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DELIVERABLE 1.4

Identification of Food Waste Relevant Marketing Standards

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Project title	**BR**inging Evidence-b**A**se**D** food **C**hain solutions to prevent and **R**ed**U**ce food waste related to **M**arketing standards, and deliver climate and circularity co **B**enefits		
Project acronym	BREADCRUMB		
Call topic	HORIZON-CL6-2023-FARM2FORK-01		
Type of action	HORIZON-RIA		
Coordinator	EIGEN VERMOGEN VAN HET INSTITUUT VOOR LANDBOUW- EN VISSERIJONDERZOEK - EV ILVO		
Deliverable due date	28/02/2025		
Project number	101136701		
Project start date	01/01/2024	Duration	36 months
URL	https://www.breadcrumb-project.eu		

D1.4 – Identification of Food Waste Relevant Marketing Standards

Due date:	**28/02/2025** **Delivery date:** **28/02/2025**
Work package	WP1
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Version	Version 0.7
Dissemination level	Public

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Version and amendments history

Version	Date (DD/MM/YYYY)	Created /Amended by	Changes
0.1	10/01/2025	VLTN (Nika Palaguta)	Draft of chapters 1 and 3.
0.2	20/01/2025	VLTN (Nika Palaguta, Paulina Szwed, Chantal den Broeder)	Content editing and styling of chapters 1 and 3; draft of chapters 2 and 4.
0.3	24/01/2025	VLTN (Nika Palaguta, Paulina Szwed, Chantal den Broeder)	Content editing and styling of chapters 2 and 4; draft of chapters 5, 6, 7, executive summary
0.4	31/01/2025	VLTN (Nika Palaguta, Paulina Szwed, Chantal den Broeder)	Content editing and styling of chapters 5, 6, 7, and executive summary.
0.5	03/02/2025	VLTN (Nika Palaguta, Paulina Szwed, Chantal den Broeder)	Content editing and styling of all chapters.
0.6	17/02/2025	UCPH UNIBO	Internal Quality Review
0.7	21/02/2025	VLTN (Nika Palaguta, Paulina Szwed, Chantal den Broeder)	Incorporation of quality review comments.

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LIST OF ABBREVIATIONS

Abbreviations	Full Name
EC	European Commission
EU	European Union
UN	United Nations
SDG	Sustainable Development Goal
FAO	Food and Agriculture Organization
FW	Food Waste
FMS	Food Marketing Standards
F&V	Fruits and Vegetables
PO	Producers Organization
PDO	Protected Designation of Origin
PGI	Protected Geographical Indication
TSG	Traditional Specialty Guaranteed
GDPR	General Data Protection Regulation
WP	Work Package
M	Month
HORECA	Hotel, Restaurant and Café / Catering
OECD	Organization for Economic Cooperation and Development
UNECE	United Nations Economic Commission for Europe
IDI	In-Depth Interviews
IFS	International Featured Standards
GAP	Good Agricultural Practice
CLD	Causal Loop Diagram

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EXECUTIVE SUMMARY

This report is the **fourth deliverable (D1.4)** of work package 1 (WP1) within the BREADCRUMB project. In an effort to identifiy food marketing standards most relevant to food waste, the report presents **hypotheses** on the relationship between public and private food marketing standards, and on the relationship of the food marketing standards with food waste. The hypotheses are the result of work performed within task 1.4 (T1.4), which took place from November 2024 (M11) to February 2025 (M14). The formulation of the hypotheses utilised data obtained in task 1.3 (desktop research to develop an inventory of food marketing standards, a survey, and in-depth interviews), as well as the conceptual framework model developed in task 1.2 of the work package.

The report is accompanied by a series of **appendices** including **diagrams** of each hypothesis. To facilitate utilization of this report, the following is highlighted for readers:

Introductory Chapter: The **introductory chapter** provides an overview of the BREADCRUMB project, the report structure, and how this task relates to other work packages in the project.

Chapter 2: The second chapter is dedicated to providing an overview of the **objectives and methodology of task 1.4.** Included in this chapter is how data and results from previous tasks in the work package - namely tasks 1.2 and 1.3 – were incorporated into the development of the hypotheses. The risks encountered and the consequent mitigation measures implemented are also covered in this chapter.

Chapter 3: The third chapter explores the **relationship between public and private food marketing standards.** Literature review, as well as the research results based on analysis of the inventory, survey responses, and in-depth interviews are all discussed, culminating in the formulation of hypotheses on the nature of the relationship.

Chapter 4: The fourth chapter in this deliverable focuses on the **relationship between food marketing standards and food waste**. Similar to the previous chapter, a literature review, as well as research results based on analysis of the inventory, survey responses, and in-depth interviews are explored and utilised to formulate the hypotheses on the nature of the relationship.

Chapter 5: The fifth chapter presents a **holistic causal loop diagram**, incorporating all the hypotheses developed in relation to food waste.

Chapter 6: The sixth chapter provides an overview of the **key findings** that have come out of the data and subsequent hypotheses. Where possible, a cross-comparison of the hypotheses is carried out. Readers who would prefer an immediate overview of the results of this task, are encouraged to go directly to the chapter Key Findings.

Concluding Remarks and Next Steps: The final chapter provides concluding remarks, placing the results of the research within the **broader EU and international context.** The limitations of the study are noted, and an overview is provided about how the data can be used by other **tasks and work packages** in the project, as well as by **external stakeholders.**

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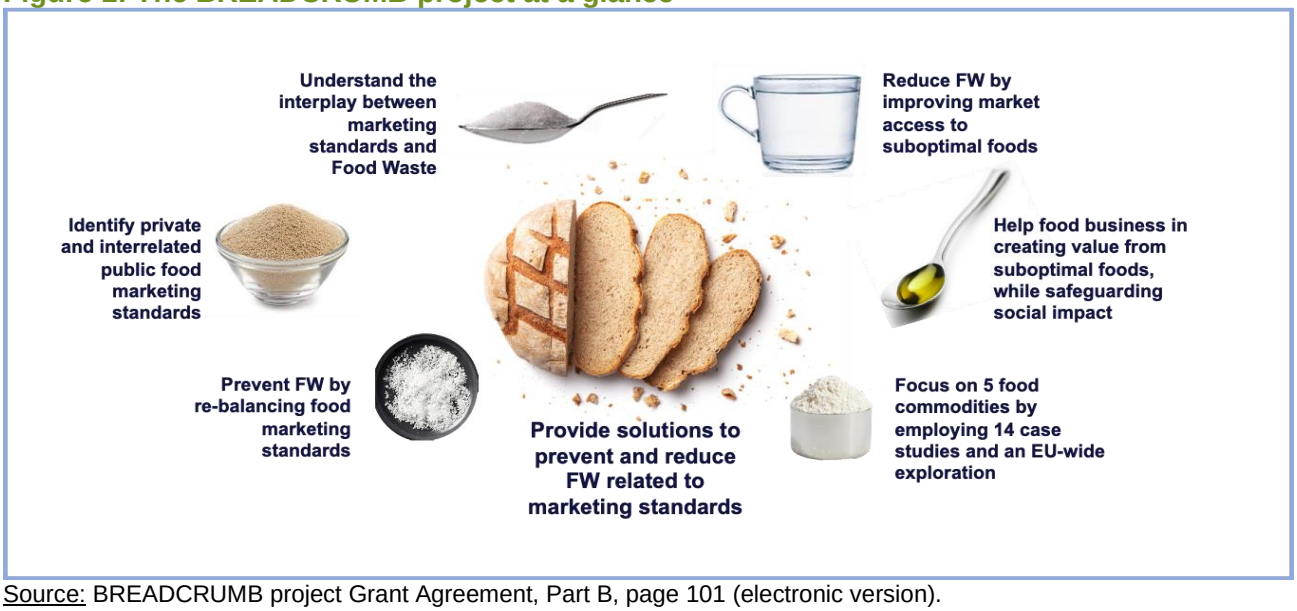
1. INTRODUCTION

1.1 BREADCRUMB Project Overview

The BREADCRUMB project aims to provide an empirical, evidence-based understanding of the purpose and nature of food marketing standards and their impact on FW generation and, based on this evidence, propose interventions that strike a balance between reducing FW and the other objectives pursued by these standards. Furthermore, the project strives to improve market access for suboptimal foods by guiding food businesses to select appropriate marketing channels and by fostering change in consumers' acceptance of suboptimal foods. All of this information will be structured into operational and policy guidance on how to prevent/reduce FW related to marketing standards.

More specifically, the Grant Agreement defines the following procedure for the project: "(i) establish a holistic view of marketing standards and identify those with key relevance to FW generation; (ii) create evidence-based estimates of FW generated as a consequence of marketing standards; (iii) provide solutions that alleviate the negative impacts of marketing standards on FW, based on a valid understanding of the underlying mechanisms of FW generation and trade-offs with other objectives (re-balancing marketing standards); (iv) enhance the business potential of "sub-optimal" foods; (v) inform and guide food businesses, consumers, owners of standards and policy regulators on how to prevent/reduce FW related to marketing standards".[1]

Figure 1: The BREADCRUMB project at a glance



Source: BREADCRUMB project Grant Agreement, Part B, page 101 (electronic version).

Moreover, the project intends to incorporate a **gender perspective** and **intersectional analysis** across the project. Both are pertinent to better understand the design and response to marketing standards affecting food choices, usage, and waste.

[1] European Commission. (2023). "Grant Agreement Project BREADCRUMB." European Commission, European Research Executive Agency, (November), page 101 (electronic version).

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To verify the results, the project will employ various **validation** methods involving participants external to the project:

- External Advisory Board (4-5 individuals: researchers, practitioners with complementary expertise);
- Marketing Standards Interest Group (20-30 individuals: food businesses, civil society organisations, FW entrepreneurs, policy actors, and Joint Research Centre representatives);
- Specified consultation events, such as workshops, to widen the validation process with a larger group of diverse actors.

The research within the project has been approved by the Committee for Ethics in Social Science and Humanities (COMESSH) of the Flanders Research Institute for Agriculture, Fisheries and Food (ILVO). ILVO is the coordinator of the BREADCRUMB project.

The BREADCRUMB project focuses on five food commodity categories: fruits and vegetables, meat (poultry, bovine, pork), fish, eggs and cereals. This is due to the expertise of the project's consortium partners, as well as evidence at the EU level that these commodity categories are subject to significant food waste along the supply chain.[2] The BREADCRUMB project does not focus per se on food safety standards, i.e. the project takes the perspective that food safety cannot be compromised and, therefore, must be abided by before being able to come onto the market; there is no room for manoeuvre. The task also does not cover standards explicitly related to import into or export outside of the EU.

The following **definitions** were used throughout the task to ensure consistency:[3]

Food marketing standards: These are defined as obligatory rules or optional reserved terms aiming to address the expectations of consumers and to improve the economic conditions for the production and marketing as well as the quality of agricultural products. They establish rules regarding product characteristics and other requirements that must be met for products to circulate within in the EU market.

Private food marketing standards: These are defined as not EU or national legislation, but rather food marketing standards developed and operated by entities other than government bodies - this can include individual companies, food manufacturers, non-governmental organisations, industry associations, and retailers. They operate within the legal framework but are voluntary in nature.

Public food marketing standards: These are defined as standards established by government agencies or inter-governmental bodies. The standards are often mandatory baseline (minimum) criteria needed for food products in order to legally access the market.

Food waste: In accordance with the EC definition[1] food waste is defined as any food and its associated inedible parts (such as bones or fruit cores) that does not find its way to human consumption and rather becomes discarded. This can occur at all stages of the food supply chain, from farm to fork. In BREADCRUMB, if food products are returned to the land, utilised as animal feed, composted, subjected to anaerobic digestion, or left unharvested, they are considered food waste.

[2] The following percentages have been cited at the EU level in terms of food waste along the value chain: fruits and vegetables (43%), meat (23%), fish (51%), eggs (29%), and cereals (20%). Please refer to:
Calderia, C. et al. (2019). "Quantification of food waste per product group along the food supply chain in the European Union: A mass flow analysis." *Resources, Conservation & Recycling,* Volume 149, pp. 479-488.

[3] A full list of definitions utilised in the research process is available in the appendices section under "Key Definitions".

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1.2 Goals and Report Structure of Deliverable 1.4

This report is the fourth deliverable (D1.4) of work package 1, which took place from November 2024 (M11) to February 2025 (M14), within the BREADCRUMB project. The first objective of task 1.4 was to develop a set of hypotheses on (i) the links and the cause-effect intensity (in qualitative terms) between specific food marketing standards and FW and (ii) the links between different food marketing standards (public and private). By utilising the hypotheses to update the conceptual framework model developed in task 1.2, the second objective of task 1.4 was to identify those food market standards most relevant to food waste. **D1.4 builds on the fieldwork research conducted for the previous task (T1.3**), including the data derived from **desktop research, surveys, and interviews**.

The report starts with a description of the goals and methodology of the work conducted in task 1.4. It reiterates some of the key aspects of each data collection methodology, explaining the motivation, process and relevance for the T1.4. Next, the report discusses the relationship between public and private food marketing standards and the relationship between food marketing standards and food waste based on the research and literature reviews conducted in WP1. After describing these relationships, the report discusses the proposed hypotheses on the relationships between standards and between food marketing standards and food waste. The following chapter provides an updated version of the conceptual framework model, to visually demonstrate which standards are most relevant in the context of food waste. A summary of the results, in particular those standards most relevant to food waste is provided in the “Key Findings” chapter. The report finishes with the concluding remarks and next steps, including how the results can be utilised further within the project and externally.

1.3 Links with other BREADCRUMB Work Packages and Tasks

This report centres on task 1.4, which presents a set of hypotheses on (i) the links and the cause-effect intensity (in qualitative terms) between specific food marketing standards and FW; (ii) the links between different public and private food marketing standards; and (iii) an update of the conceptual framework model proposed in D1.2.

The acquired understanding of food marketing standards obtained in task 1.3 is the basis for task 1.4, which in turn will feed into other work packages within the project. More specifically, the results of work package 1, and specifically the hypotheses and the updated conceptual framework model, will also be utilised in subsequent work packages, namely: (i) **WP 3** to help identify those standards which will be considered in the modelling task; and (ii) **WP 4** when determining which specific food product from each of the targeted five food commodities to focus on when looking to improve market access and business potential of foods that do not meet marketing standards, but are still safe to eat (i.e. suboptimal foods), and the development of the ‘Food Value Navigator’ - a model for food businesses to have a preliminary assessment of the business potential of suboptimal foods.

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2. OBJECTIVES AND METHODOLOGY

2.1 Objectives of Task 1.4

Task 1.4 within work package 1 started in November 2024 (M11) and concluded at the end of February 2025 (M14). Focusing on the five food commodity categories being addressed in the BREADCRUMB project – i.e. fruits and vegetables, meat, fish, egg, and cereals - the objectives of the task were two-fold. The first objective of task 1.4 was to develop hypotheses on: (i) the relationship between public and private food marketing standards, and (ii) the links, cause-effect intensity between food marketing standards and food waste. Based on these hypotheses, the second objective was to then identify the food marketing standards most relevant to food waste.

2.2 Methodology – Tasks 1.2, 1.3, and 1.4

Task 1.4 builds upon the previous tasks in WP1. To develop the hypotheses, data obtained in task 1.3 was utilized, as well as the conceptual framework model developed in task 1.2.

2.2.1 Task 1.2

Based on extensive desktop research and literature review (grey and academic), the conceptual framework model developed in task 1.2 depicts the potential influence on food waste of food marketing standard categories outlined in Regulation (EU) 1308/2013. The framework model does not rely on the provisions of the regulation itself but rather on the categories it outlines. The categories of food marketing standards outlined in the regulation are as follows:[4]

a. Technical definitions, designation, and sales descriptions.
b. Classification criteria, such as grading into classes, weight, sizing, age and category.
c. Species, plant variety, animal race, or the commercial type.
d. Presentation, labelling linked to obligatory marketing standards, packaging, rules to be applied in relation to packing centres.
e. Criteria such as appearance, consistency, conformation, product characteristics and the percentage of water content.
f. Specific substances used in the production method.
g. The type of farming and production method including oenological practices and advanced systems of sustainable production.
h. Coupage of must and wine, including definitions thereof, blending and restrictions thereof;
i. The frequency of collection, delivery, preservation and handling, the conservation method and temperature, storage, and transport.
j. The place of farming and/or origin, excluding poultry meat and spreadable fats.
k. Restrictions as regards the use of certain substances and practices.
l. Specific use.
m. The conditions governing the disposal, the holding, circulation, and use of products.

[4] Regulation (EU) No 1308/2013 of the European Parliament and of the Council of 17 December 2013 establishing a common organisation of the markets in agricultural products and repealing Council Regulations (EEC) No 922/72, (EEC) No 234/79, (EC) No 1037/2001 and (EC) No 1234/2007 (page 714).
https://eur-lex.europa.eu/eli/reg/2013/1308/oj/eng
The standard category related to coupage of must and wine, is not applicable to the BREADCRUMB project, which rather focuses on five food commodity categories: fruits and vegetables, meat, eggs, cereals, and fish.

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The possible connection between categories of food marketing standards and food waste outlined in the model, guided the work in task 1.3 and ultimately in task 1.4, to help isolate the specific standards most relevant to food waste.

2.2.2 Task 1.3

Task 1.3 entailed the identification of public and private food marketing standards related to the project's five food commodity categories, as well as obtaining data to understand the relationship between public and private food marketing standards, and their relationship to food waste. More specifically, the following stages of data collection were undertaken in task 1.3.

a) **Desktop research**: During this stage, partners explored online sources to identify and categorise private and public food marketing standards found in academic, scientific, and grey literature, official databases / collections of standards, and keyword searches in electronic databases. Analysis of the standards identified included a quality check (cleaning data to remove duplicates, standardize the naming, addressing any information gaps, spelling and grammar check), classification of standards according to several categories (public, private, international, EU, member state, supply chain stage, food commodity, categories from Regulation 1308/2013), and identifying and summarising any evident patterns. The desktop research stage resulted in an inventory of 1,350 food marketing standards (public and private standards combined).

b) **Survey** (hosted on Survey Monkey): For the survey, the responses were collected by the task lead using the Survey Monkey platform. A license in Survey Monkey was selected as it (1) ensured data collection privacy and (2) provided additional technical possibilities compared to the various free survey options (such as question logic / filters). It was an EU-wide survey targeting business / industry involved in the various stages of the food supply chain, at the EU and national member state levels. The survey aimed to: (1) collect additional private and public standards established and/or adhered to in the EU; (2) solicit expert opinions on the interrelations between public and private standards, and their relationship with food waste; and (3) facilitate the acquisition of additional contacts in the food supply chain, and potential interviewees. The final questionnaire was the result of a collaborative effort amongst the BREADCRUMB partners, and was made available in the following 10 languages: English, Dutch, Spanish, Italian, Polish, Slovenian, Portuguese, French, German, and Danish. Similar to the inventory, preparation for analysis of the survey data included key steps such as: translating all answers into English, cleaning the data to remove duplicates, incomplete responses, and anomalies, a spelling and grammar check, calculating the number of responses (complete, semi-complete, incomplete response), and transformation of the dataset to be ready for analysis. Excel software, including the PIVOT tables, as well as SPSS Statistics ver. 29 was used for analysis of the survey. The initial sample size was 176; however, following data cleaning, the usable sample size was 106. Any responses in the survey which specifically noted food marketing standards were integrated into the inventory.

c) **Interviews:** To complement the research and data obtained during desktop research and the survey, a total of 31 in-depth interviews took place targeting business / industry, and consumer associations. The aim was to obtain in-depth information about the origin and purpose of both public and private food marketing standards, implementation challenges, the relationship between public and private standards, and any perceived links between standards and food waste. Similar to the survey, the interview questions were the result of a collaborative effort amongst the BREADCRUMB partners. Project partners were also provided with an Interview Protocol prepared by the task lead, providing guidance on how to prepare and conduct an in-depth interview and process (clean) the data. Interviews took place with entities located in Germany, Italy, Portugal, Denmark, Spain, and Slovenia. Before conducting an analysis of the interview results, coding in accordance with themes

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was established utilizing EU GDPR compliant software Quirkos.[5] The qualitative theme coding structure was based on the MOA model – i.e. motivations, opportunities, and abilities to implement food marketing standards, as well as to address food waste. Drafting of the analysis incorporated triangulation of data utilizing more than one source of information by complementing the interview data with a literature review and statistical information. Any discussions in the interviews which specifically noted a new food marketing standard were integrated into the inventory.

