Matteo and Secondi, Luca	10.1016/j.resconrec.2019.01.025	yes
16	Low-Hanging Fruit: Reducing Food Waste by 2030	2019	ONE EARTH	1	3	yes		
17	A Quantitative and Qualitative Study of Food Loss in Glasshouse-Grown Tomatoes	2022	Horticulturae	8	1	Thorsen, Margaret and Mirosa, Mir and a and Skeaff, Sheila	10.3390/horticulturae8010039	yes
18	How Much Food Loss and Waste Do Countries with Problems with Food Security Generate?	2023	Agriculture-Basel	13	5	Duran-S and oval, Daniel and Duran-Romero, Gemma and Uleri, Francesca	10.3390/agriculture13050966	yes
19	An analysis of multi-stakeholder initiatives to reduce food loss and waste in an emerging country? Brazil	2021	Industrial Marketing Management	93		Matzembacher, Daniele Eckert and Vieira, Luciana Marques and de Barcellos, Marcia Dutra	10.1016/j.indmarman.2020.08.016	yes
20	Investigating food loss and waste issues from a network perspective - Green Metamorphoses: Agriculture, Food, Ecology	2020				Fiore, M. and Pellegrini, G. and Conto, F.	10.3920/978-90-8686-898-8_18	yes
21	Food Loss and Waste: Measurement, Drivers, and Solutions - Annual Review of Environment And Resources	2019		44		Spang, Edward S. and Moreno, Laura C. and Pace, Sara A. and Achmon, Yigal and Donis-Gonzalez, Irwin and Gosliner, Wendi A. and Jablonski-Sheffield, Madison P. and Momin, Md Abdul and Quested, Tom E. and Winans, Kiara S. and Tomich, Thomas P.	10.1146/annurev-environ-101718-033228	yes
22	Farmer harvest decisions and vegetable loss in primary production	2019	Agricultural Systems	176		Johnson, Lisa K. and Bloom, J. Dara and Dunning, Rebecca D. and Gunter, Chris C. and Boyette, Michael D. and Creamer, Nancy G.	10.1016/j.agsy.2019.102672	yes
23	Market power and food loss at the producer-retailer interface of fruit and vegetable supply chains in Germany	2022	Sustainability Science	17	6	Herzberg, Ronja and Schmidt, Thomas and Keck, Markus	10.1007/s11625-021-01083-x	yes
24	A Systematic Review of Factors Affecting Food Loss and Waste and Sustainable Mitigation Strategies: A Logistics Service Providers' Perspective	2021	Sustainability	13	20	Yan, Han and Song, Min-Ju and Lee, Hee-Yong	10.3390/su132011374	yes
25	Quality Standards and Contractual Terms Affecting Food Losses: The Perspective of Producer Organisations in Germany and Italy	2023	Foods	12	10	Pietrangeli, Roberta and Herzberg, Ronja and Cicatiello, Clara and Schneider, Felicitas	10.3390/foods12101984	yes
26	Handling food waste and losses: Criticalities and methodologies - Sustainable Food Supply Chains: Planning, Design, And Control Through Interdisciplinary Methodologies	2019				Garcia-Flores, Rodolfo and Juliano, Pablo and Petkovic, Karolina	10.1016/B978-0-12-813411-5.00018-1	yes
27	Quantifying Postharvest Loss and the Implication of Market-Based Decisions: A Case	2017	Horticulturae	3	3	McKenzie, Tara J. and Singh-Peterson, Lila and Underhill, Steven J. R.	10.3390/horticulturae3030044	yes