Data Privacy

For both the survey and interviews, the project partners abided by EU GDPR requirements, ensuring consent, confidentiality of personal data, and anonymization of responses. Before the survey started, respondents were provided an information sheet about the project, and asked to complete a consent form in accordance with EU GDPR before being able to proceed further. Similarly, a few days before each interview, the interviewee was given a participant information sheet and a consent form to complete. Time was given for the participant to review the information and to ask any questions or raise concerns. Before conducting an interview, the signed consent form had to be obtained from the interviewee. Participants in the survey and interviews were assured that in accordance with EU GDPR, only the project researchers would have access to the data collected during the study. Participants' identities would remain confidential, and all responses would be anonymized. Any personal information obtained would be stored securely (password protected within the institution files of the partners conducting the interviews), and only the anonymized interview transcripts were shared with T1.4 partners, and not disclosed to anyone outside of the research team without the participant's explicit consent.

2.2.3 Task 1.4

To develop the hypotheses partners adhered to the following systematic method. For all hypotheses formulation, the conceptual framework model (task 1.2), the inventory of food marketing standards, survey, and interview data (task 1.3), and literature review (tasks 1.2 and 1.3) were utilised to come forth with:
a) hypotheses on the relationship between public and private food marketing standards; and
b) hypotheses on the relationship between food marketing standards and food waste.

Relationship between public and private food marketing standards

In regards to the relationship between public and private standards, the following approach was adhered to when developing the hypotheses.

i) Comparison of the results of the survey with interview discussions, focusing on the questions pertaining to the relationship between public and private standards;

ii) Identification in the inventory where there were private standards on the same topic / related to a public standard;

iii) Incorporation of literature review on patterns and connections between public and private standards; and

[5] Quirkos homepage: https://www.quirkos.com

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iv) Identification of the category / categories within Regulation 1308/2013 that the public and private standards fall into (i.e. type of farming method, or classification / grading, for example).

Table 1: Key Survey and Interview Questions for Hypotheses Development (relationship between public and private food marketing standards)

Survey		Interviews
In your opinion, for your entity, the relations between the private food marketing standards (for these commodities) that you listed and public standards are: 1 - totally complementary 2 - somewhat complementary 3 - not at all complementary 4 – unclear		a) What food marketing standards (public and private) are relevant for your organization / company? i.e. which standards does your organization / company have to comply with? b) How do private food marketing standards in your organization / company interact with public food marketing standards? c) What factors influence your organization's / company's decision to adhere to private food marketing standards (e.g., access to the market, good reputation, other factors for example)? d) Thinking about private food marketing standards, what type of actors mostly establish them?

Source: Author, based on the survey and interview questions in the BREADCRUMB project (WP1).

Relationship between food marketing standards and food waste

Similar to the approach utilized to compare and uncover the relationship between public and private standards, in regards to the relationship between food marketing standards and food waste, the following approach was employed to develop the hypotheses.

i) Comparison of the results of the survey with interview discussions, focusing on the questions pertaining to the relationship between food marketing standards and food waste;

ii) Identification in the inventory where via desktop research and literature review, partners had identified standards that were perceived to have an effect on food waste;

iii) Incorporation of a literature review that highlighted patterns and connections between food marketing standards and food waste; and

iv) Identification of the category / categories within Regulation 1308/2013 that the standards fall into, and based on the inventory, survey, interview, and literature review data, outline within the Conceptual Framework Model how the standards are related to food waste.

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Table 2: Key Survey and Interview Questions for Hypotheses Development (relationship between food marketing standards and food waste)

Survey		Interviews
a) In your opinion, for your entity, what effect do the PUBLIC / PRIVATE food marketing standards (for x commodity) have on FOOD WASTE: 1 - reduce food waste 2 - increase food waste 3 - have no connection to food waste 4 - the connection is unclear b) Is the amount of food waste generated within your entity measured? c) Does your organization track what is done with food that does not comply with a food marketing standard?		a) What happens with the products that do not fulfil the food marketing specifications? {Follow-up questions to spur discussion: Are the products donated, for example? Or used perhaps in another capacity – such as valorization initiatives? Are there other actions taken? If yes, can you say more about them? If no, why not?} b) Can you provide examples of how adherence to these standards has either increased or reduced food waste? c) Are there specific policies or practices that have been effective in mitigating food waste while maintaining compliance with these standards?

Source: Author, based on the survey and interview questions in the BREADCRUMB project (WP1).

The following standardized hypothesis template was utilized each time a hypothesis was developed.

Table 3: Draft Template for Hypotheses

Topic	Content
Hypothesis	Draft one-two sentences description.
Data collection points	Inventory
	Survey
	Interviews
	Literature review
	Food waste statistics (if located)
Regulation 1308/2013	Identification of relevant categories.
Conceptual Framework Model	Outline briefly how the hypothesis fits into the model.
Summary	Draft a one paragraph overview.

Source: Author, hypotheses development approach within in the BREADCRUMB project (task 1.4).

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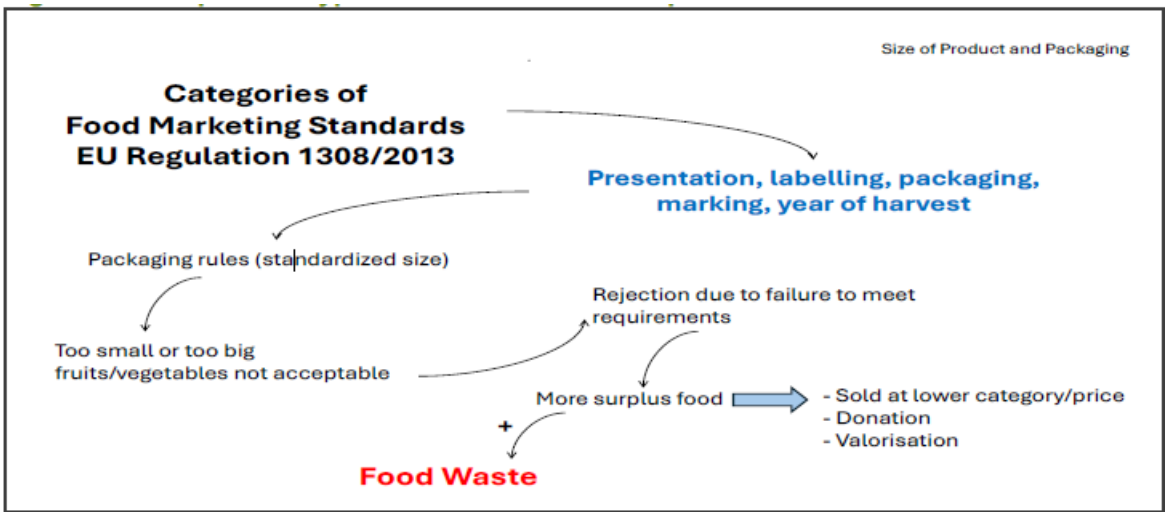
Figure 2: Example of a Hypothesis within the Conceptual Framework Model[6]



Source: Author, based on a hypothesis developed within the BREADCRUMB project (task 1.4).

The hypotheses were discussed at the November and December work package 1 meetings, as well as the project's General Assembly meeting in November 2024 (M11). To help further validate the hypotheses, two online webinars took place – one in November 2024 (M11) with the project's Food Marketing Standards Interest Group (FMSIG), and a second webinar took place in January 2025 (M13) with external (i.e. outside of the project) food supply chain stakeholders. At the work package meetings, as well as the webinar with the FMSIG, a SWOT (Strengths, Weaknesses, Opportunities, Threats) exercise took place to fully discuss and receive feedback on hypotheses under development, and improve them.

Figure 3: SWOT Exercise Questions

STRENGTHS	WEAKNESSES
What type / quantity of data has been utilized to create the hypothesis? Is there evidence of data triangulation? (literature review, inventory, survey, interviews, etc.) What is the applicability of the hypothesis? Are there examples of standards illustrating the hypothesis? Does it takes into consideration the current context?	What could be improved in the hypothesis? - Is more data, literature review needed? - Is the applicability too narrow or too extensive? - Will it be too difficult to prove?
OPPORTUNITIES	**THREATS**
Where / how will the hypothesis be most useful? Is there a chance for it to be empirically utilised? What upcoming events / platforms can be utilised to obtain more feedback on the hypothesis? Are there suggestions on how to further validate a hypothesis?	Is it "outdated" or soon will be "outdated" based on expertise about what is happening in the food sector? Any other possible obstacles to establishing a validated hypothesis?

[6] A full explanation of this particular hypothesis can be found in Table 17.

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Source: Author, based on the SWOT questions developed and utilised in the BREADCRUMB project (task 1.4).

All of the hypotheses developed in this study do however need to be seen within their respective **contexts**. In particular, when looking at the relationship between standards and food waste, even though a standard may augment or mitigate food waste, there are always **trade-offs** that need to be taken into account.

There may be a number of reasons (including economic, environmental and social ones) why a standard is put in place. A predominant underlying factor for all standards is to facilitate trade in the supply chain while ensuring that the product is safe and meets consumers' expectations. Effective management of a supply chain includes the ability to not only address **trade** but to balance it with market shifts such as the emergence of more **sustainability initiatives**, with the United Nations Sustainable Development Goals (SDGs), EU Green Deal, Farm to Fork Strategy, EU Biodiversity Strategy for 2030 being a few examples. A **balance** between the three pillars of **economic, environmental, and social benefits**, is crucial to ensuring the longevity of a supply chain and the businesses operating within it. Supply chains and the respective standards influencing them are **complex**. Results from the inventory, survey, and interviews discussed in the previous task of work package 1 (task 1.3 / deliverable 1.3) demonstrate that there are multiple food marketing standards that need to be adhered to simultaneously by actors in the supply chain.

There also needs to be made a **distinction between surplus food and food waste**, since not all surplus food becomes food waste. There is a systematic process that all food goes through when coming onto the market and there are options available so that surplus food can still be consumed. The research results in task 1.3 / deliverable 1.3 demonstrate that a conscious effort is made across the supply chain stages to still utilize surplus food. A variety of activities were noted in the research, such as alternate markets to sell the food at a **lower price**, **donation**, and **valorisation**. These options were taken into account when formulating the hypotheses related to food waste.

2.3 Risks and Mitigation Measures

The following risks and mitigation strategies were identified and respectively implemented during task 1.4.

a) Risk: Insufficient data on food waste amounts. When developing hypotheses on food waste, it is evident that optimally there be food waste data to bolster the hypotheses. Information about food waste generation related specifically to food marketing standards proved difficult to find and was sparse.

Mitigation: Additional literature review and desktop research was conducted to locate, to the best extent possible, food waste estimates (percentages) into the hypotheses. Data from the survey and interviews were also utilized to augment the discussion within the hypotheses.

b) Risk: Obtaining a broad representation of food supply chain actors in the workshop with external stakeholders. A broad and solid representation of external stakeholders (the Grant Agreement stipulated at least 50 registrations for the webinar) is necessary to obtain balanced feedback on the hypotheses.

Mitigation: In October 2024 (M10) the task lead started to organize the external workshop by drafting a provisional agenda, and in particular identifying potential attendees. A tentative list of invitees was circulated to work package partners for their input. All partners participated in disseminating the

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workshop invitation and it was announced on the project's public website as well as social media. Ultimately, there were 62 registrations for the webinar with external stakeholders.

3. RELATIONSHIP BETWEEN PUBLIC AND PRIVATE FOOD MARKETING STANDARDS

3.1 Meaning of Public and Private Food Marketing Standards

The European Commission defines food marketing standards as "**a set of rules aimed to ensure that the single market is supplied with standardised quality agricultural products that meet consumer expectations**" (European Commission, 2020). The overall aim of food marketing standards is to improve economic conditions for production, enhance product quality, provide transparent product information, and enable easy access to standardised and satisfactory quality products, thereby effectively catering to the needs and preferences of consumers (Nes & Ciaian 2021; Russo et al., 2022).

Public standards are typically government-mandated regulations addressing baseline market necessities, such as ensuring food safety, managing environmental impacts, or protecting consumer health through risk assessments and labelling requirements. These standards often rely on governmental inspections to ensure compliance. Public standards are generally designed to **consider the needs and interests of all stakeholders**, including producers, consumers, and the broader public. They can be **mandatory**, like EU regulations and national legislation, or **voluntary de jure and mandatory de facto**, like Codex Alimentarius, UNECE, and OECD standards that constitute the foundation of international trade. **Private standards**, on the other hand, are often **voluntary** (not mandated legally) and developed by industry bodies, retailers, or independent organisations. These standards focus on specific supply chain management goals, such as enhancing product differentiation, ensuring liability protection, and improving perceived food safety and / or nutritional value. Private standards also tend to **prioritise the needs of the entities that establish them** (such as companies, producers, or other private organisations), thereby reflecting their specific business or economic interests. These standards may also address broader topics than public standards, such as ethical concerns, competitive positioning, and extending beyond mere safety to bring forth products that are perceived to be of better quality and marketability.

3.2 Literature Review

Public and private FMS are **frequently complementary** (Bremmers & Purnhagen, 2018). Public standards were initially the primary regulatory mechanisms to safeguard public health and ensure food safety. However, as the complexity of supply chains increased, governments struggled to keep up, necessitating the involvement of private entities in regulation. **Private standards emerged to fill this gap**, particularly as public authorities became more constrained in monitoring and enforcing food safety across increasingly globalised supply chains. Henson and Humphrey (2010) argued that public standards provide a baseline for food safety and quality, while private standards may add specific requirements related to sustainability, ethical sourcing, or animal welfare, which is their (private standards') main role (2011, p.160). While public standards can be slower to adapt, an advantage of private standards in comparison is their **flexibility, responsiveness, consumer-oriented** and **market-driven** nature (Mena et al., 2011). **Private standards filling regulatory voids,** especially in areas like organic certification or animal welfare, can be found in the study by Charlotte Berg and Helena Röcklinsberg (2018). These private standards provide additional layers of regulation, particularly when public standards are either insufficient or less stringent, thus shaping industry practices and offering consumers a higher assurance of welfare practices. Another relevant discussion can be found in the literature on certification and accreditation, where private standards,

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such as organic certification, are seen as tools for shaping market behaviours and filling regulatory gaps, especially when public regulations are absent or lagging. This is exemplified by studies that focus on the role of certification bodies in legitimising standards, such as those described in the work on the globalisation of the organic sector and the tensions between public and private roles in standard-setting (Fouilleux & Loconto, 2017).

Not only are public and private standards complementary, but **private standards frequently build upon public ones**, such as EU and CODEX standards (Henson & Humphrey, 2011; Casey, 2017). Many times, when the private standard is built upon a public one, it is not only more detailed, but also much stricter (Vandemoortele, 2011; Wright, 2013). For example, retailers seeking to uphold and strengthen their reputation frequently implement food quality and safety requirements that surpass government regulations. These measures often involve rigorous certification and compliance protocols, including adherence to environmental and animal welfare standards, the use of traceability systems, and undergoing third-party audits. By promoting these standards, retailers can sometimes justify charging higher prices (Fulponi, 2006; Hobbs, 2010; Squatrito et al., 2020). On the other hand, **suppliers often find themselves at a disadvantage,** lacking the leverage to negotiate favourable terms with powerful retailers and being compelled to comply with the enacted private standards (Devin et al., 2016; Ghosh & Eriksson, 2019; Richards & Hamilton, 2019).

Some organisations (such as the FAO) believe that private standards can be perceived as a trade barrier (Henson and Humphrey, 2010; 2011; Harvinga and Verbruggen, 2017). Countries may adopt private standards as part of their export strategies to meet the demands of importing nations, which may have stricter public regulations (Henson & Reardon, 2005; Reardon et al., 2012). Some authors claim though that the effect of private standards depends on the products and most of the time these standards may serve as catalysts to trade (Fiannkor et al., 2020). Nevertheless, when transparent, it is possible to tailor private standards to fit local conditions (Henson & Humphrey, 2011). Consequentially, private standards **can help to align production practices across different countries**, minimising disparities that stem from variations across national regulations (Carlsson & Johansson, 2013).

Sometimes, **private standards can also inspire public ones**, as in the case of organic food standards (Daugbjerg & Botterill, 2012). The study by Rao et al. (2021) discusses how private standards have influenced the development and evolution of public food safety regulations in Europe, highlighting the reciprocal relationship between the two (Bremmers & Purnhagen, 2018). There are opportunities for collaboration between public and private entities to create harmonized standards that benefit all stakeholders. Such collaboration can help reduce duplication of efforts, streamline compliance processes, and ensure that public and private standards address critical issues in the food system (Matinez, 2007; Eruaga, 2024).

While seeming to be mostly complementary, **the relationship between private and public food standards can at times be unclear or non-complementary**. Private standards, typically driven by market differentiation and brand protection, often exceed the requirements set by public regulations, particularly in areas such as food safety, sustainability, and ethical sourcing (Fulponi, 2006). This divergence arises because private standards cater to specific consumer segments or market niches, whereas public standards are aimed at broader societal protection, creating a **gap between the two** (Henson & Humphrey, 2010). Retailers may also implement private standards that exceed public regulations to enhance brand reputation (Dolan & Humphrey, 2000). Moreover, **private standards evolve rapidly** in response to changing market demands, whereas **public standards are usually slower to adapt** due to the regulatory processes involved (Mena, 2011; Henson & Humphrey, 2010). Additionally, private standards are often voluntary, meaning producers must navigate a complex landscape of both mandatory public regulations and optional private certifications. This can place a

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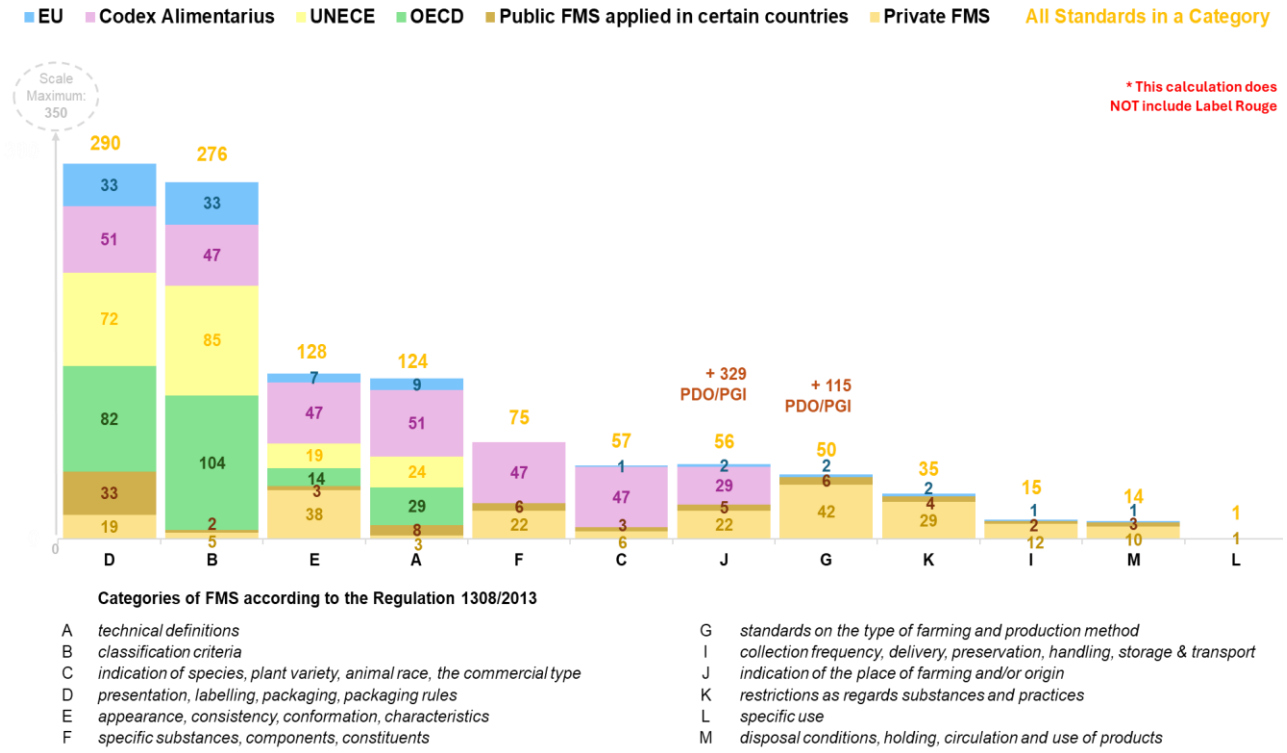
significant compliance burden on producers, particularly smallholders, who may struggle to meet multiple sets of standards simultaneously, further complicating the relationship between private and public frameworks (Henson & Humphrey, 2010). In some cases, **private standards can even undermine public governance by creating parallel systems** that operate independently of official regulatory mechanisms, weakening the authority of public institutions (Fuchs, Kalfagianni, & Arentsen, 2009). This fragmentation of regulatory control can lead to confusion in the market, where the multiplicity of standards dilutes the clarity of what is necessary versus what is optional. The resulting burden on smallholders (primary production, processing and manufacturing, SMEs), who may struggle to meet the different requirements, especially within a given amount of time, further obscures the potential complementarity between private and public standards.

3.3 Evidence from the Inventory

3.3.1 Fruits & Vegetables

Standards applied to **fruits and / or vegetables** in the Inventory cover **639 standards,** including the EU, UNECE, OECD, Codex Alimentarius standards, PDO/PGI in various countries, standards and legislation applicable on a national level, and private retailers' standards. Figure 4 provides an overview of identified standards applicable to fruits and vegetables, keeping in mind that a food marketing standard can pertain to more than one category of Regulation 1308/2013.

Figure 4: Fruits and Vegetables: Number of FMS in the Inventory by Categories in Regulation 1308/2013 and Origin



Source: BREADCRUMB project, Inventory of food marketing standards (WP1).
"Public FMS applied in certain countries" refers to national member state public standards.

OECD, UNECE, **Codex Alimentarius** standards and **EU regulations** cover a large number of standards of FMS form categories **'D'** (product marking, labelling, presentation, and packaging), **'B'**

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(classification criteria)**, 'E'** (appearance, consistency, conformation, product characteristics and the percentage of water content) and **'A'** (the technical definitions) from Regulation 1308/2013. **Codex Alimentarius** standards also cover categories **'F'** (specific substances used in production), **'C'** (indication of species, plant variety, animal race, the commercial type) and **'J'** (origin).

A share of **private standards** is more noticeable in categories **'E'** (appearance, consistency, conformation, product characteristics and the percentage of water content), **'G'** (farming and production method), and **'K'** (restrictions as regards substances and practices). These standards focus on specific quality attributes such as size, shape, and firmness, and ethical production practices. Examples of these private standards are seen in Austria, Belgium, and Germany, where stringent visual quality rules are enforced. A notable example is the Hoogstraten strawberries standard in Belgium, which classifies strawberries into categories based on external characteristics, or GLOBAL G.A.P. standards in Germany, which emphasise food safety, environmental sustainability, and workers' welfare. Adhering to these standards provides retailers ample opportunities to differentiate their products and increase their competitive advantage.

Private standards can be complementary to public ones. More specifically, there are private standards that emphasise farming methods, substances, and practices used in production (categories **'G'** and **'K'** in Regulation 1308/2013). For example, in recent years, a number of certifications appeared (e.g. EKO-NL - marks products produced according to organic farming standards in the Netherlands, Biogarantie - an organic certification label in Belgium that prioritises natural methods and prohibits the use of synthetic pesticides and fertilisers, Integrated Crop Management - an eco-friendly cultivation method from Italy that guarantees reduction of chemical substances usage). In addition, many large retailers launched their own product lines highlighting adherence to organic farming and Regulation (EU) 848/2018 on organic production and labelling of organic products (e.g. Bio (Carrefour), Zéro résidu de pesticides (Groupe Casino), and Aldi's Bon et Bio). Public and private FMS for fruits and vegetables frequently **overlap** in category **'E'** (appearance, consistency, conformation, product characteristics, and the percentage of water content) since many private standards strongly emphasise the aesthetic characteristics of goods and their uniformity in a package. With regard to these visual requirements, private standards can be more specific and nuanced than public ones (e.g. private retailers' requirements in Germany and Portugal evident in the inventory).

Finally, some standards for fruits and vegetables **contradict public standards** such as OECD, UNECE, and Codex Alimentarius regarding visual uniformity. Notably, at least 2 organisations / companies in France focus on **food waste prevention**: "Antigaspillage Alimentaire" and "Les Gueules Cassées". The organisation "Antigaspillage Alimentaire" collects and distributes unsold food still suitable for consumption via a website and an app that connects individuals, associations, and businesses interested in buying and selling such goods. The existence of this organisation prompted the French government to introduce an anti-waste label for the retailers participating in the exchange. "Les Gueules Cassées", on the other hand, rescues and sells imperfect fruits and vegetables, promoting waste-free consumption.

3.3.2 Cereals

Public standards for cereal consist of **Codex Alimentarius** guidelines, several **EU-level legislative acts** influencing cereal production, traceability, and labelling, **country-level** standards, and **PDO/PGI**. These standards cover categories **'D'** (product marking, labelling, presentation, and packaging) and **'E'** (appearance, consistency, conformation, product characteristics and the percentage of water content) from Regulation 1308/2013. More specifically, **public standards** for cereals focus on the **safety and quality** of products **including labelling and packaging**

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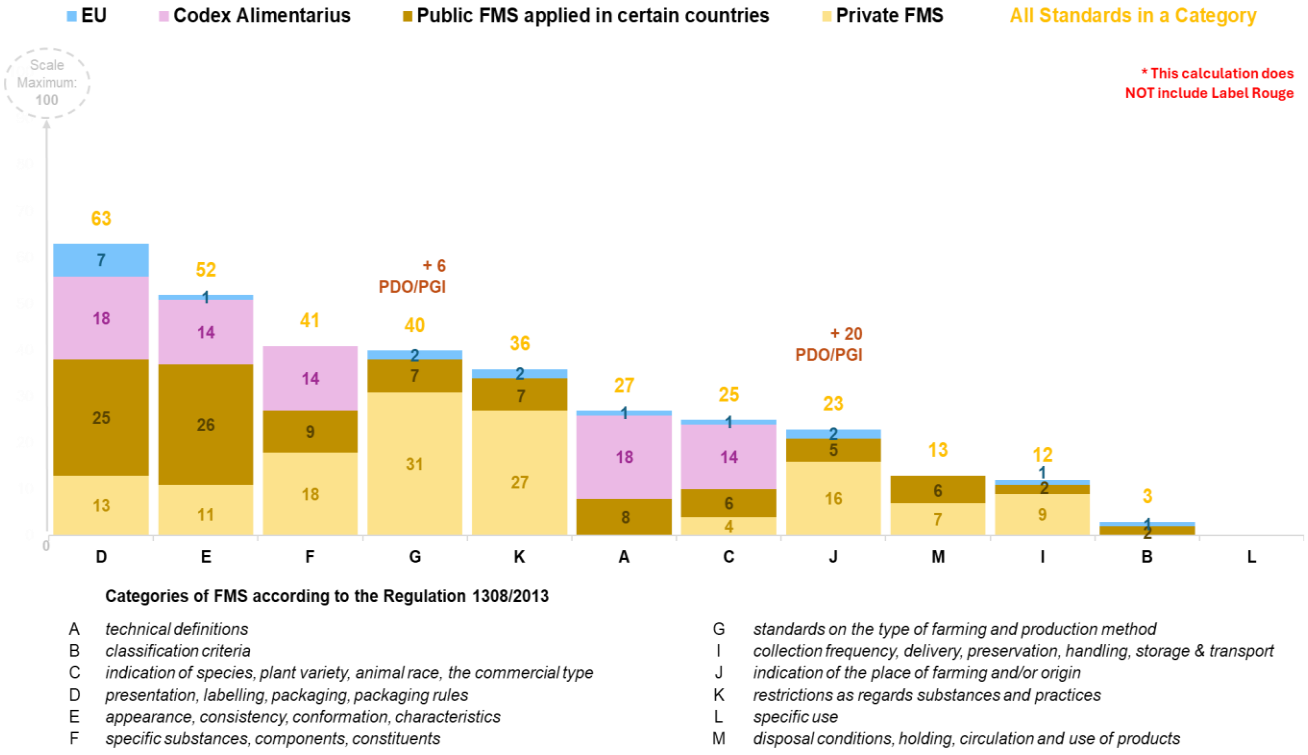
requirements, ingredient list (including allergens such as gluten), moisture content, contaminants such as heavy metals, pesticide residues, mycotoxins, the presence of extraneous matter, nutritional information, expiration date, storage instructions, and country of origin.

Figure 5: Cereals: Number of FMS in the Inventory by Categories in Regulation 1308/2013 and Origin



Source: BREADCRUMB project, Inventory of food marketing standards (WP1).
"Public FMS applied in certain countries" refers to national member state public standards.

Private standards for cereals are more pronounced in categories **'G'** (farming and production method), **'K'** (restrictions as regards substances and practices), **'J'** (origin) and **'F'** (specific substances used in production). As a response to consumer demands, these standards stress the importance of **sustainable production**, including organic production. Examples include GLOBAL G.A.P., "ProTerra standard", "Sustainable Cereal and Oilseed", "Donau Soja", "Europe Soya", "Belgische Biogarantie", "Flor de Peira", and "Cereais do Alentejo".

Like fruits and vegetables, **private standards for cereals are complementary to public ones**. While public standards overall focus more on the appearance and presentation of the products, private standards stress special types of production (e.g. bio, organic, fewer residues of pesticides) and / or applicable practices (e.g. sustainable, ethical, enforcing respectful labour practices).

3.3.3 Animal products: meat (bovine, pork, poultry), eggs, fish[7]

[7] Regulation 1308/2013 does not apply to the fish and aquaculture sector, but if translating the identified aquaculture and fish-related standards in accordance to Regulation 1308/2013, this section highlights which standard categories would be applicable.

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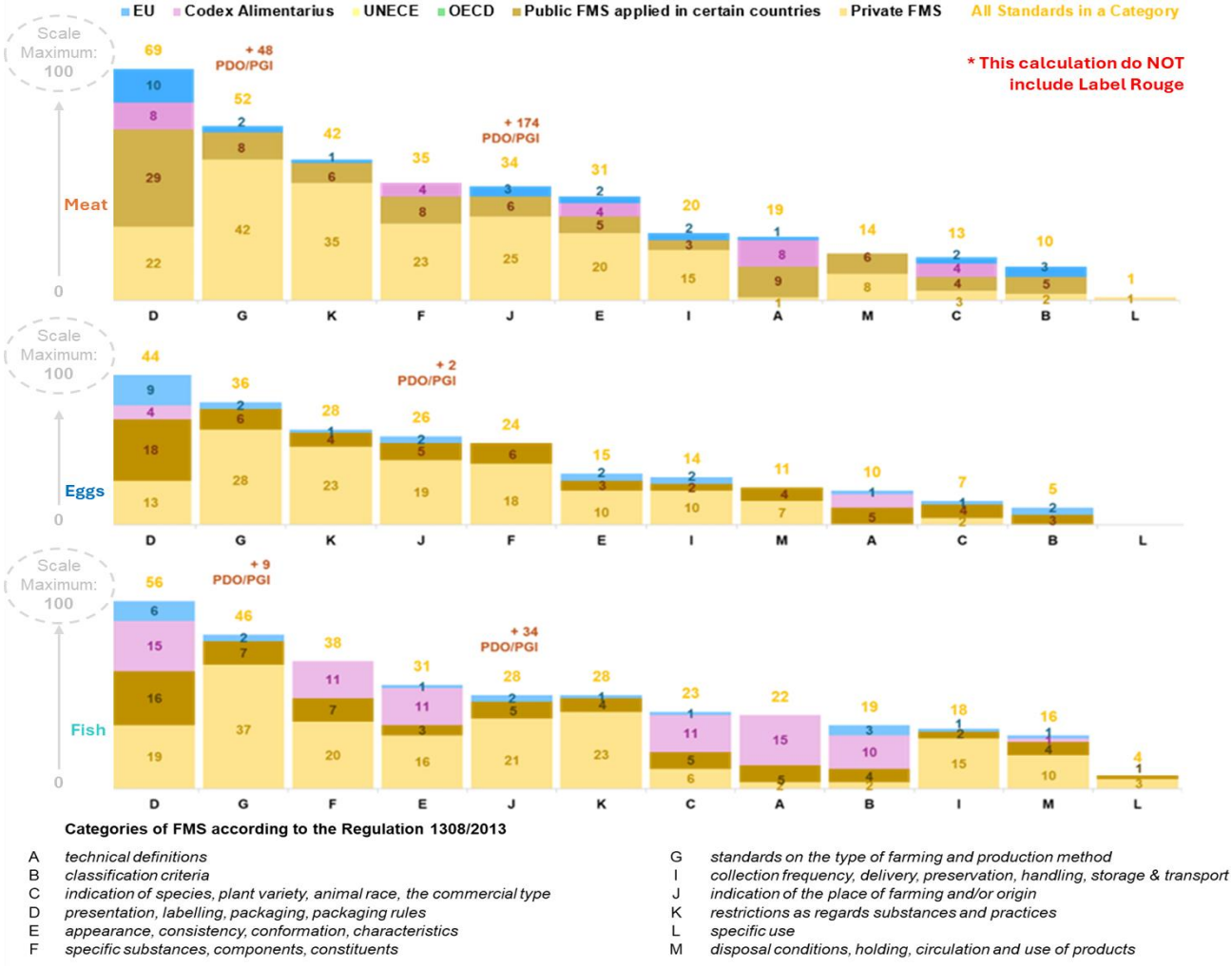
The Inventory includes standards for meat and processed meat products (such as ham), fish, and aquaculture. These include **national** and **EU legislation, PDO/PGI in various countries, and Codex Alimentarius standards**. The Inventory also contains over a hundred standards applicable to eggs, mostly covered by the EU, national public, and a few private standards.

Public standards for these animal products focus on ensuring **safety, quality,** and transparency in production, marketing, and consumption. They establish guidelines for labelling and traceability information, set maximum contaminant levels, and define microbiological and hygiene standards to ensure food safety. Additionally, measures are in place for labelling nutritional and health information, geographical indications, and the origin of products and product parts, as well as for the sizing categorisation for eggs and fish. These **public standards** can fall into category **'D'** (product marking, labelling, presentation, and packaging) – a category of standards **most common** for meat, eggs and fish overall, as well as **'J'** (origin), **'A'** (the technical definitions), **'B'** (classification criteria), **'G'** (farming and production method) and **'K'** (restrictions as regards substances and practices) from Regulation 1308/2013**.**

Figure 6: Meat (bovine, pork, poultry), Eggs, Fish: Number of FMS in the Inventory by Categories in Regulation 1308/2013 and Origin



Source: BREADCRUMB project, Inventory of food marketing standards (WP1).
"Public FMS applied in certain countries" refers to national member state public standards

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As regards **private standards**, the most common categories are category **'G'** (farming and production method) and **'K'** (restrictions as regards substances and practices). The appearance of these categories in private standards represents the market responding to the growing consumer demand for animal welfare. For example, the Belbeef and BePork standards in Belgium, and the "Better Life Quality" in the Netherlands adhere to strict animal welfare standards. Standards such as "Agri-Ethique" and "Bio Equitable En France" in France significantly emphasise preserving biodiversity, environmentally friendly production, and ethical agriculture. Enforcing these standards on producers address consumer demands for more ethical and cruelty-free production. Category **'F'** (specific substances used in production) is another prominent category in private standards for animal products, which can also be explained by the growing consumer demand for sustainable farming practices and organic products. Many private standards for animal products collected in the Inventory, such as AB (L'agriculture biologique), "Agri-Ethique", Bleu-Blanc-Coeur, Debio/ KRAV certification, and Bio Equitable En France, focus on organic, sustainable production. Other prominent categories in private animal product standards are **'J'** (origin), **'I'** (frequency of collection, delivery, preservation and handling, conservation method, and temperature storage and transport), and **'M'** (conditions governing the disposal, holding, circulation and use of products), which can be explained by the desire to ensure the customers of the traceability and the safety of the product. For instance, private standards, such as those developed by the Marine Stewardship Council (MSC) and Global Seafood Alliance (GSA), emphasise sustainability and traceability in the seafood industry and the Viandes et oeufs de France logo assures the consumer that the meat and eggs come from animals born, raised, slaughtered, cut, and processed in France.

Finally, appearance, consistency, conformation, product characteristics and the percentage of water content (category **'E'**) is another category that stands out as important for meat, eggs and fish. Examples include the Food Quality Assurance System (QAFP) of the Association of Meat Producers and Employers of the Meat Industry in Poland, which prohibits injecting meat and subjecting it to treatments that introduce water or other substances. The Pork of Weleer sold in Carrefour with the Quality Supply Chain label signifies that the pork is produced with animals fed 100% natural, non-GMO feed. The Viandes et oeufs de France guarantees, among others, that animals under the logo are fed with a healthy and sustainable diet.

Private standards for animal products are frequently **complementary to public standards, stressing environmental concerns and animal welfare considerations** (categories **'F', 'G'** and **'K'** according to Regulation 1308/2013). For example, the Belbeef standard for bovine, the BePork Animal Welfare standard, and the Pork of Weleer with the "Quality Supply Chain" label in Belgium include components dedicated to animal welfare. Similarly, a private standard, "Better Life Quality", in the Netherlands, focuses on animal welfare and providing information on the condition of animals to the consumers. Standards such as "Agri-Ethique" and "Bio Equitable En France" in France significantly emphasise preserving biodiversity, environmentally friendly production, and ethical agriculture. The European sustainability label, 'On the way to PlanetProof', guarantees that the products with this quality label comply with strict environmental criteria respecting nature, climate, and animals. In the fish sector, private standards like the IFFO RS and Marin Trust Standard emphasise sustainability in producing marine ingredients like fishmeal and fish oil, and the Global Seafood Alliance's Seafood Processing Standard (SPS) certifies seafood processing plants based on responsible sourcing practices. Private standards applying to eggs (appearing mostly in France and covering multiple other products as well) also emphasise organic, sustainable production (e.g., Bleu-Blanc-Coeur, Bio Sud Ouest France). Given the importance of safety and traceability, private standards are also complementary in terms of **origin (category 'J'** in Regulation 1308/2013). While EU standards such as those outlined in Regulation (EU) No 1308/2013 and Regulation (EU) No 1169/2011 establish general rules for country-of-origin, labelling, and information provision to consumers, private standards such as Belbeef, The Viandes et oeufs de France, the Seafood

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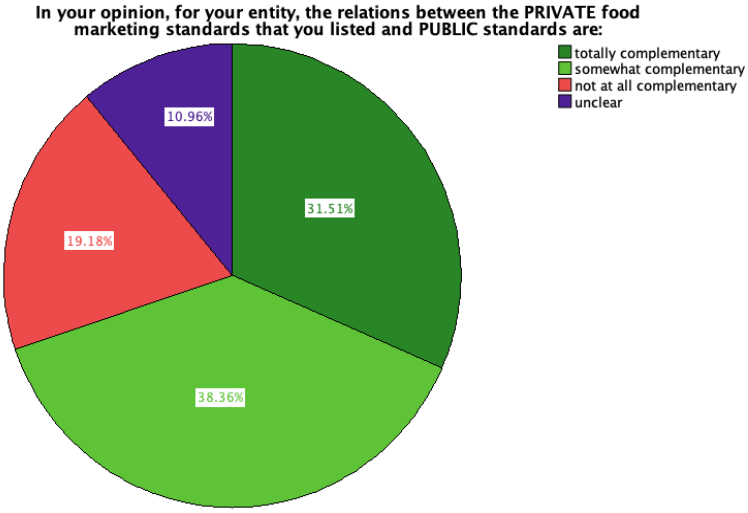
Processing Standard (SPS), Pisciculteurs de France, as well as some retailers' B2B standards in Belgium, also specifically highlight the traceability of the animal products under their certification.

3.4 Evidence from the Survey

3.4.1 Assessment of the complementarity of standards

In the survey, respondents were asked to assess the relationship between the private and public food marketing standards that they listed. They assessed the relations on a 4-point scale, ranging from "totally complementary" to "not at all complementary" (with an additional option for "unclear connection"). If combining the results from the two categories of "totally complementary" (31.51%) and "somewhat complementary" (38.36%), it can be concluded that the **private food marketing standards** examined in the study **were generally considered complementary to public standards,** with a total of about **70%** viewing them as such.

Figure 7: Survey Responses: Relationship between the Private and Public Standards



Source: Results of the survey on food marketing standards within the BREADCRUMB project (WP1).

On the other hand, 19.18% of the standards were labelled by respondents as "not at all complementary", and 10.96% were described as having an unclear relationship. It can be concluded that private and public marketing standards are **largely complementary** to each other. However, other types of relationships were less common and, to some extent, unclear to the respondents.