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ID	Title	Year	Journal	Vol.	Issue	Authors	DOI	Included in the review?
28	Study of Two Commercial Domestic Tomato Supply Chains in Queensland, Australia Relational and Logistical Dimensions of Agricultural Food Recovery: Evidence from California Growers and Recovery Organizations	2020	Sustainability	12	15	Meagher, Kelsey D. and Gillman, Anne and Campbell, David C. and Spang, Edward S.	10.3390/su12156161	yes
29	Approaches for reducing wastes in the agricultural sector. An analysis of Millennials' willingness to buy food with upcycled ingredients	2021	Waste Management	126		Coderoni, Silvia and Perito, Maria Angela	10.1016/j.wasman.2021.03.018	yes
30	Food systems sustainability: The complex challenge of food loss and waste - Sustainable Food Supply Chains: Planning, Design, And Control Through Interdisciplinary Methodologies	2019				Vittuari, Matteo and De Menna, Fabio and Garcia-Herrero, Laura and Pagani, Marco and Brenes-Peralta, Laura and Segre, Andrea	10.1016/B978-0-12-813411-5.00017-X	yes
31	A systems approach to assessing environmental and economic effects of food loss and waste interventions in the United States	2019	Science of the Total Environment	685		Muth, Mary K. and Birney, Catherine and Cuellar, Am and a and Finn, Steven M. and Freeman, Mark and Galloway, James N. and Gee, Isabella and Gephart, Jessica and Jones, Kristal and Low, Linda and Meyer, Ellen and Read, Quentin and Smith, Travis and Weitz, Keith and Zoubek, Sarah	10.1016/j.scitotenv.2019.06.230	no
32	Food loss and waste in the Brazilian beef supply chain: an empirical analysis	2021	International Journal of Logistics Management	32	1	Magalhaes, Vanessa S. M. and Ferreira, Luis Miguel D. F. and Cesar, Aldara da Silva and Bonfim, Renato Manzini and Silva, Cristovao	10.1108/IJLM-01-2020-0038	yes
33	Review of policy instruments and recommendations for effective food waste prevention	2019	Proceedings of the Institution Of Civil Engineers-Waste And Resource Management	172	3	Schinkel, Jennifer	10.1680/jwarm.18.00022	yes
34	Impact of information technology and knowledge sharing on circular food supply chains for green business growth	2022	Business Strategy and The Environment	31	5	Ersoy, Pervin and Boruhan, Gulmus and Mangla, Sachin Kumar and Hormazabal, Jorge Hern and ez and Kazancoglu, Yigit and Lafci, Cisem	10.1002/bse.2988	no
35	Sustainable Development Goals: a review of SDG 12.3 in food supply chain literature	2022	Benchmarking an international journal			Jacob-John, Jubin and D'Souza, Clare and Marjoribanks, Timothy and Singaraju, Stephen		
36	Environmental impacts of food losses along the entire Swiss potato supply chain - Current situation and reduction potentials	2017	Journal Of Cleaner Production	140	2	Willersinn, Christian and Moebius, Sabrina and Mouron, Patrik and Lansche, Jens and Mack, Gabriele	10.1016/j.jclepro.2016.06.178	yes
37	Drivers of implementing Big Data Analytics in food supply chains for transition to a circular	2021	Journal Of Enterprise Information Management			Kazancoglu, Yigit and Pala, Melisa Ozbiltekin and Sezer, Muruvvet Deniz and Luthra, Sunil and Kumar, Anil		