3.4.2 Differentiation of standards

Private standards seen **as an extension of or fully supportive of public regulation** (e.g., such as GLOBAL G.A.P, GRASP, BRC) are structured in such a way that they fill in gaps left by public standards or reinforce them with additional criteria, particularly in areas like food safety, animal welfare, and environmental concerns. Many private standards listed by respondents (such as Certification BEA, Cereais do Alentejo) align closely with public standards, ensuring greater consistency and consumer trust. Standards like GLOBAL G.A.P, GRASP, and BRC are internationally recognised, complementing national regulations while ensuring global compliance. These standards often build upon public standards by providing additional benchmarks for quality.

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According to the survey results, there were standards seen as **somewhat complementary** to public regulations. These were largely standards related to animal welfare and cosmetic standards for fruits and vegetables. These standards covered areas that public standards do not fully address or may differ slightly in terms of focus. They address niche concerns within the food industry that public standards do not fully capture (such as specific animal welfare regulations). Some of these "somewhat complementary" standards, like 'Pera Rocha' (PDO designation for a native Portuguese pear variety) and 'Alcobaça' apples (of the Alcobaça region in Portugal) serve regional needs, complementing but not fully aligning with broader national or international public standards. However, challenges may arise when private standards prescribe inconsistent quality or safety benchmarks across different regions or sectors. In these cases, standards may fail to promote innovation or higher quality if they do not fully complement public regulations.

There were also standards viewed by respondents as **not complementary** with public standards. Examples include IFS FOOD, GLOBAL GAP plus MODULOS, and Checked Quality Hessen. This could indicate conflicting requirements or different priorities between private and public entities. There may be a disconnect between these standards and public regulations, leading to inefficiencies or confusion for businesses trying to meet both. Some of these standards may prioritise commercial or aesthetic over broader public health or safety concerns, which could explain the lack of complementarity. Entities might face additional resource strain to meet these non-complementary standards, especially if they are more stringent or irrelevant to public welfare concerns. Adhering to public and private standards that do not fully complement each other can lead to fragmented compliance efforts, with businesses struggling to balance competing demands, especially since the public ones are very often mandatory.

Some standards are perceived as **having unclear relationships with public standards** due to vagueness or lack of available information. ~~Examples include Food Requirements Private Label~~. Some private standards might not be well-communicated or understood, leading to uncertainty about how they relate to public standards. This lack of clarity can create confusion, especially for small and medium-sized enterprises (SMEs) that may struggle to comprehend and comply with multiple standards. It is possible that some of these standards are still evolving, making it difficult to assess their alignment with public regulations. However, the evolving nature of some private standards may further complicate their alignment with public regulations, delaying integration efforts and hindering streamlined food safety and quality control.

3.5 Evidence from the Interviews

The results of the interviews point to a **complementary** relationship between public and private food marketing standards. Interviewees differentiated between both categories of standards in that the **public** ones were considered the **most basic standards that must be adhered to accede onto the market.** They are the absolute minimum requirements. These standards are evident at the EU level, national member states, and inter-governmental levels, such as the Codex Alimentarius Commission and UNECE. Results of the interviews demonstrated that standards established at the international level by inter-governmental (public) entities often serve as a basis for European Commission and national EU member state legislation. These standards cover core issues that cannot be compromised on, particularly those related to food safety, as well as uniformity of products to help facilitate trade. Conversely, private food marketing standards are standards that are defined by entities other than public government bodies, such as individual companies, food manufacturers, non-governmental organisations, industry associations, and retailers. **Private standards were seen in the interviews as being not only complementary to each other, but with private ones building upon the public ones.** Not one interviewee noted that private standards contradicted public standards.

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Both public and private standards must be adhered to by actors in the food supply chain. While the public standards serve to establish the baseline requirements, according to the interview results, the private standards go a step further to provide a competitive advantage. As one interviewee noted, *"Public marketing standards are the foundation of business operations. If a company does not comply with the laws regarding the production of a specific product, it risks heavy fines or closure of business. So implementing this marketing standard category is not a problem because it is absolutely necessary. As far as private marketing standards are concerned...not meeting private marketing standards means losing a customer"* (Interview 20). The **competitive advantage** is achieved by **differentiating the product.** Some interviewees noted that the private standards tend to be more strict to improve the overall perceived quality of a product and have it stand out, with various factors subsequently incorporated into the private standard, such as social and environmental concerns. One interviewee summarised it by saying*, "In my organisation we definitely have to work with both – all public standards must be adhered to (the legal component) and we have to keep in mind the private standards as well in order to find the best market for a product"* (Interview 16). There was also mention in the interviews that **private standards,** in essence, are in **competition with each other,** with comparability being the only decisive advantage in the marketplace. Achieving such differentiation demonstrates that additional, specific investments had been made to create a value-added product for the consumer. It was noted in the interviews that this also provides the **opportunity to request a higher price.**

The interviewee discussions highlighted a perceived **power imbalance** in the food supply chain, where downstream actors can disproportionately influence which standards need to be adhered to by upstream actors in the chain. In particular, large-scale retailers with majority shares in the market were noted as having the most sway in terms of what private standards are put forth in a food supply chain. As one interview noted*, "…it is very dependent on retail and wholesale because they have such great market power"* (Interview 10). The need for more transparency about how private standards are created and implemented was also raised by several (5) interviewees. One interviewee noted, *"Public food marketing standards, like legislation, are known by producers, while private quality schemes or private retailer standards are known only if they are involved in them"* (Interview 23). However, there was also evidence provided in the interviews of private marketing standards being quite **transparent.** This was particularly the case with NGOs where public consultations with all actors along the food supply chain were part of the basic process when establishing a new standard.

3.6 Overview of Results

Research results pertaining to analysis of the inventory, literature review, the survey, and in-depth interviews highlight that there is predominantly a complementary relationship between public and private food marketing standards, with private food marketing standards expanding upon the public ones. The summary below highlights the main conclusions from this chapter, which in chapter 5 will serve as the foundation when developing hypotheses on the relationship between public and private food marketing standards.

There is **predominantly a complementary relationship** between public and private food marketing standards. In particular, if combining the results from the survey in regards to the two categories of "totally complementary" (31.51%) and "somewhat complementary" (38.36%), it can be concluded that the private food marketing standards examined in the study were generally (i.e. approximately 70%) considered complementary to public standards. In the inventory, several examples are visible, such as with organic production. Retailers such as Carrefour (Bio), Groupe Casino (Zéro résidu de pesticides) and Aldi (Bon et Bio) have launched their own product lines highlighting adherence to

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organic farming and EU Regulation Regulation (EU) 848/2018 on organic production and labelling of organic products. Private standards tend to align closely with public ones, ensuring greater consistency and consumer trust, complementing national regulations while ensuring global compliance.

The standards were not, however, only complementary with each other. Results of the research demonstrated examples of where **private standards built / expanded upon the public ones**. These private standards put in place more stringent requirements to make the product **more competitive**. While they fell into several categories, category **'G'** (farming and production method) was the most prominent for fruits and vegetables, cereals, as well as meat, eggs and fish. Category **'E'** (appearance, consistency, conformation, product characteristics and the percentage of water content) also played a prominent role in private standards for fruits and vegetables. The standards in these two categories focus on specific characteristics related to perceived quality - such as size, shape, and firmness – as well as ethical production practices, including animal welfare, environmental sustainability, and workers' welfare. Adhering to these standards allows an entity to differentiate its products by responding to a growing consumer demand for a particular quality as well as ethical practices. For example, the Belbeef and BePork standards in Belgium, and the "Better Life Quality" in the Netherlands adhere to strict animal welfare standards. Standards such as "Agri-Ethique" and "Bio Equitable En France" in France significantly emphasise preserving biodiversity, environmentally friendly production, and ethical agriculture. In regards to the private standards, the interviewee discussions highlighted a perceived **power imbalance** in the food supply chain, with downstream actors disproportionately influencing which private standards need to be adhered to by upstream actors in the chain. Conversely, the presence of stringent private standards can also **drive improvements in public standards.** As private retailers enforce higher standards, regulatory bodies may respond by updating public regulations to ensure broader compliance across the industry. This dynamic can lead to a "mutual reinforcement" between private and public standards, where private initiatives push for innovation and public bodies follow by adjusting regulations to maintain consistency and ensure broader compliance across sectors (Smith, 2009).

There were though also standards viewed as **not complementary** with public standards. While in the interviews not one interviewee noted that private standards contradicted public standards, in the survey 19.18% of the standards identified by respondents were deemed as "not at all complementary". This could be indicative of conflicting requirements or different priorities between private and public entities, leading to inefficiencies or confusion for businesses trying to meet both.

Finally, the research results demonstrated that there is also a **lack of clarity and understanding** about standards. Nearly 11% (i.e. 10.96%) of private food marketing standards identified in the survey were perceived as having **unclear relationships with public standards** due to vagueness or lack of available information. Some private standards might not be well-communicated or understood, leading to uncertainty. The need for **more transparency** about how private standards are created and implemented was also raised by several (5) interviewees. The lack of transparency and clarity can create confusion for supply chain actors, especially for small and medium sized enterprises that may struggle to comply with multiple standards.

3.7 Hypotheses

Based on the research results in work package 1, the following hypotheses have been developed on the relationship between public and private food marketing standards. These hypotheses demonstrate a complementary relationship between public and private standards, but also instances where the private standards build upon the public ones, in order to appeal to a particular consumer base (i.e. by adhering to sustainability or ethical practices for example). A summary of each

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hypothesis is provided, followed by a table to demonstrate what data was used, and where it came from (i.e. inventory, survey, interviews, literature review). The data is not exhaustive since it is based on what was uncovered via the research done in the first work package.

3.7.1 Relationship between public and private standards – Animal Welfare

Hypothesis: Private food marketing standards refer to public marketing standards, such as those outlined by the World Organization for Animal Health (WOAH), as a basis to build upon to ensure that production methods and controls are put in place that assure adequate welfare for farmed animals.

Summary: Enforcing animal welfare standards addresses consumer demands for more ethical and cruelty-free production. According to Eurobarometer research across the EU member states (2023), 84% of Europeans believed that the welfare of farmed animals should be better protected in their country, and similarly, 90% of respondents considered that farming and breeding practices should meet basic ethical requirements.[8] Not including animal welfare requirements in standards, not only dismisses a particular consumer base, but also government initiatives and legislation, such as the EU's Farm to Fork Strategy and the 2023 Commission proposal on animals in transport, which outline approaches to ensure a higher level of animal welfare in the EU.[9]

Table 4: Relationship Between Public and Private Standards – Animal Welfare

Topic	Content
Hypothesis	Private food marketing standards refer to public marketing standards, such as those outlined by the World Organization for Animal Health (WOAH), as a basis to build upon to ensure that production methods and controls are put in place that assure adequate welfare for farmed animals.
Data collection points	**Inventory** - The World Organization for Animal Health (WOAH) is an intergovernmental organization established to gather and disseminate information not only about animal diseases, but to create standards (public) related to animal welfare to improve the health and welfare of animals throughout the world, regardless of socio-economic, religious, or cultural context. https://www.woah.org/en/what-we-do/animal-health-and-welfare/animal-welfare/#ui-id-1 - Global Red Meat Standard The objective of the Global Red Meat Standard (GRMS) is to deliver transparency within animal welfare, quality, food safety and hygiene in

[8] The Eurobarometer in-person interviews were conducted between March 2-26, 2023, with a total of 26,376 respondents from the 27 EU Member States, including different social and demographic groups. https://ec.europa.eu/commission/presscorner/detail/en/ip_23_4951

[9] Animal Welfare within the EU's Farm to Fork Strategy: https://food.ec.europa.eu/system/files/2020-06/aw_platform_20200615_pres-02.pdf

Commission proposal on animals in transport: https://ec.europa.eu/commission/presscorner/detail/en/ip_23_6251

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	factories that slaughter, cut, debone, process and handle meat and meat products from pork, beef, lamb/sheep, goat and horse. The transparency is delivered through an independent certification process based on ISO/IEC 17065. https://www.grms.org - Belbeef The Belbeef standard in Belgium is a comprehensive certification system for Belgian beef, ensuring quality and safety throughout the production process. The standard adheres to the official legal requirements regarding food safety, traceability, and animal welfare and consolidates the common standards demanded by various customers. https://www.belbeef.be - BePork The BePork standard provides quality assurance for pork, goes beyond legal requirements at all supply chain stages, focusing on enhanced safety, an emphasis on animal health, welfare, and sustainability. https://belpork.be/nl/bepork/ - Beter Leven Keurmerk The 'Beter Leven Keurmerk' standard is from the Animal Protection Society, which has the label guaranteed by independent certifying institutions. It is an instrument to make livestock farming more animal-friendly through consultation and gradual development. The Better Life quality mark helps you with this by providing insight into how well the animal behind your product has been cared for. By choosing products with a star, you choose products for which you know what the living conditions were like for the animal. And the more stars, the more animal-friendly and therefore the better the living conditions. https://beterleven.dierenbescherming.nl/over-het-keurmerk/wat-is-beter-leven/ - Demeter The Demeter standards for animal welfare reflect correct fodder and pasture for their species and provide enough space to roam free. https://demeter.net/demeter-products/meat/ https://demeter.net/demeter-products/eggs-poultry/
	Survey - According to the survey results: a) A total of 69.87% of respondents considered the relationship between public and private food marketing standards to be complementary. b) Private standards were seen as an extension of or fully supportive of public regulation, and thus structured in such a way to either fill in gaps left by public standards, or reinforce them. c) Many private standards listed by respondents of the survey align closely with public standards ensuring greater consistency.
	Interviews

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	- According to the interview results: a) Interviewees differentiated between both categories of standards in that the public ones were considered the most basic standards that have to be adhered to in order to accede onto the market. They are the absolute minimum requirements. These standards are evident not only at the EU level, but also national member state, and inter-governmental levels such as the Codex Alimentarius Commission. Conversely, private food marketing standards are standards that are defined by entities other than public government bodies, such as individual companies, food manufacturers, non-governmental organizations, industry associations, and retailers. Private standards were seen in the interviews as being complementary to and building upon the public ones within the legal framework. Not one interviewee noted that private standards were in contradiction to the public standards. b) Both public and private standards need to be adhered to by actors in the food supply chain. While the public standards serve to establish the baseline requirements, according to the interview results, the private standards go a step further to provide a competitive advantage. *"Public marketing standards are the foundation of business operations. If a company does not comply with the laws regarding the production of a specific product, it risks heavy fines or closure of business. So implementing this marketing standard category is not a problem because it is absolutely necessary. As far as private marketing standards are concerned...not meeting private marketing standards means losing a customer"* (Interview 20). c) The competitive advantage is achieved by differentiating the product. Some interviewees noted that the private standards tend to be stricter in order to further improve the overall quality of a product and have it stand out, with various factors subsequently incorporated into the private standard such as social (including animal welfare) and environmental concerns.
	Literature review (not exhaustive) - Martinez, Marian G., Andrew Fearne, Julie A. Caswell, and Spencer Henson. (2007). "Co-regulation as a possible model for food safety governance: Opportunities for public–private partnerships." *Food Policy*, Volume 32, Issue 3, pp. 299-314. https://doi.org/10.1016/j.foodpol.2006.07.005 - Nes, Kjersti, and Pavel Ciaian. (2021). *Joint Research Centre Technical Report: Marketing standards for food products – A review of literature.* Luxembourg: Publications Office of the European Union. https://publications.jrc.ec.europa.eu/repository/handle/JRC126936 - Purnhagen, Kai P., and Alexandra Molitorisova. (2022). "Public and Private Enforcement in European Union Food Law." *European Journal of Risk Regulation,* Volume 13, Issue 3, pp. 464-476.

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	https://doi.org/10.1017/err.2021.59 - Smith, Garry. (2009). "Interaction of Public and Private Standards in the Food Chain." *OECD Food, Agriculture and Fisheries Papers,* No. 15, Paris: OECD Publishing. http://dx.doi.org/10.1787/221282527214 - Vandemoortele, Thijs, and Koen Deconinck. (2011). "When are private standards more stringent than public standards?" *American Journal of Agricultural Economics,* Volume 96, Number 1, pp. 154-171. https://www.jstor.org/stable/24477061 - Wolff, Christiane, and Michael Scannell. (2008). "Implication of Private Standards in International Trade of Animals and Animal Products". *76th General Session of the International Committee of the World Organization for Animal Health,* Paris, May 25-30, 2008 (session paper).
Regulation 1308/2013	Category G – Type of farming and production method is evident in terms of husbandry and animal welfare practices.

Source: Author, hypothesis template developed in the BREADCRUMB project (task 1.4).

3.7.2 Relationship between public and private standards – Organic Production

Hypothesis: Private organic standards not only build upon, but significantly exceed the EU requirements in terms of allowed processes, substances used, and number of audits.

Summary: Private organic regulations go beyond the EU organic regulation (Regulation (EU) No. 848/2018) in terms of farm conversion, preservation of local species (not specifically outlined by the EU), usage of substances such as pesticides, herbicides, fungicides, and fertilisers (EU allows some usage under certain conditions, while some private organic standards do not), promotion of shorter supply chains, and regular audits.

Within the European Green Deal (2019), the Farm to Fork Strategy aims to have 25 percent of the EU's agricultural land be under organic farming by 2030 (European Union 2020: 11). The Commission's Organic Action Plan (2021-2027) increases research and innovation funding for organic development under Horizon Europe by 30% of the budget for R&I actions in the field of agriculture, forestry and rural areas (European Commission 2021: 5). According to Organics Europe, in 2022, the EU's total area of farmland under organic production grew to 16.9 million hectares, and compared to 2021, the number of organic producers in the EU increased by 10.8 percent, while trends from 2019 to 2023 indicate that the EU organic market is growing, reflecting sustained interest and potential for future expansion in this sector.[10]

Table 5: Relationship Between Public and Private Standards – Organic Production

Topic	Content
Hypothesis	Private organic standards, not only build upon, but significantly exceed the EU requirements in terms of:

[10] Organics Europe Annual Report 2023: https://read.organicseurope.bio/?publication=ifoam-organics-europe-annual-report-2023/organics-in-europe-at-a-glance#

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	• allowed processes • substances used • number of audits
Data collection points	**Inventory** - Regulation (EU) No. 848/2018 (“Organic” regulation) of the European Parliament and of the Council of 30 May 2018 on organic production and labelling of organic products. Replaces the previous organic Regulation (EC) No 834/2007 and introduces several updates and changes aimed at further harmonizing organic rules across the EU member states, including labelling of organic products, and production activities. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018R0848 https://agriculture.ec.europa.eu/farming/organic-farming/organic-production-and-products_en - Naturland Naturland requires full farm conversion to organic methods and explicitly bans genetic engineering and nanomaterials across all areas of production, the EU regulation imposes these restrictions only partially. The standard also sets stricter limitations on inputs, including fertilisers, mandates crop rotation with nitrogen-fixing plants like legumes and imposes precise restrictions on animal stocking density. In terms of food processing, Naturland provides stricter controls on raw material sourcing, permissible additives, and processing methods. https://www.naturland.de/images/01_naturland/_en/Standards/Comparison_Naturland-EC-organic-regulation.pdf - Bio Cohérence Bio Cohérence mandates a complete conversion of the entire farm. It also prohibits the use of certain inputs that are permitted under EU regulations, such as pesticides, herbicides, fungicides, non-organic fertilisers, synthetic preservatives, artificial colourings and flavouring. It also requires rigorous measures to prevent GMO contamination, including traceability protocols, and revokes certification if contamination occurs. Additionally, the label emphasises local production and self-sufficiency, with stricter limits on external inputs, especially for livestock feed, which must be largely sourced from the farm or nearby Bio Cohérence-certified operations. https://www.biocoherence.fr - Demeter Demeter prohibits partial farm conversion as well with the aim of fostering a self-sustaining ecosystem. It also strictly prohibits a number of substances such as pesticides, herbicides, and fertilisers completely (as opposed to the EU Regulation 848/2018), and discourages the use of hybrid seeds. The standard also prescribes minimal processing of fruits and vegetables to preserve their natural qualities. https://demeter.net/about/demeter-brand/

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	Survey - According to the survey results: a) Standards for fruits and vegetables collected in the survey reflect a necessity to adhere to sustainability practices. Among important standards for fruits and vegetables, participants named public organic standards for the residue levels and additional pesticide analyses required by traders, as well as private organic standards such as ZERYA (https://zerya.org/?lang=en) and Tesco Nature Choice (http://midkentgrowers.co.uk/tesco-standard/).
	Interviews - According to the interview results: a) Interviewees highlight that providing details about production processes, including environmental and social aspects like efforts to protect biodiversity, ensuring fair employment conditions, and upholding animal welfare in husbandry, enhances the overall image of a product. As a result, these environmental and social considerations are increasingly integrated into private standards, which typically require certification granted through an independent third-party audit or inspection. *"Secondary standards or private standards, as we call them, are often a challenge for our customers. Because they are simply stricter than what they have to do by law. And because they want to meet these standards if they want to supply their products"* (Interview 7). *"With these high standards, higher prices can actually be achieved. It's better than just having some kind of EU organic label on the packaging because it actually has an economic benefit"* (Interview 7). *"Private standards represent the specific demands a customer has on a given product. The greater the company's ability to meet these marketing standards, the higher the unit sales price and, thus, the revenue. For example, organic fruit products allow you to obtain higher selling prices because the consumer recognises their value"* (Interview 20).
	Literature Review (not exhaustive) - Bio Cohérence. (2024). "Tableau comparatif du cahier des charges Bio Cohérence et de la réglementation européenne en agriculture biologique." Last accessed December 2024. https://www.biocoherence.fr - Mancini, M. C. (2019). "Public and private food standards." In *EU bioeconomy economics and policies: Volume II,* edited by L. Dries, W. Heijman, R. Jongeneel, K. Purnhagen, and J. Wesseler, pp. 47–62. Switzerland: Springer Nature. https://link.springer.com/book/10.1007/978-3-030-28642-2 - Naturland. (n.d.). "A one-to-one comparison of the Naturland standards with the EU organic regulation." Last accessed December 2024.

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	https://www.naturland.de/images/01_naturland/_en/Standards/Comparison_Naturland-EC-organic-regulation.pdf - Squatrito, S., Arena, E., Palmeri, R., and B. Fallico. (2020). "Public and private standards in crop production: Their role in ensuring safety and sustainability." *Sustainability*, 12(2), pp. 1-16. https://www.mdpi.com/2071-1050/12/2/606
Regulation 1308/2013	Category G - Type of farming and production method and category K – Restrictions as regards the use of certain substances and practices, are evident via the specific requirements that need to be adhered to during organic production. Private organic standards become stricter by enacting more limitations on allowed substances and practices, and checking adherence by regular audits.

Source: Author, hypothesis template developed in the BREADCRUMB project (task 1.4).

3.7.3 Relationship between public and private standards – Fish Stock Management

Hypothesis: Public EU standards on fish stock management are used as a basis for private standards to address conservation and sustainable fishing.

Summary: Regarding fish stock management, private standards utilize as a basis EU regulations on fish management and conservation, such as EU Regulation 1380/2013, to put forth complementary requirements that promote the sustainability of fish stocks, and careful management of other species and habitats within the ecosystem affected by fishing activities.

Food from aquatic sources plays a critical role in global food and nutrition. According to a World Economic Forum paper of 2024, 23.8 million tonnes of global edible aquatic food loos and waste took place in 2021, equalling 14.8 percent of aquatic food produced that same year (World Economic Forum 2024: 4). Just over 3 billion people currently rely on aquatic foods to provide their average intake of animal protein (World Economic Forum 2024: 5). Given the nutritional benefits of aquatic foods (omega-3 polyunsaturated fatty acids, vitamins, minerals) coupled with the rise in global population (expected to rise 8.5 billion by 2030), it is paramount to ensure sustainable fish stock management.[11]

Table 6: Relationship Between Public and Private Standards – Fish Stock Management

Topic	Content
Hypothesis	Public EU standards on fish stock management are used as a basis for private standards to address conservation and sustainable fishing.
Data collection points	**Inventory** - Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013 on the Common Fisheries Policy.

[11] Organization for Economic Co-operation and Development (OECD). (2021). "OECD-FAO Agricultural Outlook 2021-2030." Paris: OECD Publishing. Last accessed January 2025. https://doi.org/10.1787/19428846-en

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	Regulation 1380/2013 lays down provisions concerning the Common Fisheries Policy (CFP), which covers the following: (a) the conservation of marine biological resources and the management of fisheries and fleets exploiting such resources; (b) in relation to measures on markets and financial measures in support of the implementation of the CFP, fresh water biological resources, aquaculture, and the processing and marketing of fisheries and aquaculture products. The CFP applies to activities carried out in the territories of the Member States, in European Union waters and by European Union fishing vessels outside European Union waters. The aim of the CFP is to ensure that fishing and aquaculture activities are environmentally sustainable in the long-term and are managed in a way that is consistent with the objectives of achieving economic, social and employment benefits, and of contributing to the availability of food supplies. The Regulations also promotes the fight against IUU fishing activities. https://eur-lex.europa.eu/eli/reg/2013/1380/oj/eng - Marine Stewardship Council (MSC) Fisheries Standard - The MSC Fisheries Standard is used to assess if a fishery is well-managed and sustainable. The Standard reflects the most up-to-date understanding of internationally accepted fisheries science and management. Certification to the MSC Fisheries Standard is voluntary, and open to all fisheries who catch marine or freshwater organisms in the wild. The fisheries are assessed by accredited independent certification bodies (Conformity Assessment Bodies – "CABs") and not the MSC. To be in compliance with the MSC Fisheries Standard, the following must be adhered to: a) Sustainable Fish Stocks: Fishing must be at a level that ensures it can continue indefinitely and the fish population can remain productive and healthy; b) Minimize Impacts: Fishing activity must be managed carefully so that other species and habitats within the ecosystem remain healthy; and c) Fisheries Management: Fishing must comply with relevant laws and be able to adapt to changing environmental circumstances. https://www.msc.org/standards-and-certification/fisheries-standard
	Survey - According to the survey results: a) A total of 69.87% of respondents considered the relationship between public and private food marketing standards to be complementary. b) Private standards were seen as an extension of or fully supportive of public regulation, and thus structured in such a way to either fill in gaps left by public standards, or reinforce them. c) The standards highlighted in the survey for fish were heavily influenced by consumer demand for safety, ethical sourcing, and sustainability.

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	Interviews - According to the interview results: a) Interviewees differentiated between both categories of standards in that the public ones were considered the most basic standards that have to be adhered to in order to accede onto the market – the baseline requirements. Conversely, private food marketing standards were seen in the interviews as being complementary to and building upon the public ones within the legal framework. b) Some interviewees pointed out that today consumers want to know more about where a food product is coming from and how it has been made. According to interviewees, it is a benefit for the overall image of a product to provide information about production processes, including environmental and social concerns such as consideration given to respecting and maintaining biodiversity and species conservation. For this reason, environmental and social responsibility components are increasingly incorporated into private standards. *"Consumers are increasingly conscious about what they are buying and don't want to be lied to or misled; they want to see the proof of where a product is coming from and how it has been formulated or produced. A key issue today is to demonstrate that you are responsibly treating resources. It is has to do with reputation and customer trust"* (Interview 15). *"…bluefin tuna is a species that has always been a bit in the spotlight of environmental organizations and has had certain restrictions. One way in which we have been able to differentiate ourselves from companies that perhaps do not use the same practices, has been to obtain all the certifications…"* (Interview 3).
	Literature review (not exhaustive) - European Commission. (2019). "Working Document: Marketing standards framework for fishery and aquaculture products." *European Commission*, SWD (2019) 455 final, (December): 1-75. https://oceans-and-fisheries.ec.europa.eu/document/download/d1b689fe-4dd3-417e-8f78-2e667e39d483_en?filename=swd-2019-455_en.pdf - EUR-Lex. (2013). Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013 on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC. https://eur-lex.europa.eu/eli/reg/2013/1380/oj - Marine Stewardship Council (MSC). (2024). "The MSC Fisheries Standard." Last accessed December 2024. https://www.msc.org/standards-and-certification/fisheries-standard

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	- Smith, Garry. (2009). "Interaction of Public and Private Standards in the Food Chain." *OECD Food, Agriculture and Fisheries Papers,* No. 15, Paris: OECD Publishing. http://dx.doi.org/10.1787/221282527214 - Van Hal, Ollie, Hannah H.E. van Zanten, Friederike Ziegler, Johan W. Schrama, Kiki Kuiper, and Imke J.M. de Boer. (2023). "The role of fisheries and fish farming in a circular food system in the European Union." *Sustainable Production and Consumption*, Volume 43, pp. 113-123. https://www.researchgate.net/publication/375416688_The_role_of_fisheries_and_fish_farming_in_a_circular_food_system_in_the_European_Union
Regulation 1308/2013	The fish sector is not governed by Regulation 1308/2013, however, if using the categories from this regulation, the most applicable is Category I – Frequency of collection, delivery, preservation and handling, conservation method and temperature, storage and transport. In terms of "frequency of collection" may overlap with the general requirements for fisheries management and conservation within Regulation 1380/2013 (Common Fisheries Policy).

Source: Author, hypothesis template developed in the BREADCRUMB project (task 1.4).

3.7.4 Relationship between public and private standards – Sustainable Production Methods

Hypothesis: Private food marketing standards build upon the general sustainable production requirements outlined in public standards, such as EU Regulation 1308/2013.

Summary: Sustainability refers to meeting not only the resource needs of today, but also those of the future. At the international level, the United Nations launched the Sustainable Development Goals (SDGs) in 2015 with the aim of member countries achieving 17 sustainability goals by 2030 (United Nations 2022). At the EU level, the European Green Deal first introduced in 2019, demonstrates the EU's commitment to ambitious, long-term environmental and climate goals. The 8th Environment Action Programme (8EAP) of 2022 sets out the EU's environmental policy till 2030, and the objectives to achieve a more climate-neutral and resource-efficient economy. In this respect, the Farm to Fork Strategy, at the heart of the European Green Deal, aims to make food systems more sustainable, resilient, fair, and healthy. A flagship initiative of the Farm to Fork Strategy is the proposal for a legislative framework for sustainable food systems (SFS). There is also growing consumer demand for products that are produced in an environmentally friendly manner. According to Bassi (2023), analysis of responses from 27,498 European citizens across different social and demographic groups in EU member states, demonstrates that 90% of the respondents recognized protecting the environment as important, and climate change as a serious problem (Bassi 2023: 6).

Table 7: Relationship Between Public and Private – Sustainable Production Methods

Topic	**Content**
Hypothesis	Private food marketing standards build upon the general sustainable production requirements outlined in public standards, such as EU Regulation 1308/2013.
Data collection points	**Inventory**

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	- Regulation (EU) No 1308/2013 of the European Parliament and of the Council of 17 December 2013 establishing a common organisation of the markets in agricultural products and repealing Council Regulations (EEC) No 922/72, (EEC) No 234/79, (EC) No 1037/2001 and (EC) No 1234/2007. *"Contributing to a sustainable use of natural resources and to climate change mitigation"* (page 738). *"Promoting and carrying out research into integrated sustainable production or other environmentally sound production methods"* (page 740). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R1308 - Belbeef Belbeef is a private standard concerning meat which has been bred, born, slaughtered, and cut in Belgium. Via its requirements, it guarantees that the meat has been exigently controlled and adheres to quality requirements/specifications for all links in the beef chain. The requirements set are strictly and regularly checked at the level of each link by Independent Certification Bodies (OCIs), which in turn are accredited by the Belgian Accreditation Institution of the Federal Government (BELAC). In 2019, Belbeef introduced its Sustainability Monitor, which includes specifications related to animal nutrition, animal welfare, animal health, water and energy usage, soil health, and biodiversity preservation. https://www.belbeef.be/nl/thema/duurzaamheid - Dutch Initiative on Sustainable Cocoa (DISCO) DISCO acknowledges the complexity of the root causes behind the critical social, economic, and environmental sustainability issues in the cocoa sector. The vision is that in cocoa-production regions important to the Dutch cocoa industry the following will be achieved: cocoa-related deforestation and forest degradation in producing regions where the Dutch cocoa industry and their trade partners are sourcing from will have ended in their supply chains by 2025; https://www.idhsustainabletrade.com/initiative/dutch-initiative-on-sustainable-cocoa-disco/ - On the Way to PlanetProof On the way to PlanetProof is a European sustainability label that proves more sustainable agricultural production. Products with this quality label comply with strict environmental criteria related to 8 sustainability themes. Therefore, choosing certified products is good for the planet because the farmers and growers produce with respect for nature, climate, and the animals. https://www.planetproof.eu/en/ - Milieukeur

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	Milieukeur is a certification label which indicates that products or services have been produced or provided with consideration for the environment. Milieukeur covers a wide range of products and services, including agriculture, food, construction materials, and cleaning products. For food products, Milieukeur certification typically focuses on aspects such as sustainable agricultural practices, resource usage, and environmental impact throughout the production process. Food products that meet Milieukeur standards may be labelled accordingly, providing consumers with assurance that they have been produced in an environmentally responsible manner. https://sweetpoint.nl/nl/duurzaam/milieukeur/
	Survey - According to the survey results: a) A total of 69.87% of respondents considered the relationship between public and private food marketing standards to be complementary. b) Private standards were seen as an extension of or fully supportive of public regulation, and thus structured in such a way to either fill in gaps left by public standards, or reinforce them.
	Interviews - According to the interview results: a) Private standards were seen in the interviews as being complementary to and building upon the public ones within the legal framework. b) Sustainability affects food supply chains in that for a supply chain to not only survive, but to also thrive today and in the future, it is to a certain extent dependent on the context and environment in which it operates. Commercial actors in the food supply chain as well as consumers are aware of this, and consequently sustainable production has become a cornerstone of food production. One interviewee poignantly highlighted that environmental, social, and economic practices are all intertwined and therefore each one is as important as the other and relevant for the healthy functioning of any entity. *"I do not see social practices or environmental sustainability as being in conflict with economic and financial factors. All are important and relevant for the healthy functioning of the company. It is a balancing act – ensuring that we move forward with sustainability, but in a manner that is cost-effective as well"* (Interview 1).
	Literature review (not exhaustive) - Nes, Kjersti, and Pavel Ciaian. (2021). *Joint Research Centre Technical Report: Marketing standards for food products – A review of literature.* Luxembourg: Publications Office of the European Union. https://publications.jrc.ec.europa.eu/repository/handle/JRC126936 - Smith, Garry. (2009). "Interaction of Public and Private Standards in the Food Chain." *OECD Food, Agriculture and Fisheries Papers,* No. 15, Paris: OECD Publishing.

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	http://dx.doi.org/10.1787/221282527214 - Vandemoortele, Thijs, and Koen Deconinck. (2011). "When are private standards more stringent than public standards?" *American Journal of Agricultural Economics,* Volume 96, Number 1, pp. 154-171. https://www.jstor.org/stable/24477061 - Wolff, Christiane, and Michael Scannell. (2008). "Implication of Private Standards in International Trade of Animals and Animal Products". *76th General Session of the International Committee of the World Organization for Animal Health,* Paris, May 25-30, 2008 (session paper).
Regulation 1308/2013	Category G – The type of farming and production method including oenological practices and advanced systems of sustainable production. Category G is evident in terms of the sustainability initiatives put in place by private standards in alignment with and building upon Regulation (EU) No 1308/2013.

Source: Author, hypothesis template developed in the BREADCRUMB project (task 1.4).

3.7.5 Relationship between public and private standards – Traceability Labelling for Eggs

Hypothesis: Private labelling standards for traceability align with public standards due to their shared emphasis on product safety, but complement public standards by providing additional information for consumers.

Summary: The additional assurances outlined in these private labelling standards, can include but are not limited to issues such as:

- Emphasis on ethical and eco-friendly farming practices, such as animal welfare, minimising greenhouse gas emissions, conserving biodiversity, or using renewable resources.
- Enhanced quality control, such as systematic and periodic inspections of all certified operations, including detailed record-keeping and verification processes for feed and housing conditions of the animal.

Traceability on eggs in the EU is already very extensive. Several EU Member States have developed efficient marking systems at the level of packing centres for eggs. Member States are allowed to exempt eggs from marking at the production site when it is carried out in the first packing center to which eggs are delivered, as long as this exemption is proportionate, non-discriminatory and does not undermine the objective of traceability of the eggs.

Food labelling plays a critical role in connecting producers and consumers (Corallo et al. 2021; Sayogo et al. 2021; Change et. al 2023). Labelling is not only legally mandatory, but also influences consumer choices by providing essential information about food quality, safety, and origin. Labels are a tool in ensuring transparency in food production and distribution, communicate compliance with certain standards, and thereby enhancing consumer trust and enabling informed consumer decision-making.

Table 8: Relationship Between Public and Private Standards – Traceability Labelling for Eggs

Topic	Content

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Hypothesis	Private labelling standards for traceability align with public standards due to their shared emphasis on product safety, but complement public standards by providing additional information for consumers.
Data collection points	**Inventory** - Commission Delegated Regulation (EU) 2465/2023: Adopted on 17 August 2023, this specifies marketing standards for eggs (complements Regulation (EU) No 1308/2013), and outlines detailed requirements for egg marking, packaging, and labelling to ensure traceability and transparency in the market. https://eur-lex.europa.eu/eli/reg_del/2023/2465/oj/eng - Commission Delegated Regulation (EU) 2464/2023 of 17 August 2023 amending Regulation (EU) No 1308/2013 of the European Parliament and of the Council, as regards marketing standards for eggs. https://eur-lex.europa.eu/eli/reg_del/2023/2464/oj - Commission Implementing Regulation (EU) 2466/2023 of 17 August 2023 laying down rules for the application of Regulation (EU) No 1308/2013 of the European Parliament and of the Council as regards marketing standards for eggs. https://eur-lex.europa.eu/eli/reg/2023/02466/oj - Corrigendum to Commission Delegated Regulation (EU) 2023/2465 of 17 August 2023 supplementing Regulation (EU) No 1308/2013 of the European Parliament and of the Council as regards marketing standards for eggs, and repealing Commission Regulation (EC) No 589/2008 (Official Journal of the European Union L, 2023/2465, 8 November 2023). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023R2465R%2801%29 - Several private standards in France, such as: The Viandes et oeufs de France logo assures the consumer that the meat and eggs come from animals born, raised, slaughtered, cut, and processed in France. It also guarantees a production method that respects the environment, animal welfare and animals fed with a healthy and sustainable diet . Guaranteeing total traceability, as for all French production, the Viandes et oeufs de France logo meets rigorous health standards. https://www.tests-et-bons-plans.fr/conso-reperer-les-logos-des-viandes-francaises-dans-l-alimentation.html - IKB Ei IKB stands for Integral Chain Control, and is a private quality system for all links in the poultry sector. The entire egg chain is controlled. The following guarantees are included in IKB Ei: • All links in the production column must meet the IKB requirements.

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	• The participant needs to adhere to all legal and extra-legal requirements in the areas of hygiene, food safety, animal welfare, and trade standards. • The participant guarantees traceability and transparency, by recording information about the supply and disposal of eggs and animals. Participants are also required to stamp their eggs before leaving the yard. https://ikbei.nl/overikbei/ - Danish organic 'Ø-logo' Danish producers are producing in accordance with the EU rules, as well going beyond it. The pullets used in organic production in Denmark must be raised under organic conditions and have access to a big outdoor area (2 m2 per pullet) from when they are 6 weeks old in the summer half of the year and from 9 weeks old in the winter half of the year. https://en.foedevarestyrelsen.dk/food/labelling-and-marketing-of-food/organic-food
	Survey - According to the survey results: a) A private standard entity, located in Germany, and focused on traceability labelling of eggs was mentioned by respondents – the KAT system. KAT is the supervisory body overseeing the origin and traceability of eggs from alternative poultry husbandry forms within Germany and neighbouring European countries. The basis of all KAT requirements are the guidelines and regulations laid down by the EU and egg marketing standards. However, the KAT criteria go beyond these, specifying the control and monitoring of eggs using types of husbandry and the strict recording of egg movements from the farm to the consumer. Under KAT there is a maximum limit on flock size, but permitted is to have several flocks in the same barn where they are separated by netting. https://www.was-steht-auf-dem-ei.de/en/kat-association/index.php
	Interviews - According to the interview results: a) The interviewees highlighted that traceability is required to ensure food safety, but it is also seen as a value-added component for customers, especially when it comes to demonstrating sustainability measures such as organic production, for example, or the origin of the raw material from a specific area. *"It [label] offers consumers a consistent and transparent way to recognise products that align with social and environmental responsibility, and animal welfare values"* (Interview 15). *"There has been customer pressure to make things clearer in the label"* (Interview 17).