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ID	Title	Year	Journal	Vol.	Issue	Authors	DOI	Included in the review?
	economy and sustainable operations management							
38	Exploration of Food Security Challenges towards More Sustainable Food Production: A Systematic Literature Review of the Major Drivers and Policies	2022	Foods	11	23	Wahbeh, Sabreen and Anastasiadis, Foivos and Sundarakani, Balan and Manikas, Ioannis	10.3390/foods11233804	yes
39	Environmental Profile of the Swiss Supply Chain for French Fries: Effects of Food Loss Reduction, Loss Treatments and Process Modifications	2016	Sustainability	8	12	Mouron, Patrik and Willersinn, Christian and Moebius, Sabrina and Lansche, Jens	10.3390/su8121214	no
40	In quest of reducing the environmental impacts of food production and consumption	2017	Journal Of Cleaner Production	140	2	Sala, Serenella and Anton, Assumpcio and McLaren, Sarah J. and Notarnicola, Bruno and Saouter, Erwan and Sonesson, Ulf	10.1016/j.jclepro.2016.09.054	no
41	Understanding Farm-Level Incentives within the Bioeconomy Framework: Prices, Product Quality, Losses, and Bio-Based Alternatives	2021	Sustainability	13	2	Jansen, Sarah and Foster, William and Anriquez, Gustavo and Ortega, Jorge	10.3390/su13020450	yes
42	Reducing post-harvest food losses through innovative collaboration: Insights from the Colombian and Mexican avocado supply chains	2018	Journal Of Cleaner Production	199		Bustos, Carolina Arias and Moors, Ellen N. M.	10.1016/j.jclepro.2018.06.187	yes
43	Estimating the Blue Water Footprint of In-Field Crop Losses: A Case Study of US Potato Cultivation	2018	Sustainability	10	8	Spang, Edward S. and Stevens, Bret D.	10.3390/su10082854	yes
44	Analyzing quality and modelling mass loss of onions during drying and storage	2019	Computers And Electronics in Agriculture	164		Islam, Md. Nahidul and Koerner, Oliver and Pedersen, Jakob Skov and Sorensen, Jorn Nygaard and Edelenbos, Merete	10.1016/j.compag.2019.104865	no
45	Strategies for reducing the waste of fruit and vegetable supply chains: the search for sustainable wholesale systems	2022	Horticultura Brasileira	40	3	Lima, Dag M. and Marsola, Karina B. and de Oliveira, Andrea L. R. and Belik, Walter	10.1590/s0102-0536-20220313	no
46	Drivers of food waste - Food Loss and Food Waste: Causes and Solutions	2019						yes
47	Tomato tales Comparing loss-reduction drivers and opportunities across US fresh tomato supply chains - Economics of Food Loss in the Produce Industry	2020						yes
48	Modeling the key factors leading to post-harvest loss and waste of fruits and vegetables in the agri-fresh produce supply chain	2022	Computers And Electronics in Agriculture	198		An and, Santosh and Barua, M. K.	10.1016/j.compag.2022.106936	yes
49	Modeling the drivers of post-harvest losses - MCDM approach	2018	Computers And Electronics in Agriculture	154		Raut, Rakesh D. and Gardas, Bhaskar B. and Kharat, Manoj and Narkhede, Balkrishna	10.1016/j.compag.2018.09.035	yes
50	Strategies for FLW reduction - Food Loss and Food Waste: Causes and Solutions	2019						no

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D2.2 – Report on available data and information about food loss drivers

Annex 3

List of grey literature reviewed

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Table 5. List of grey literature reviewed

ID	Country	Title (in english)	Authors (main organisation)	Author list	Language	Included in the review?
1	Italy	The potential of the primary sector and the consumer in the management of food surpluses	OERSA	Scalvedi, L., Grant, F., Scognamiglio, U., Rossi, L.	Italian	yes
2	Italy	Position paper on food losses and waste food	Slow food	Ursula Hudson, Marta Messa	Italian	yes
3	Belgium	Belgium braces for poor potato harvest following long period of drought	the Brussels Times	Dylan Carter	English	yes
4	Norway	Risk assessment of fish health and welfare in freshwater aquaculture	VKM	Ulf Erikson (chair), Dag Berge, Eirik Biering, Brit Hjeltnes and Espen Rimsta	Norwegian	yes
5	Italy	Damages on nectarines by thrips in northern Italy: monitoring and control on late attacks	Centro Ricerche Produzioni Vegetali	Maria Grazia TOMMASINI, Gianni CEREDI	English	yes
6	Belgium	Fight against food loss and waste - Press Folder	Region wallonne	Carlo Di Antonio, Rene Collin, Mazime Prevot	French	yes
7	Belgium	To reduce food loss within the Walloon food industry	Fevia Wallonie	Liesje De Schamphelaire	French	yes
8	Belgium	Taking Action to Reduce Food Loss on the Farm - A Guide from Theory to Practice by Value Chain	Manger Demain, Collèges des Producteurs & Région Wallonne	-	French	yes
9	Belgium	Loss and waste in the food chain	Departement Landbouw en Visserij afdeling Monitoring en Studie	Kris Roels & Dirk van Gijseghem	Dutch	yes
10	Greece	Challenges in reducing food losses at producers' level: the case of Greek agricultural supply chain producers	University of Western Macedonia, Greece	Stella Despoudi	English	yes
11	Greece	LOSS OF FOOD: An issue that concerns us all (Special Issue)	Piraeus Bank		Greek	yes
12	EU	Reducing food loss on the farm (final report)	EIP-AGRI FOCUS GROUP, 20 members from different EU regions	Shane Ward (University College Dublin)	English	yes
13	Greece	Food Loss during mechanical harvesting	Eleutherotypia News	Theofanis Gemtos (University of Thessaly)	Greek	yes
14	Greece	Development of tools and measures to reduce food loss and waste	Papageorgiou Sophia, University of Waste Attica	Papageorgiou Sophia, University of Waste Attica	Greek	yes
15	Spain	Food Loss reflection in primary sector in Navarre	Buruxka	Ángel Lizarraga, Bodegas Lezaun, Bodegas Navarrsotillo, Jesús Delgado, Jorge Aragón, Mikel Subiza, SAT Ega Verde, SAT La Torre Verde y Uztaldibiok	Spanish	yes
16	Spain	Food Waste Analysis in Agri-food Supply Chain of Basque Country	Hazi / Elika Fundazioa		Spanish	no
17	Spain	Diagnosis of the fruits and vegetables losses in the primary sector	Espigoladors	Berta Vidal-Monés, Raquel Díaz Ruiz, Marc Farrés Jansà	Catalan	yes
18	Spain	Food Loss and Waste diagnosis of the pork sector: quantification, environmental and economical impact	ARC (Catalan Waste Agency) CREDA - UPC - IRTA DACC (Department of Climate Action, Food and Rural Agenda from the Catalan government)	Ariadna Bàllega, Amèlia Sarroca, Miquel Andón, Núria Martínez, Montserrat Núñez, Víctor Rancaño, Marta Ruiz	Catalan	yes

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ID	Country	Title (in english)	Authors (main organisation)	Author list	Language	Included in the review?
19	Spain	Food Loss and waste diagnosis in primary production, agri-food industry and wholesale distribution of peaches and nectarines	ARC (Catalan Waste Agency), CREDA - UPC - DACC (Department of Climate Action, Food and Rural Agenda from the Catalan government)	Berta Vidal-Monés, Diana Reinoso, Raquel Díaz Ruiz	Catalan	yes
20	Spain	Loss and waste diagnosis of the fruit sector of peaches, nectarines, pears and apples: quantification, sustainability impact and economical impact	ARC (Catalan Waste Agency), CREDA - UPC - IRTA, DACC (Department of Climate Action, Food and Rural Agenda from the Catalan government)	Assumpció Anton, Maria Aurell, Raquel Díaz-Ruiz, Nancy Peña, Laura Tey, Elsa Varela, Berta Vidal-Monés	Catalan	yes
21	USA	Wasted: How America Is Losing Up To 40 Percent of Its Food from Farm to Fork to Landfill. (Second Edition of NRDC's Original 2012 Report)	NRDC (Natural Resources Defense Council)	Dana Gunders, Jonathan Bloom, JoAnne Berkenkamp, Darby Hoover, Andrea Spacht, Marie Mourad.	English	yes
22	GLOBAL	Food Loss and Waste: Measurement, Drivers, and Solutions	Department of Food Science and Technology, University of California, Energy and Resources Group, University of California, Berkeley, Department of Biotechnology and Food Engineering, University of California, Program of Biotechnology and Food Engineering, Guangdong Technion-Israel Institute of Technology, Department of Biological and Agricultural Engineering, University of California, Nutrition Policy Institute, University of California, Division of Agriculture and Natural Resources, Department of Public Health Sciences, University of California, The Waste and Resources Action Programme (WRAP), Department of Civil and Environmental Engineering, University of California, Agricultural Sustainability Institute, University of California.	Edward S. Spang, Laura C. Moreno, Sara A. Pace, Yigal Achmon, Irwin Donis-Gonzalez, Wendi A. Gosliner, Madison P. Jablonski-Sheffield, Md Abdul Momin, Tom E. Quested, Kiara S. Winans, Thomas P. Tomich	English	yes
23	Mediterranean	FOOD LOSSES AND WASTE: GLOBAL OVERVIEW FROM A MEDITERRANEAN PERSPECTIVE	FAO, CIHEAM	Roberto Capone, Anthony Bennett, Philipp Debs, Camelia Adriana Bucatariu, Hamid El Bilali, Jennifer Smolak, Warren T.K. Lee, Francesco Bottalico, Yvette Diei-Ouadi, Jogeir Toppe.	English	yes
24	Spain	Digital platforms: mapping the territory of new technologies to fight food waste	Department of Management, University of Turin, Turin, Italy, and Universitat Abat Oliba CEU de Barcelona, Barcelona, Spain	Massimo Cane, Carmen Parra	English	yes