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	"…the final consumer is guaranteed not only the information on the origin of the product, but also everything that has been controlled on it…" (Interview 3).
	Literature Review (not exhaustive) - Corallo, Angelo, Maria Elena Latino, Marta Menegoli, and Roberta Pizzi. (2021). "Assuring effectiveness in consumer-oriented traceability: Suggestions for food label design." *Agronomy,* 11(4), 613, pp. 1-17. https://www.mdpi.com/2073-4395/11/4/613 - Sayogo, Djoko Sigit, Holly Jarman, David F. Andersen, and Joanne Luciano. (2016). "Labeling, Certification, and Consumer Trust." In *Private Data and Public Value,* edited by Holly Jarman and Luis F. Luna-Reyes, 67-88. Switzerland: Springer, Cham. https://link.springer.com/chapter/10.1007/978-3-319-27823-0_4 - Chang, Min-Yen, Ching-Tzu Chao, and Han-Shen Chen. (2023). "Exploring the impact of human–animal connections and trust in labelling consumers' intentions to buy cage-free eggs: Findings from Taiwan." *Foods*, 12(17), 3310, pp. 1-16. https://www.mdpi.com/2304-8158/12/17/3310
Regulation 1308/2013	Category D - Presentation, labelling, packaging, marking, year of harvest. Public and private labelling standards are in alignment to ensure food safety, with the private standards providing additional information (production process, sustainability efforts, for example).

Source: Author, hypothesis template developed in the BREADCRUMB project (task 1.4).

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4. RELATIONSHIP BETWEEN FOOD MARKETING STANDARDS AND FOOD WASTE

4.1 Literature Review

A literature review on the relationship between food marketing standards and food waste highlights how standards contribute to and can also mitigate food waste. The literature specific to standards and mitigation, predominantly demonstrates how standards provide a level of harmonization and quality, garnering consumer trust and purchase of a product (Boutrif, 2003; Raak et al., 2017; Nes and Ciaian, 2021). Conversely, a plethora of studies focus on how current standards augment food waste, such as for example via strict production methods, aesthetic criteria, and date marking (Frieling et al., 2013; Gosh and Eriksson, 2019; Arnold, 2022; Kechagias et al., 2024; Pereira et al., 2024).

Standards that impose **strict substance and quantity level specifications** on fresh produce can significantly contribute to food waste. Although food safety is paramount and cannot be compromised at any stage, standards that implement requirements that go beyond the baseline safety standards set by national governments (i.e. public standards) can augment food waste. Cicatiello et al. (2016) found that overly stringent regulations in retail, such as those concerning pesticide residues, often lead to product rejections, thus contributing to food waste. Private standards, which add on more requirements than the legally mandated public ones, can increase food waste, particularly in countries where the cost of technological innovations and certifications is high (Trienekens & Zuurbier, 2008; Hobbs, 2010; Wouters & Geraets, 2012). Eco-standards, including organic certifications, are also examples. They can contribute to food waste due to their strict production methods or farming. Products that do not meet these rigorous criteria, even if safe and nutritious, may be discarded or deemed unsuitable for sale (Göbel, 2015; de Hooge, 2018; Cicatiello et al., 2016).

Standards focusing on **aesthetic criteria, such as size, color, and shape**, also lead to rejection of the products even though they are safe to consume (Raak et al., 2017). Porter et al. (2018) highlight how cosmetic standards in Europe and the U.K. led to avoidable food waste during production, particularly for fresh fruits and vegetables. Similar findings by Gillman et al. (2019) and Johnson et al. (2019) emphasize that strict quality standards influence harvest decisions and cause considerable food waste on farms. The pressure on suppliers to meet these stringent standards might result in **overproduction** as producers try to ensure they meet retailers' expectations, thereby exacerbating food waste. This is compounded by growing **consumer demand** for aesthetically perfect produce, further tightening retail specifications and exacerbating food waste (Mena et al., 2014; Jeswani et al., 2021). Bilska et al. (2018) conducted a case study in a Polish supermarket highlighting how non-conformance to cosmetic standards resulted in substantial waste of fruits and vegetables deemed unsatisfactory for consumers. Similarly, de Hooge et al. (2018) emphasize the implications of these specifications, pointing out that supply chain practices often prioritize aesthetic qualities over food usability, leading to increased waste. Horoś and Ruppenthal (2021) provide insights from grocery retail owners, who recognize the challenges posed by consumer expectations for visually perfect products, further reinforcing the notion that demanding cosmetic standards contribute to food waste. In the **meat sector** consumer and retailer expectations also play key roles. Lebret (2021) discusses how variability in meat cut sizes, juiciness of the meat, nutrient composition, as well as other attributes, can augment food waste in the retail environment. Similarly, in the **fish sector** food marketing standards related to minimum size requirements of the fish, contribute to food waste (Storup, 2016; Hedley & Catchpole, 2015; Gasco, 2018). Garske et al. (2020) argue that by improving the regulation for selectivity of the sizing for fish, food waste can be mitigated.

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Priefer et al. (2016) identify that excessive production levels - such as what can happen in order to meet strict aesthetic requirements - often leads to **overstocking**, particularly among private labels, as they are not distributed effectively across different markets. The overproduction of supermarket own brands that cannot be sold elsewhere is a significant contributor to food waste. This issue is exacerbated by the **short shelf life** of perishable items, which results in products being discarded once they approach their **'best before' or 'sell by' dates** (de Steur et al., 2016). There is **consumer confusion** around food expiration dates (Patra et al., 2022). Moreover, consumer confusion regarding product labelling affects purchasing decisions, as shoppers often avoid items close to their expiration dates, perceiving them as less fresh (Calvo-Porral et al., 2017).

Aesthetic requirements not only contribute to inefficiencies throughout the supply chain, (from production to retail) resulting in food waste, but are **environmentally costly,** as discussed in Messner et al. (2021). Wunderlich and Martinez (2018) also discuss the importance of addressing cosmetic standards to conserve natural resources throughout the food supply chain, indicating that reducing food waste can significantly impact environmental sustainability.

Although not related to a specific standard per se, the literature review also demonstrates that **effective management of supply chains** is crucial in the fight against food waste. Ineffective forecasting leads to uncertainties in demand and subsequently affects inventory levels, contributing to overstocking (Tromp et al., 2016). Buzby et al. (2015) highlight that a considerable amount of fresh produce is lost in U.S. supermarkets due to the uncertainty surrounding demand and inventory management practices, leading to the stocking of products with varied expiration dates. Inefficient inventory management and inadequate demand forecasting further complicate the situation, as Mena et al. (2011) illustrate that these factors contribute to excessive unsold inventory.

4.2 Evidence from the Inventory

4.2.1 Public food marketing standards

The OECD, CODEX Alimentarius, and UNECE standards are not technically legally binding but have become a foundation of many mandatory standards. The main goal of the OECD, CODEX Alimentarius and UNECE standards is trade facilitation, especially internationally. Given this aim, these standards focus on providing a set of rules to drive down transaction costs by ensuring the transparency of market exchange and being reflective of the perceived consumer preferences (Mattsson 2015). Generally, these standards contain (a) a definition or description of the product; (b) minimum requirements focusing on the product being clean, free of pests, sound, and free of foreign matters and odours; (c) quality requirements, e.g. damage tolerance, size, shape, colour, other characteristics particular to the products (such as length of the stem, cut shape, colouration of certain parts); (d) packaging, labelling, marking and presentation.

To a certain extent, public standards such as those of the OECD, CODEX Alimentarius and UNECE standards help to **prevent food waste by guaranteeing a certain level of quality harmonisation across all products, facilitating trade and, ultimately, purchase of the product.** Public standards, particularly when inconsistent across countries, can potentially result in food waste when products fail to meet the regulatory requirements of a destination market. Internationally recognised food standards help to ensure that food products meet safety criteria, reduce the risk of spoilage during transportation and storage, and improve handling practices (Raak et al., 2017). Public standards can also guide national governments in developing integrated food control systems, which help to prevent food waste due to ineffective management (Hathaway, 2013).

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These standards, however, **can have adverse effects on food waste generation**. For instance, the **lack of a unified cross-country labelling system** referring to food expiration dates may lead to food waste. CODEX Alimentarius recommends using two types of date labels on food products to differentiate between safety and quality. The 'best-before' date indicates when a food will likely maintain its optimal taste and nutritional value while properly stored, whereas the 'use-by' date is used for perishable items that might become a health risk shortly after their production. Misunderstanding between these two types of labels leads consumers to unnecessarily discard food, thinking it has spoiled or lost quality. (Wilson et al., 2017; Kavanaugh et al., 2020).

More specifically, the standards contain requirements for several classes of produce based on their quality ('Extra' – for some products, 'Class I' and 'Class II') with the requirements focused on appearance (firmness, colour, visible defects), with the higher classes being increasingly more stringent. This focus on a **strict hierarchical classification** based, at least partially, on **appearance** can cause safe, nutritious produce to be discarded. In addition, calls for **uniformity** in size, shape, and appearance within the same package mean that items that do not conform to these uniformity standards may be rejected despite being perfectly safe for consumption. For example, the UNECE standard FFV-15, divides cucumbers into 3 classes. Classes 'Extra' and 'Class I' must be uniform in size and "practically straight", with strict limits on curvature. 'Class II' cucumbers are allowed the highest number of 'defects' such as crookedness and colour variations. However, even within 'Class II' strict rules are imposed in terms of the defects allowed: "Crooked cucumbers having a height of the inner arc of more than 20 mm per 10 cm of length are allowed, provided they have no more than slight defects in colouring and have no defects or deformation other than crookedness, and are separately packed" (UNECE standard FFV-15, 2023, section 'B', p.4). The CODEX standard for green asparagus prescribes that Extra Class asparagus must be "very well formed and practically straight" with tips that are "very compact", and the asparagus be green for at least 95% of its length, and Class II asparagus must be green for at least 60% of its length and have shoots that are "more curved" (CODEX STAN 225-2001, p.1-2). The UNECE standard for berry fruits stipulates that in Extra Class and Class I, bilberries and blueberries must be "practically free of agglomerated berries" (UNECE standard FFV-57, 2023, section 'C', p.4) (berries stuck together) while agglomerated berries are safe to consume. The Extra Class pineapples must have a "single and straight crown with no side-shoots" (UNECE standard FFV-49, 2021, section 'C', p.4). Similarly, the OECD standard for plums in Class II allows some shape irregularities, but these must not go beyond a certain limit, which means that produce with significant but harmless irregularities could be rejected. Oversized fruits are also prohibited (International Standards for Fruit and Vegetables PLUMS, 2021).

When it comes to uniformity, for artichokes, for instance, the size variation within a package must not exceed 1.5 cm for artichokes with diameters between 6 cm and under 9 cm and 2 cm for artichokes with diameters of 9 cm or more. If the size variation within a package exceeds the allowed limits, safe artichokes can be rejected (UNECE standard FFV-03, part III, p.4). For tomatoes sized by diameter, the size range must not exceed 10 mm for small tomatoes and 15–20 mm for larger ones (UNECE standard FFV-36, part III, p.5). Similarly, CODEX Alimentarius's standard for oranges determines the maximum difference between fruits in a package allowed (CODEX STAN 245, p.3). Even though the size does not impact the safety or taste of products in the package, those that fall outside these uniform size ranges may be rejected.

Given that food waste prevention is not the main goal of these standards, but rather trade, these standards may help to prevent food waste by guaranteeing quality harmonisation across products, facilitating trade and purchase. However, they also contain certain provisions that can potentially lead to a part of the produce being wasted (Arnold, 2022). The above examples of the public OECD, CODEX Alimentarius and UNECE standards enhance the message that uniform and ideally shaped products are the necessary quality and norm. Those foods that do not meet these standards run the

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danger of being deemed by consumers as not of high enough quality. Many consumers hesitate to choose such “suboptimal” foods (Barbe et al., 2017; Symmank et al., 2018).

4.2.2 Private food marketing standards

Public standards can also be incorporated into private standards, where the requirements for the size, weight, calibre may be even more stringent (Hooge et al., 2018). There are several examples of this in the compiled inventory, particularly downstream in the supply chain at the retailer and wholesaler level. A key focus for retailers and wholesalers is **maintaining and enhancing reputation**, which leads them **to impose higher-than-government (public) standards** for food quality and safety. Evident from the inventory, stringent certification and compliance processes can relate to an array of subjects such as environmental and animal welfare, traceability systems, and third-party audits. As higher standards in such areas are implemented to respond to civil society and consumer wants, the stricter requirements are thrust upon suppliers, which can lead to more food being discarded if the food does not meet these evolving standards (Fulponi, 2006; Hobbs, 2010). Additionally, the existence of mega-trends in the marketplace, such as the growing desire for out-of-season goods, is largely beyond the control of individual companies. These **shifts in consumer behaviour** create challenges for suppliers and retailers, as they necessitate the constant availability of perishable products, which are more susceptible to spoilage. **Seasonal variations** in supply and demand further complicate the situation, as retailers often face mismatches between what is available and what consumers want (Mena et al., 2011).

The power imbalance between retailers and suppliers is a major factor in this situation. **Suppliers often lack the bargaining power** to negotiate better terms with dominant retailers, leading to a cycle where overproduction is encouraged, and excess, unsold inventory is discarded, driving up food waste (Devin et al., 2016; Ghosh & Eriksson, 2019). As a result, many harvested products that fall below these standards are discarded or redirected for other uses, like animal feed that provides less revenue or donations. Additionally, adherence to strict standards **leads to the truncation of the distribution of available produce**. Retailers may only sell the portion of a farm's production that meets the high retail quality standards, while other products not meeting the standards, yet perfectly edible, are excluded from the market (Richards & Hamilton, 2019). Shelf space can be limited and expensive, so **retailers prioritise products that will sell quickly, leaving little room for imperfect produce**. Organic products are also typically **priced at a premium,** and when these higher prices deter customers, unsold goods are left on the shelves and eventually discarded. The higher price of organic products, requires a stronger demand to sell at the same rate as conventional products (Eriksson et al., 2014).

One of the main drivers of food waste at the retail level is **overstocking**, which arises from the challenge of managing unpredictable and seasonal demand, combined with supermarkets' efforts to meet customer expectations for high on-shelf availability. Retailers may expand their product assortments to offer customers a **broad selection**, which increases the complexity of managing inventories. **Inventory replenishment** on its part is frequently automated, which can lead to excess stock and higher waste levels. At the same time, common **strategies for managing excess stock**, such as price discounts or donations, are reactive and not efficient for food waste prevention, while a more proactive approach to forecasting demand, tailoring assortment planning, and adjusting replenishment processes can significantly reduce food waste (Riesenegger & Hübner, 2022).

According to the inventory results, the organic sector is a good example where private standards on organic food implemented by entities such as individual retailers and non-government entities exceed mandatory public standard requirements, leading to the rejection of produce that does not meet these heightened expectations. Private organic standards can significantly exceed the EU

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requirements (Regulation 2018/848 - “Organic” regulation) in a number of ways, such as allowed processes, substances used, and number of audits. This can result in waste, as non-compliant produce is discarded, even when it is still fit for consumption (Patel & Woodward, 2007). Moreover, generally the requirements in organic production limit certain substances, such as preservatives for example, which can lead them to **spoil faster**, which increases the likelihood of waste if not sold quickly. Organic food is particularly vulnerable, as it is often more sensitive to temperature and humidity changes (Cicatiello et al., 2016). Mismanagement in the supply chain, such as **inefficient transportation, handling, and storage,** can also contribute to waste.

4.3 Evidence from the Survey

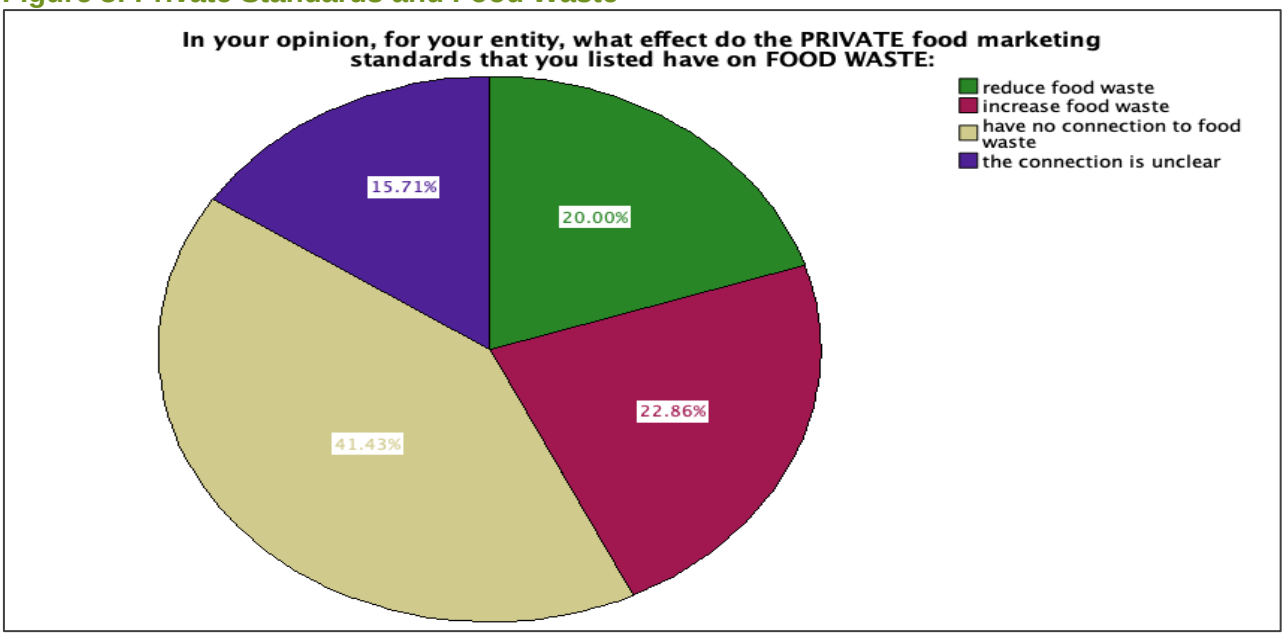
4.3.1 Private food marketing standards and food waste

Respondents were asked to evaluate how **private food marketing standards** adhered to by their organization / entity impacts food waste. The results showed that **20%** of the standards were seen as **reducing food waste,** while a similar proportion, **22.86%,** were viewed as **contributing to food waste.** Interestingly, nearly half of the standards (**41.43%)** were perceived as having **no impact on food waste**, and for **15%** the connection was considered **unclear.**

Table 9: Private Standards and Food Waste	Number of Standards (N)	Percentage (%)
Reduce food waste	14	20.00%
Increase food waste	**16**	**22.86%**
Have no connection to food waste	**29**	**41.43%**
The connection is unclear	11	15.71%

Source: Results of the survey on food marketing standards within the BREADCRUMB project (WP1).

Figure 8: Private Standards and Food Waste



Source: Results of the survey on food marketing standards within the BREADCRUMB project (WP1).

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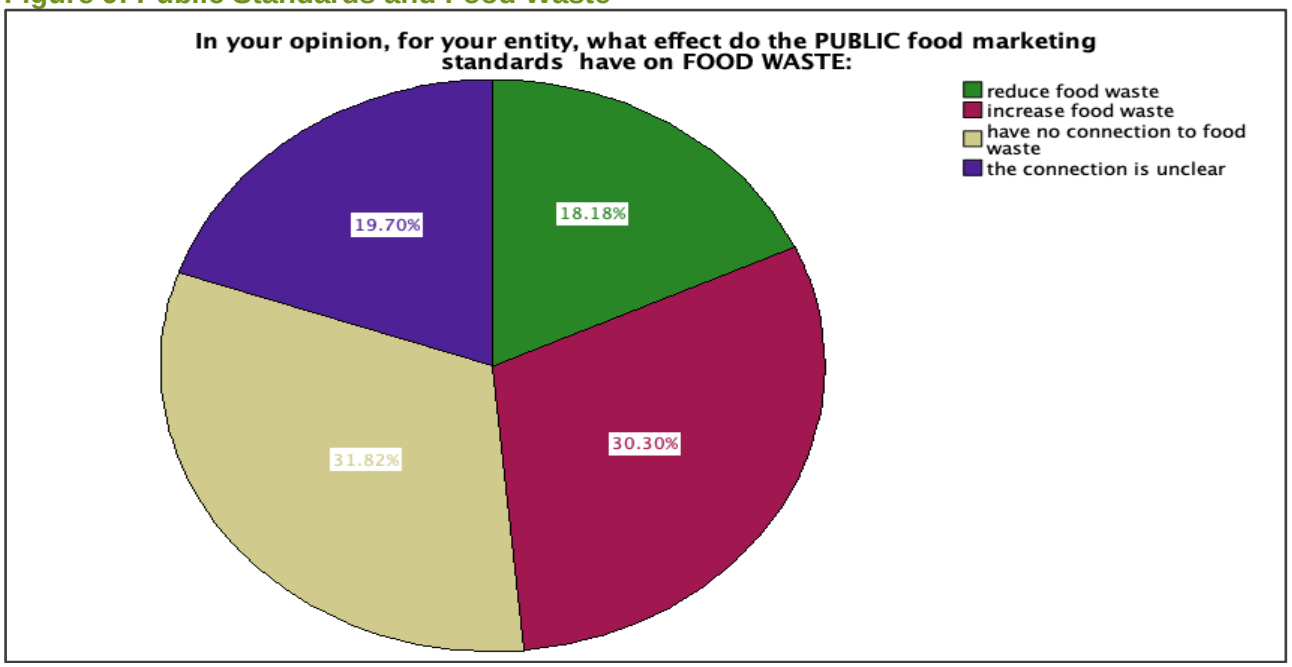
4.3.2 Public food marketing standards and food waste

For **public food marketing standards**, the situation is different from that pertaining to private standards. While a significant portion of responses still indicated that the connection between public standards and food waste is **unclear (19.70%),** with a **similar share (18.18%)** viewing these standards as **reducing food waste**, **a higher proportion of public standards** were perceived as **contributing to food waste (30.30%**). Fewer respondents **(31.82%)** viewed these standards as having **no connection** to food waste.

Table 10: Public Standards and Food Waste	Number of Standards (N)	Percentage (%)
Reduce food waste	14	18.18%
Increase food waste	**16**	**30.30%**
Have no connection to food waste	**29**	**31.82%**
The connection is unclear	11	19.07%

Source: Results of the survey on food marketing standards within the BREADCRUMB project (WP1).

Figure 9: Public Standards and Food Waste



Source: Results of the survey on food marketing standards within the BREADCRUMB project (WP1).

4.3.3 Private vs. public food marketing standards and food waste

Respondents were asked about the effect of private and public standards on food waste. To compare their responses quantitatively, the answers were recoded as continuous variables. The goal was to assess the relationship between reducing and increasing food waste while treating other categories as less significant. The variable was recoded as follows: -1 for reducing food waste, 1 for increasing food waste, and 0 for the remaining categories. The analysis, controlling for commodity type, shows that public standards adhered to by respondent entities have a stronger effect on increasing food waste compared to private standards ($F(1, 50) = 6.71$, $p = .013$, $\eta^2 = .12$). Both means were above

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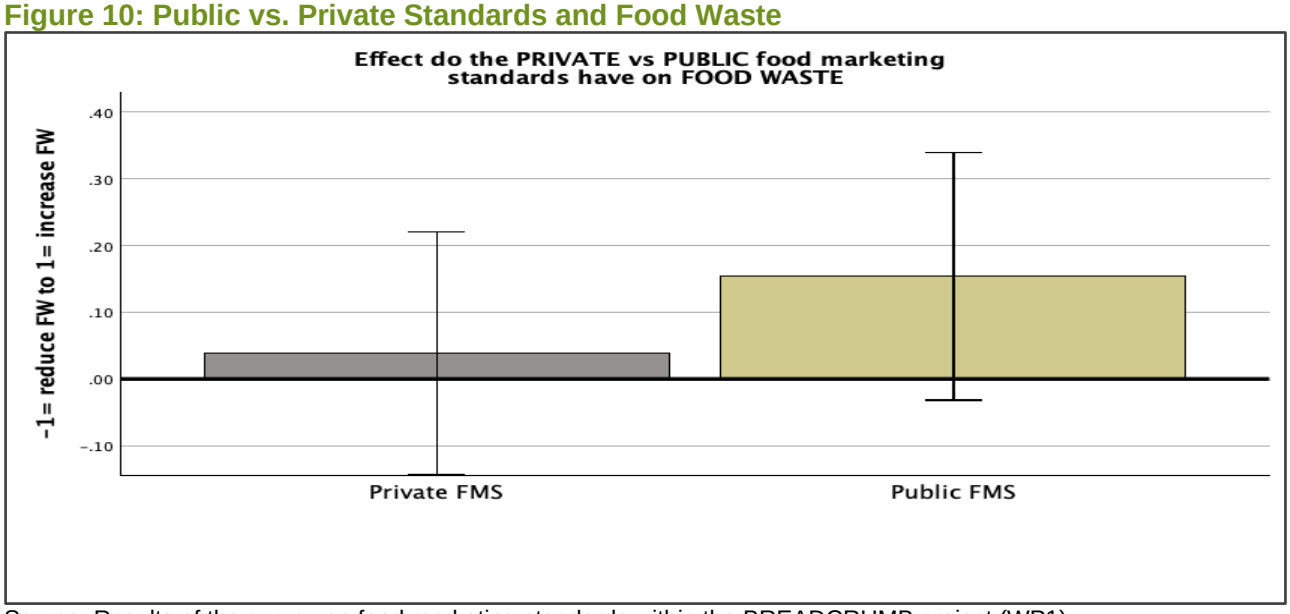
zero (Private Standards: *M* = 0.04, *SD* = *0.66*; Public Standards: *M* = 0.15, *SD* = 0.70), indicating that both types of standards generally contributed to increasing food waste. However, the impact of public standards was significantly greater. This effect is notable when excluding the "no connection" and "unclear" categories, as these were the most frequent.

Figure 10: Public vs. Private Standards and Food Waste



Source: Results of the survey on food marketing standards within the BREADCRUMB project (WP1).

Private and public food marketing standards have a **dual impact on food waste**—both contributing to its **reduction** and, in some cases, inadvertently **increasing** it. This dynamic is shaped by the focus, objectives, and level of flexibility of these standards.

Private food marketing standards listed by respondents were mainly about: how to meet **commercial and consumer-driven needs**, focusing on **quality, freshness,** and **distribution efficiency**. These standards ensure that products meet consumer expectations, often emphasizing factors like appearance, size, and ripeness. Private standards promoting freshness and local production align consumer demand with the supply of aesthetically pleasing and ripe products. This helps reduce waste by ensuring that products meet consumer expectations, leading to higher consumption rates and less spoilage at the retail level. Examples of private standards that contribute to **minimizing food waste** include:

- **Commercial Distribution Standard**: Efficient distribution systems minimize losses during transportation and storage, reducing spoilage and waste.
- **Fishermen's Guilds**: Encourages responsible fishing practices, ensuring that fish caught meet quality standards, thus reducing unnecessary waste.
- **Conditioned Byproduct**: This standard suggests repurposing or processing by-products, preventing waste by creating new products from surplus materials.
- **Quality Standards:** Ensuring high standards of freshness and taste can lead to lower waste rates due to less spoilage or consumer rejection.

According to the survey results, there were several private standards found to **increase food waste**, particularly those focusing on aesthetics, size, or specific consumer demands. A strict focus on aesthetic perfection in fruits and vegetables leads to the discarding of "ugly" produce, despite its being perfectly edible. Examples from the survey include:

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- **Cut Specification and Cosmetic Standards**: Private standards for specific sizes or appearance can lead to high trim waste and the rejection of perfectly edible, but visually imperfect, produce. For example, non-standard-sized vegetables may be discarded before even reaching retail shelves.
- **Overstocking and Shelf Life**: Short shelf-life products that are overstocked can go unsold, leading to spoilage and waste once they expire.
- **Customer-Specific and Retail Chain Standards**: High specifications set by customers and large retailers may result in food being rejected if it does not meet exact standards, even if the product is safe and consumable.

It seems that public food marketing standards are typically designed with **broader societal goals**, focusing on sustainability, safety, and food security. These standards often address food waste through initiatives that promote efficient resource use and the redistribution of surplus products. Such public policies effectively reduce waste while addressing hunger and social inequality. Respondents listed the following as mitigating food waste:

- **EU Marketing Standards**: Emphasize best practices for product handling, reducing spoilage during distribution by ensuring quality and safety.
- **Reusable Packaging**: Promotes sustainability through packaging that can be reused, which directly cuts down on material waste and indirectly reduces food waste by preserving product quality.
- **Donations for Social Solidarity (Law No. 62/2021 in Portugal)**: Encourages the redistribution of surplus food to reduce waste and combat food insecurity by redirecting excess food to those in need.

Despite the positive intent, according to the respondents' opinions, some public standards can also **contribute to food waste**, particularly when they are **overly rigid** or **misapplied**. Examples provided in the survey include:

- **Seizing and Disposal Regulations**: Public standards that dictate the seizure of products deemed unfit for sale can lead to unnecessary waste, especially if the criteria are too stringent.
- **Marketing Standards for Organic Products**: Standards can lead to increased waste when products don't meet specific ingredient and substance level requirements and are therefore discarded, even if they are safe to consume.

Private food marketing standards listed by respondents are often driven by **market demand and consumer preferences** and, therefore, tend to focus heavily on quality, freshness, and appearance. While they help ensure that products reach consumers in optimal condition, the aesthetic and size requirements of private standards can lead to a significant increase in **waste**, particularly in production and retail. **Public food marketing standards** are more likely to emphasize **sustainability and safety**. Although they can contribute positively to food waste reduction through initiatives like food donations and packaging reuse, public standards can also **increase waste** via overly rigid regulations that lead to the disposal of safe, consumable products. Private and public standards are **interconnected**, with both playing a role in shaping food waste outcomes. Private standards can complement public goals by improving distribution efficiency and promoting product repurposing, but they can also exacerbate waste through rigid criteria. Public standards, while focused on safety and sustainability, can also inadvertently increase waste due to strict compliance requirements.

The survey results revealed that public standards have a significantly higher negative impact on food waste, meaning that they contribute to its increase more than private standards do. However, it is

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important to emphasize that in some cases, food waste may not have been a primary measure for these entities, and even if it was, it might not have aligned with the specific standards required to accurately assess the impact of a single standard. When an entity adheres to only one or two standards, it is relatively straightforward to evaluate their impact on food waste. In contrast, adhering to multiple regulations simultaneously complicates this assessment, as each standard can have different effects on food waste. The results indicate that there still is much to learn about the nuances of the connection between food marketing standards - whether public or private – and food waste.

4.4 Evidence from the Interviews

4.4.1 The importance of addressing food waste

There were a number of reasons (including environmental and social concerns) that were evident from interview discussions in terms of why it was important to address food waste. However, there was a recurring factor for all interviewees across all stages of the supply chain - the **economic repercussions**. The majority of interviewees represented commercial enterprises. A key objective of any commercial enterprise is to generate revenue to ensure coverage for the costs of business operations. However, the interview results demonstrated that revenue is directly connected to the overall environment of operation, and this includes taking into account **social and environmental sustainability** in order to ensure fiscal soundness and longevity. It is within this context that food waste was spoken of in the interviews. One interviewee poignantly highlighted that environmental, social, and economic practices are all intertwined and therefore, each one is as important as the other and relevant for the healthy functioning of any entity. There were also non-commercial enterprises participating in the interviews – such as food banks, environmental non-governmental organizations (NGOs), and consumer organizations. While not as much emphasis was placed on the economic repercussions of food waste in the interviews with these entities, the issue was still evident, particularly in terms of how addressing food waste not only has positive social and environmental repercussions but essentially makes economic sense – whether that be a company not spending money on costly disposal requirements, or a family ensuring that the money spent on food is indeed for food that is consumed and not thrown away. The interview discussions demonstrated that the importance of addressing food waste is acknowledged by food chain actors, and while the economic impact of food waste is key, it is also directly linked to sustainability.

The importance of addressing economic, as well as social and environmental factors (including food waste), was evident when interviewees were asked to “rank” how important it was for them that their suppliers maintain practices to ensure economic, social, and environmental sustainability. There were 19 interviewees who worked with suppliers and 12 interviewees who were not working with suppliers (i.e., 6 entities active solely in primary production, 4 consumer entities, 1 food bank, 1 NGO). Out of the 19 interviewees working with suppliers, 11 of them provided answers which ranked the importance of their suppliers adhering to economic factors (such as pricing), environmental practices, social sustainability practices, and food waste reduction practices on a scale from one to ten. The remaining respondents, while not providing answers specifically for the ranking, did elaborate on what the entity they were representing was doing in terms of addressing sustainability and food waste, such as valorisation and food donation efforts.

Respondents working with suppliers were asked to rank how relevant environmental, social sustainability, and food waste reduction practices were in comparison with economic factors. The ranking was on a scale of 1 to 10, with 1 being indicative of solely economic factors being relevant, and 10 being indicative of solely environmental factors, social sustainability, or food waste reduction practices being relevant. Out of the 19 interviewees working with suppliers, 11 of them provided answers summarised in table 11. There were 5 interviewees (interviewees # 2, 16, 17, 19 and 20)

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who consistently provided a ranking greater than 5, meaning that they **viewed environmental, social sustainability, and food waste reduction practices as more relevant for their entity than economic ones**. There was one interviewee (in the fish sector) who consistently provided a ranking of 5 for all practices when compared to economic factors, meaning that striking a balance was seen as key.

Table 11: Environmental, social sustainability, and food waste reduction practices compared to economic factors

Interview Number	Commodity Category	Supply Chain Stage	Economic vs. environmental practices (Scale 1-10)	Economic vs. social sustainability practices (Scale 1-10)	Economic vs. food waste reduction practices (Scale 1-10)
9	All commodities	Retail and Distribution (including wholesale) / Wholesaler	7	6	4
18	All commodities	Retail and Distribution (including wholesale) and Food Services	5	4	4
19	All commodities	Food Services	7	6	9
21	All commodities	Retail and Distribution (including wholesale) / Distribution	4	5	7
2	Fish	Retail and Distribution (including wholesale) / Distribution	10	10	10
4	Fish	Retail and Distribution (including wholesale) / Retail	5	5	5
6	Fruits and Vegetables	Primary Production and Processing & Manufacturing	3	10	N/P*
16	Fruits and Vegetables	Primary Production and Processing & Manufacturing	7	7	9

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17	Fruits and Vegetables	Primary Production and Processing & Manufacturing	10	9	10
20	Fruits and vegetables	Processing & Manufacturing	8	6	6
29	Fruits and Vegetables, Meat, Fish	Retail and Distribution (including wholesale) / Distribution	N/P*	2	N/P*

Source: Results based on data obtained from interviews within the BREADCRUMB project (WP1).
*N/P = Not provided

4.4.2 What is being done with surplus food?

The interviews highlighted that a variety of different efforts are taking place to utilize surplus food so that it does not become food waste. Surplus food is defined as food that does not meet a standard's criteria but is still safe to consume, and therefore, a new market for the food needs to be found. The majority of interviewees (23 out of 31) indicated that products which do not fulfil the food marketing specifications are still utilized in a particular capacity – namely **donated**, **valorised,** or **sold at a discounted rate**. Donations to charities and food banks (mentioned by 10 interviewees) took place primarily in the primary production, retail and distribution, and food services stages of the supply chain. Based on the interviews, valorisation efforts (mentioned by 9 interviewees) primarily took place in the fruits and vegetables, and fish sectors. In the case of fish, feed was made, and for fruits and vegetables they were processed into jams, juices, and purees. All interviewees, except for 2 of them, replied in the affirmative that they considered valorisation as a viable option for surplus food. However, interview discussions highlighted the cost that comes with valorisation, such as additional knowledge, skills, and technology, and in this respect, valorisation was an opportunity but also a challenge. Another activity interviewees engaged in to address surplus food was searching for alternative markets, which involved selling the food at a discounted rate. Due to not meeting all the requirements within a standard, the food is subsequently downgraded to a lower category, which affects how the product can be further utilized (i.e., such as valorised for feed) and its selling price. Online market platforms and apps were mentioned in the interviews as part of a systematic effort to sell surplus food.

In addition to the above-mentioned activities to utilize surplus food, the interviews shed light on several practices being implemented which mitigate food waste while still maintaining compliance with the standards. In the food services sector, **freezing** certain ingredients was mentioned as a possibility to keep them fresh longer. In the retail sector, one interviewee outlined a program in their stores where they collect food that is nearing its expiry date and sell that food (in those boxes) at a discounted rate. Another example was to **make visible** to consumers, via a coloured sticker,items in the store that would soon expire and, therefore, were being sold for a reduced price. Interviewees representing not only retail, but also those in the processing and manufacturing, and food services sectors noted the importance that they place on **managing the logistical processes in the supply chain** – and that it was key to mitigate food waste. The logistical processes were particularly important for more vulnerable products such as fruits and vegetables, fish, meat - all of which have a specific life-span - and frozen foods which need to be correctly transported and stored within a particular temperature range so that they do not defrost. One interviewee provided an example about how more careful bundling and packaging can help mitigate food waste. *"…the radish is usually*

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washed to get the soil residue off the radish. The radish bulb can withstand this perfectly, but the leaf may not because of the hard jet water. Then the leaf has a hole, and the radish is discarded. That's just incredibly unnecessary" (Interview 8). There usually is a certain level of demand uncertainty for every product, but entities – in particular those further downstream in the supply chain - wanted to ensure product availability in order to capture the market. There are specific methods of analyses that can help a company to better gauge demand. **Forecasting** is, of course, key, as is building on data available regarding the quantity of items ordered and sold per year. Additionally, it needs to be taken into account if the product is seasonal or if external factors such as regularly occurring climatic conditions (rainy season for example) may or may not force a product to be in high demand for a certain period of time. To achieve this, **communication among supply chain actors** is vital. As one interviewee noted, *"Good communication with our suppliers is a good food waste mitigation practice"* (Interviews 19).

Interview results also highlighted efforts at the international and national member-state levels to address food waste. The **UNECE Code of Good Practice** provides guidance to the food sector on how to reduce losses and waste. First developed and adopted by the UNECE Working Party on Agricultural Quality Standards in 2019, the second edition of the Code of Good Practice has been expanded with a chapter on transportation and revised to better take into account challenges faced in developing and transition economies, such as lack of cooling facilities or sorting equipment. Though it is focused on fresh fruit and vegetable supply chains, the UNECE Code of Good Practice complements the **Voluntary Code of Conduct (CoC) for Food Loss and Waste (FLW) Reduction** developed by the Food and Agriculture Organization of the United Nations (FAO), which was endorsed at the 42nd Session of the FAO conference in June 2021. The FAO document establishes a framework of actions and guiding principles to reduce food loss and waste. Governments and independent entities can use the framework as a basis to develop interventions, projects, and policies to reduce FLW. An example was also given at the national level in Romania, where in 2016, Romania approved Law 217/2016 which required companies to donate or sell food at reduced prices that are close to an expiration date. In 2018 the law was further amended by Law 200/2018 and enforced by Government Decision 51/2019, requiring food sector businesses to take measures to prevent food waste – whether that be at the production, processing, storage, distribution, or retail and wholesale stages. Law 131/2020 provides fiscal incentives for food donations.

4.4.3 Food marketing standards and food waste

There were aspects within particular standards which interviewees highlighted that increased food waste, but also features of standards that mitigate food waste. It should be noted that throughout the interviews, food safety was consistently noted as an issue that could not be compromised.

- Shelf-life: The indicated shelf-life of the product relates to the expiry date indicated on the product. Several interviewees (4) noted that the "best before" date can be a source of confusion for consumers. The overall difficulty with the "best-by" date is often defining in concrete terms what it entails in terms of the quality and safety of a product. Instead of two dates, the suggestion was made by one interviewee that just one date should be sufficient, and that more resources should be devoted to exploring the safety margins for food. This is a challenge however, involving complex risk analysis as it also depends on packaging and how the food is transported and stored throughout the supply chain process. *"There is movement in the industry and manufacturers are keen to do something about it…the aim is to get away from the "best before" date and the "it is expired" mindset"* (Interview 7). If obliged to include the information, then manufacturers understandably don't want to take any risks and, therefore, may be rather conservative with dates put on the label, leading to food that is discarded while it could still be eaten.

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- Quality criteria: There are a number of different "quality" criteria included in standards, including size, colour, shape, weight, and firmness of a product. These are largely in relation to aesthetics and have little relevance to the nutritional value of the food. It was argued in several interviews that such criteria should more systematically take into account the seasonality of products. Instead, the standards are applied in the same way year-round and do not allow for deviation, thus restricting not only variety but also facilitating food waste. *"…we've often had situations where the farmer couldn't get rid of his potatoes because they were smaller than expected and weren't accepted by the retailer. And of course that's very bad for the supplier because their entire livelihood is based on it, but its's also terrible from a food waste perspective because it is actually food that could still be good to eat"* (Interview 10). A majority of the interviewees (19 out of 31) indicated that they believed product aesthetics affected consumers' purchasing decisions. Not only did aesthetically pleasing products capture consumers' attention, but they were also equated with higher quality and, therefore, more likely to be bought in the store. However, the ability to adhere to certain standards can come at a cost, particularly in the primary production, processing and manufacturing stages of the supply chain. At these stages, increased production margins to ensure that enough of the product meets all the standard's requirements is necessary, has to be carefully managed, and may result in over-production.