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ID	Country	Title (in english)	Authors (main organisation)	Author list	Language	Included in the review?
25	Spain	Loss and waste diagnosis of the citrics sector: quantification, environmental and economic impact	DACC (Department of Climate Action, Food and Rural Agenda from the Catalan government), ARC (Catalan Waste Agency), CREDA-UPC-IRTA, GIRO-IRTA	Technical team: Assumpció Anton, Carmen Capdevila, Raquel Diaz-Ruiz, Beatriz Grau, Marta Ruiz, Elsa Varela, Berta Vidal-Mones Supervision team: Maria Aurell, Elena Bagaria, Glòria Cugat, Jose Mª Gil, Míriam González, Clara Solé, Alfred Vara	Catalan	yes
26	Spain	Loss and waste diagnosis of the horticultural sector: quantification, environmental and economic impact	DACC (Department of Climate Action, Food and Rural Agenda from the Catalan government), ARC (Catalan Waste Agency), CREDA-UPC-IRTA, GIRO-IRTA	Technical team: Assumpció Anton, Ariadna Bàllega, Pooja Bhagtani, Marta Ruiz, Amèlia Sarroca Supervision: Maria Aurell, Elena Bagaria, Glòria Cugat, Jose M. Gil, Míriam González, Djamel Rahmani, Alfred Vara	Catalan	yes
27	Spain	Loss and waste diagnosis of the horticultural sector: quantification, environmental and economic impact	DACC (Department of Climate Action, Food and Rural Agenda from the Catalan government), ARC (Catalan Waste Agency), CREDA-UPC-IRTA, GIRO-IRTA	Technical team: Assumpció Anton, Ariadna Bàllega, Marta Ruiz, Amèlia Sarroca Supervision: Elena Bagaria, Glòria, Jose M. Gil, Míriam González, Alba Graells, Djamel Rahmani, Alfred Vara	Catalan	yes
28	Spain	Loss and waste diagnosis of the fish sector, anchovy: quantification and economic impact	DACC (Department of Climate Action, Food and Rural Agenda from the Catalan government), ARC (Catalan Waste Agency), CREDA-UPC-IRTA	Technical team: Saray Ramírez, Amèlia Sarroca Supervision: Elena Bagaria, Glòria Cugat, Jose M. Gil, Míriam González, Alba Graells, Pilar Todó	Catalan	yes
29	Spain	Loss and waste diagnosis of the fish sector, hake: quantification and economic impact	DACC (Department of Climate Action, Food and Rural Agenda from the Catalan government), ARC (Catalan Waste Agency), CREDA-UPC-IRTA	Technical team: Saray Ramírez, Santiago Pelosso Supervision: Elena Bagaria, Glòria Cugat, Jose M. Gil, Carles Guirado, Pilar Todó	Catalan	yes
30	Spain	Loss and waste diagnosis of the lactic sector: quantification, environmental and economic impact	DACC (Department of Climate Action, Food and Rural Agenda from the Catalan government), ARC (Catalan Waste Agency), CREDA-UPC-IRTA, GIRO-IRTA, Biosystems IRTA	Technical team: Ariadna Bàllega, Judith Domínguez, David Fernández Technical team and researchers co-authors: Miquel Andón, Ester Freixa, Laura López-Mas, Núria Martínez, Montserrat Núñez , Víctor Rancaño, Marta Ruiz Supervision: Elena Bagaria, Glòria Cugat, Jose M. Gil, Carles Guirado, Alfred Vara	Catalan	yes
31	Belgium	Food waste and food losses: prevention and valorisation, Monitoring Flanders 2015	Publisher Vlaams Ketenplatform Voedselverlies (Flemish Food Supply Chain Platform for Food Loss) Members: Department of Environment & Spatial Development; Department of Agriculture and Fisheries; OVAM (Public Waste Agency of Flanders); Department of Welfare, Public Health and Family; Boerenbond (Farmers' Union); FEVIA Vlaanderen (food industry federation), COMEOS Vlaanderen (federation for commerce and services), Horeca	Coordination of the monitor: Kris Roels and Dirk Van Gijseghem - Department of Agriculture and Fisheries Members of the monitor working groups All sectors: Kris Roels, Dirk Van Gijseghem - Department of Agriculture and Fisheries, Ann Braekevelt, Koen Smeets, Mieke Vervaet, Luc Goeteyn – OVAM, Filip Fleurbaey, Peggy Criel, Gilles Bavay, Hilde Van Lancker, Jan Kielemoes – Department of Environment & Spatial Development Agriculture: Nathalie Bernaert (ILVO - Flanders Research Institute for Agriculture, Fisheries and Food), Lies Kips (ILVO), Francois Huyghe (Boerenbond), Nele Cattoor (VEGEBE/Belgapom - Union of the Belgian vegetables processing sector and the trade in vegetables for processing/Belgian potato trade & processing industry	English	yes

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ID	Country	Title (in english)	Authors (main organisation)	Author list	Language	Included in the review?
			Vlaanderen (federation of the hospitality sector), Unie Belgische Catering (UBC - catering federation), Unizo (federation for the self-employed and SMEs), Buurtsuper.be (federation of independent supermarket owners) and the Belgian consumer organisations	association) Fisheries: Bart Vanelslander (ILVO), Mike van 't Land (ILVO) Auctions: Laurien Danckaerts (VBT – Association of Belgian Horticultural Cooperatives), Aranka Delombaerde (Department of Agriculture and Fisheries) Food industry: Liesje De Schamphelaire (FEVIA Vlaanderen) Retail: Luc Ardies (Buurtsuper.be/Unizo), Géraldine Verwilghen (COMEOS Vlaanderen) Hospitality sector and catering: Eve Diels (Horeca Vlaanderen), Annemie D'haeninck (Guidea - Knowledge Center for Tourism & Hospitality), Peter Serru (Guidea), Annabelle Casier (Guidea), Nina Van Hecke (Guidea), Geraldine Verwilghen (UBC) Households: Filip Fleurbaey (Department of Environment & Spatial Development), Jan Velghe (BV-OECO/AB-REOC - Belgian Association for Research and Expertise for the Consumer Organisations), Joke Van Cuyck (OVAM), Elfriede Anthonissen (Vlaco - Flemish compost organisation) Social approach to food surpluses: Etienne Rubens (Komosie - federation of environmental enterprises in the social economy), Caroo Torfs (Komosie), Frank Van den Branden (Department of Welfare, Public Health and Family		
32	Estonia	Food waste and food waste in Estonia food supply chain	SEI Stockholm Environmental Institute	Evelin Piirsalu, SEI Tallinn, Harri Moora, SEI Tallinn, Kadi Väli, SEI Tallinn, Kersti Aro, Eesti Maaülikool, Rando Värnik, Eesti Maaülikool, Jüri Lillemets, Eesti Maaülikoo	Esti	yes
33	Germany	Assessment of plant-based food losses in primary agricultural production Report commissioned by the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV)	Johann Heinrich von Thünen-Institut (TI), Max Rubner-Institut (MRI), Julius Kühn-Institut (JKI)	Günter Peter, Heike Kuhnert, Marlen Haß, Martin Banse, Silvia Roser, Bernhard Trierweiler, Cornel Adler	German	yes
34	Ireland	Food Loss and Waste from Farming,Fishing and Aquaculture in Ireland	Environmental Protection Agency	Jennifer Attard and Tracey O'Conno	English	yes
35	Lithuania	Identifying the level and causes of food waste and food losses throughout the food supply chain and developing recommendations	Lietuvos socialinių mokslų centro ekonomikos ir kaimo vystymo institutas	Galutinė Ataskaita		yes
36	Denmark, Finland, Sweden, Norway	Food losses and waste in primary production Data collection in the Nordic countries	NORDEN	Ulrika Franke, Hanna Hartikainen, Lisbeth Mogensen and Erik Svanes		yes

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