- Residues: Although EU legislation (Regulation (EC) 396/2005) establishes acceptable residue levels in food, it can be hard to implement if, at the same time a demand must be met for maximum sizes or weights of the produce, despite altering climatic conditions such as intense hot summers, drought, or excessive rainfall.[12] There were also examples within the interviews of residue levels being set at more stringent levels than what is legally required. For example, one of the interviewees noted, *"…the maximum residue level regulation specifies how many milligrams of a particular active substance is allowed. This is our basic standard. But it also involves a private standard where some say the regulation allows quantity x of the active substance, but we will allow 1/3 of that amount. The EU sets a requirement, but the private trade adds further specifications"* (Interview 5). Such specifications can be difficult to achieve, possibly resulting in food that is still legally safe but not being accepted by a private-level standard.

- Origin: There are some standards which not only require detailed evidence of where the product comes from, which necessitates time and expertise in traceability, to ensure that a product is not rejected for sale because of insufficient information about origin. Often traceability is required to ensure food safety, but it is also seen as a value-added component for customers, especially when it comes to demonstrating sustainability measures such as organic production, for example, or the origin of the raw material from a specific area.

Results from the interviews demonstrated that there are multiple food marketing standards that need to be adhered to simultaneously by food chain actors. Different markets can subject the same food commodity to varying marketing standards. The multiplicity element also extends to what is incorporated into the standard, in that a standard does not include just one factor but rather **multiple elements** such as appearance, environmental and social considerations, and food safety factors, for example, with all the factors needing to be achieved in order to adhere to one standard. This complex system can make it difficult to participate in the market without at least some food loss and waste during the production, processing and manufacturing stages in the supply chain.

[12] Regulation (EC) No. 396/2005 of the European Parliament and of the Council of 23 February 2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin and amending Council Directive 91/414/EEC Text with EEA relevance.
https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32005R0396

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There was a positive aspect of the standards noted by some interviewees in that the standards provide predictability. For actors further down the supply chain such, **predictability** helps in that they can plan ahead for how much of a produce they will receive, when, and its overall condition. As one interviewee in the food services sector noted, *"Compliance with these standards has certainly reduced the amount of waste as the raw materials supplied are of appropriate quality and we have been able to fully use them in the preparation of food"* (Interview 19). However, while predictability can be good for producers in that they know what they need to achieve during cultivation, at the primary production level such predictability can be hard to achieve resulting in more food waste. It is not uncommon for producers to produce more (increase production margins) to ensure they have enough quantity of a product that abides by the standard *"…in primary production it is different because generally the stricter the standard, the more food loss there will be on the field – i.e. over production to meet the strict criteria"* (Interview 16).

The importance of addressing food waste was evident based on the responses from interviewees, with economic, social, and environmental factors being taken into consideration. Clear efforts among the majority of interviewees are underway to utilize surplus food so that it does not become waste – donation, valorisation, or sale at a discounted rate. In addition, supply chain management (logistical practices, including forecasting) was noted as key in mitigating food waste. The logistical processes were particularly important for more vulnerable products such as fruits and vegetables, fish, meat - all of which have a specific life span. The interviews highlighted that there were standards that might propagate food waste – in particular, aesthetic criteria - influencing if a food product is accepted onto the market, is purchased, or is not accepted and, therefore, possibly results in food waste. However, there was also acknowledgement among the interviewees that standards can also mitigate food waste in that they provide predictability, which is also needed for the effective functioning of the market (such as avoid flooding of the market accompanied by excessive price reductions).

4.5 Gender Differences in Food Waste

Literature review has shown that gender significantly shapes consumer behavior, with men and women demonstrating **distinct patterns** in **food choices**, **purchasing habits**, and **waste management practices** (Buzby and Hyman, 2012). Women tend to be more concerned about health implications and sustainable consumption compared to men (Kanwal et al., 2022). Public food marketing standards, which dictate **shelf-life and freshness indicators**, can also influence waste behavior. In this respect, strict aesthetic standards can lead to the rejection of perfectly edible produce, particularly in fruits and vegetables, where women are often the primary purchasers and decision-makers (Zafar et al., 2022). Women are generally more receptive to marketing messages emphasizing **health and safety**, making them key targets for public and private standards (Aschemann-Witzel, 2018). Moreover, women often feel guilty about food waste, viewing it as a failure to manage the household, especially in households with children, where women prioritize family preferences over thrift and follow the norm of being a **good provider / good mother,** and this can lead to increased food waste (Cappellini and Parson, 2012; Graham-Rowe et al., 2014; Porpino, 2016; Lyndhurst, 2007; CHORIZO Project D2.3, 2024). However, it is important to emphasize that results indicating women waste more food could be an artifact of the fact that in most cases, they are primarily responsible for purchasing, cooking, storing, and other behaviours related to food consumption (Fraser & Parizeau, 2018; Brady et al., 2012; DeVault, 1991).

On the other hand, women are more likely to **engage in pro-environmental behaviours**, including conscientious food consumption and waste reduction efforts (Zelezny et al., 2000). Women generally prioritize **sustainability** and **ethical considerations** in their purchasing decisions, and tend to respond positively to private marketing standards that align with their values. For instance, as highlighted by Nemat (2000), packaging that emphasizes the environmental impact of food waste

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and encourages informed consumer choices can motivate women, who are generally more receptive to sustainability messages, to adopt practices that reduce food waste. Certifications emphasizing sustainability or ethical sourcing significantly influence their purchasing decisions, while men may not prioritize these standards as highly, resulting in different purchasing behaviors and waste patterns. Women are more likely to choose organic food products with eco-labels and certifications that indicate responsible sourcing and being concerned with the nutritional value of the food (Grunert, 2006; Cholette, 2003).

In sum, research on gender differences in food waste yields conflicting results, with some studies suggesting women waste less (Barr, 2007; Secondi et al., 2015; Cantaragiu, 2019) and others indicating the opposite (Silvennoinen et al., 2014; Visschers et al., 2016; Koivupuro et al., 2012; Buzby and Guthrie, 2002; Misiak et al., 2023). Women's roles in **food purchasing**, **preparation**, and **waste management**, coupled with **societal expectations** and **marketing influences**, contribute to these discrepancies. While women may be more prone to food waste due to societal pressures and marketing influences, they are also more likely to engage in pro-environmental behaviors and prioritize sustainability in their food choices.

4.6 Overview of Results

Research results pertaining to analysis of the inventory, literature review, the survey, and in-depth interviews highlight that both private and public standards shape food waste outcomes. The standards **can both mitigate and augment food waste**, depending on the supply chain stage and context within which they are being applied. The summary below highlights the main conclusions from this chapter.

Standards related to **quality criteria** – such as appearance, size, colour, shape – as well as specific ingredients used during production, and allowable quantities of a substance, all had the effect of augmenting food waste due to strict compliance requirements. Not adhering to the requirements may lead to rejection of the product by the buyer even though the food product is still safe to consume. In the upstream stages of the supply chain (such as production, processing and manufacturing), over-production and an increase in costs are not uncommon in order to ensure that enough quantity of a product abides by the standard requirements. While there may be other market options for any rejected food, such as donation, sale at a lower category and price, or valorisation, such initiatives are not a given and are highly dependent on the motivations and resources available to the entity that is left with surplus food.

Standards outlining **specific substances and allowable quantities** permitted during production, are normally necessary to ensure food safety, which can never be compromised. However, the research results provided examples where the allowable quantities of a particular substance, such as residue levels for example, were stricter than the legal limit. Such specifications can be difficult to achieve, resulting in food that is still legally safe, but not accepted for sale due to non-adherence with the strict requirement.

Management of these supply chains – transportation, storage, handling, temperature, and humidity – is key to ensure preservation for as long as possible, especially for more vulnerable products such as frozen foods, fruits and vegetables, fish, meat. Another key management topic highlighted in the research results was effective forecasting. Forecasting and building on previous data available regarding quantity of items ordered and sold per year, while taking into account seasonality of the product, as well as any regularly occurring external factors such as climatic conditions, influence if a product is to be in high demand over a set time period. Effective forecasting can prevent overstocking but necessitates systematic communication among supply chain actors.

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Conversely, keeping in mind that the main purpose of marketing standards is to facilitate the smooth functioning and trade in the supply chain, such stringent standards – whether it be in terms of aesthetics or type and amount of a substance / ingredient used during production - can also mitigate food waste because they provide **standardization** and **predictability,** facilitating purchase. There are examples, such as with organic products and environmental sustainability initiatives, where there is a strong consumer base buying specifically such products. The interview results demonstrated that trade and consequent revenue are key factors for food supply chain actors. However, these factors are also directly connected to the overall environment of operation which includes taking into account social and **environmental** sustainability in order to ensure fiscal soundness and longevity. **Environmental, social, and economic practices are all intertwined** and therefore each one is as important as the other and hence relevant and evident in many public and private standards.

Of note as well in this chapter is the role of gender when it comes to food waste. While research on the topic is minimal and conflicting with some studies suggesting women waste less than men, and other studies indicating the opposite, it is clear that food purchasing, preparation, and waste management, coupled with societal expectations and marketing influences are influencing factors on food waste levels. **Systematic inclusion of a gender dimension** into the discussions is key to providing a deeper understanding about the context, in terms of how food marketing standards are perceived and utilised by differing genders, and ultimately what effect this has on food waste generation and / or mitigation.

4.7 Hypotheses

Based on the research results, the following hypotheses have been developed on the relationship between food marketing standards and food waste. These hypotheses demonstrate a relationship that is indicative of standards augmenting food waste and of standards mitigating food waste. A summary of the hypothesis is provided, followed by a table to demonstrate what data was used and where it came from (i.e. inventory, survey, interviews, literature review) in order to draft the hypotheses. For this set of hypotheses, the table also includes a causal loop diagram to visually demonstrate the relationship between the standard and food waste. The data is not exhaustive since it is based solely on what was uncovered via the research done in the first work package.

4.7.1. Standards related to appearance and food waste

Hypothesis: Standards related to the appearance of a food product, in particular for fresh produce, put forth stringent requirements that must be adhered to, which either augment or mitigate food waste, depending on the supply chain stage.

Summary: The supply of aesthetically pleasing and ripe products helps to reduce waste by ensuring that products meet consumer expectations, leading to purchases and less spoilage at the retail level. However, the positive impact of predictability is not felt across the entire supply chain. While predictability is good for producers in that they know what they need to achieve during cultivation, at the primary production level such predictability can be hard to achieve resulting in more food waste. It is not uncommon for producers to produce more in order to ensure that they have enough quantity of a product that abides by the standard. There is a need to balance the retail / consumer expectations for high-quality and the need for predictability of the product, with constraints at the production level (over-production, increase in costs).

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Table 12: Standards Related to Appearance and Food Waste

Topic	Content
Hypothesis	Standards related to the appearance of a food product, in particular for fresh produce, put forth stringent requirements that must be adhered to, which either augment or mitigate food waste, depending on the supply chain stage: a) may encourage over-production (i.e. difficulty achieving the standard), possibly leading to surplus food and ultimately more food waste; b) may create consumer trust in the product and thereby encourage the purchase of the product, mitigating surplus food at the retail level, leading to less food waste.
Data collection points	**Inventory** - There are several examples in the inventory of private food marketing standards outlining necessary appearance characteristics. One example: A private label in Belgium is a quality label recognized in the Flemish food retail sector. It sets specific standards for fruits and vegetables, ensuring superior quality and freshness. Products bearing the label must meet stringent criteria, allowing producers to differentiate themselves in the market and providing consumers with assurance of high-quality produce. - Farmers must adhere to strict rules in terms of quality (appearance) and size. There are requirements regarding physical characteristics such as shape, colour, ripeness, and firmness. A product catalogue, available on-line for the private label in Belgium, outlines the label's requirements for fresh produce. Among those required of Belgian endives, for example, is that they have: • "a nicely closed top"; • "symmetrically shaped heads"; • "intact leaves firmly closing the head"; • "outer leaves must be at least up to ¾ of the head length"; • "no core abnormalities"; • "the cut end is unblemished and looks fresh". https://www.flandersfruitsandvegetables.com/sites/vlamfresh_fruit/files/publication/file/EN-Productcatalogus.pdf
	Survey - According to the survey results: a) Standards can have a dual impact on food waste – contributing to its reduction and in some cases inadvertently increasing it. This dynamic is shaped by the focus, objectives, and level of flexibility of these standards.

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	b) The supply of aesthetically pleasing and ripe products helps to ensure that products meet consumer expectations, leading to purchases and less spoilage at the retail level. c) A strict focus on aesthetic perfection in fruits and vegetables leads to the discarding of "ugly" produce despite it being perfectly edible. Retail chains may demand uniform appearance, causing significant food waste not only at the retail stage, but also upstream in the supply chain.
	Interviews - According to the interview results: a) There are a number of different "quality" criteria included in standards, including size, colour, shape, weight, and firmness of a product. These are largely in relation to aesthetics and have little relevance to the nutritional value of the food. It was argued in several interviews that such criteria should more systematically consider the seasonality of products. Instead, the standards are applied in the same way year-round and do not allow for deviation, thus restricting not only variety but also facilitating food waste. *"…we've often had situations where the farmer couldn't get rid of his potatoes because they were smaller than expected and weren't accepted by the retailer. And of course that's very bad for the supplier because their entire livelihood is based on it, but its's also terrible from a food waste perspective because it is actually food that could still be good to eat"* (Interview 10). b) A majority of the interviewees (19 out of 31) indicated that they believed product aesthetics affected consumers' purchasing decisions. Not only did aesthetically pleasing products capture consumers' attention, but they were also equated with a higher quality and therefore more likely to be bought in the store. c) There was a positive aspect of the standards noted by some interviewees in that the standards provide predictability. For actors further down the supply chain such predictability helps in that they can plan ahead for how much of a product they will receive, when, and in what overall condition. There was acknowledgement among interviewees that such standards can mitigate food waste in that they provide predictability downstream, which is needed for the effective functioning of the market. *"Compliance with these standards has certainly reduced the amount of waste as the raw materials supplied are of appropriate quality and we have been able to fully use them in the preparation of food."* (Interview 19). d) However, the positive impact of predictability is not felt across the entire supply chain. While predictability is good for producers in that they know what they need to achieve during cultivation, at the primary production level such predictability can be hard to achieve resulting in

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	more food waste. It is not uncommon for producers to produce more (increase production margins) to ensure they have enough quantity of a product that abides by the standard. The ability to adhere to certain standards can come at a cost, particularly in the primary production, and processing and manufacturing stages of the supply chain. At these stages, increased production margins to ensure that enough of the product meets all the standard's requirements is necessary, has to be carefully managed, and may result in over-production. *"…in primary production it is different because generally the stricter the standard, the more food loss there will be on the field – i.e. over production to meet the strict criteria"* (Interview 16).
	Literature review (not exhaustive) - Alina, Adam. (2015). "Drivers of Food Waste and Policy Responses to the Issue – The Role of Retailers in Food Supply Chains." IPE Working Papers 59/2015, *Berlin School of Economics and Law, Institute for International Political Economy (IPE).* https://ideas.repec.org/p/zbw/ipewps/592015.html - de Hooge, Ilona E., Eileen van Dulm, and Hans C.M. van Trijp. (2018). "Cosmetic specifications in the food waste issue: Supply chain considerations and practices concerning suboptimal food products." *Journal of Cleaner Production*, Volume 183, pp. 698-709. https://doi.org/10.1016/j.jclepro.2018.02.132 - Frieling, Dominik, Verena Stricks, Martin Wildenberg, and Felicitas Schneider. (2013). "The Beauty and the Beast – How Quality Management Criteria at Supermarkets Create Food Waste." *Environmental Science, Business, Agricultural and Food Sciences* http://conferences.chalmers.se/index.php/LCM/LCM2013/paper/download/724/338 https://www.semanticscholar.org/paper/THE-BEAUTY-AND-THE-BEAST-—-HOW-QUALITY-MANAGEMENT-Frieling-Stricks/64d05fabae1c95624b4bb6b878758697d1af25a7 - Ghosh, R., and M. Eriksson. (2019). "Food waste due to retail power in supply chains: Evidence from Sweden." *Global Food Security*, Volume 20, pp. 1-8. https://doi.org/10.1016/j.gfs.2018.10.002 - Herzberg, Ronja, Annika Trebbin, and Felicitas Schneider. (2023). "Product specification and business practices as food loss drivers – A case study of retailer's upstream fruit and vegetable supply chains." *Journal of Cleaner Production,* Volume 417, pp. 1-14. https://doi.org/10.1016/j.jclepro.2023.137940 - Johnson, Lisa K., J. Dara Bloom, Rebecca D. Dunning, Chris C. Gunter, Michael D. Boyette, and Nancy G. Creamer. (2019). "Farmer harvest decisions and vegetable loss in primary production." *Agricultural systems*, Volume 176, pp. 1-11.

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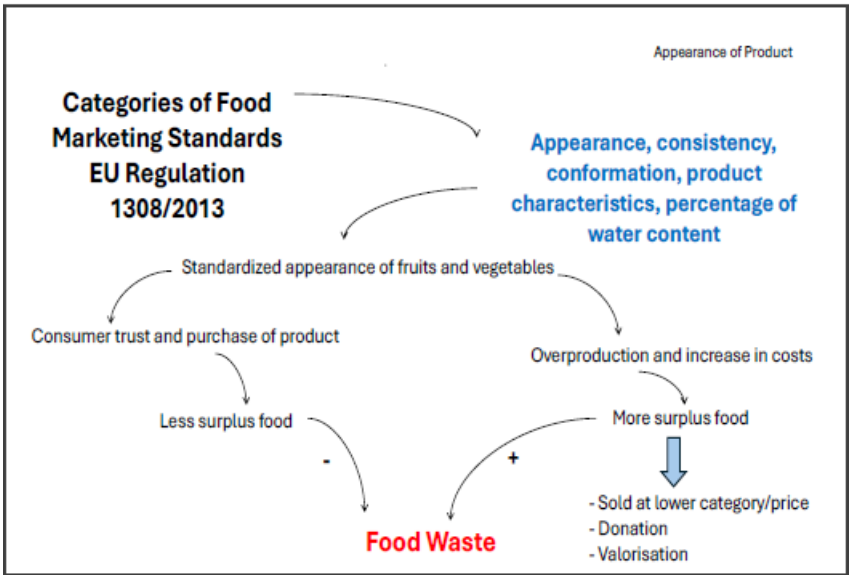
	https://doi.org/10.1016/j.agsy.2019.102672 - Mena, Carlos, B. Adenso-Diaz, and Oznur Yurt. (2011). "The causes of food waste in the supplier–retailer interface: Evidence from the UK and Spain." *Resources, Conservation and Recycling,* Volume 55, Issue 6, pp. 648-658. https://doi.org/10.1016/j.resconrec.2010.09.006 - Pereira, Camila, Vanessa Magalhaes, and Luis Ferreira. (2024). "The impact of marketing standards on producers' food waste". *Conference EurOMA 2024: Transforming people and processes for a better world.* Barcelona, Spain, July 2024, pp. 1-10. - Porter, Stephen D., David S. Reay, Elizabeth Bomberg, and Peter Higgins. (2018). "Avoidable food losses and associated production-phase greenhouse gas emissions arising from application of cosmetic standards to fresh fruit and vegetables in Europe and the UK." *Journal of Cleaner Production*, Volume 201, pp. 869-878. https://doi.org/10.1016/j.jclepro.2018.08.079
	Food waste estimates (if applicable / located) - N/A
Regulation 1308/2013	Category E – Criteria such as appearance, consistency, conformation, product characteristics, percentage of water content.
Conceptual Framework Model	

Source: Author, hypothesis template developed in the BREADCRUMB project (task 1.4).

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4.7.2 Private organic production and food waste

Hypothesis: Stringent standards for production substances and practices in private organic production contribute to food waste.

Summary: Stringent restrictions on production substances and practices in private organic standards for fruits and vegetables contribute to food waste since:

- Ban on synthetic pesticides can lead to greater vulnerability to pest damage.
- Organic food typically spoils faster due to a lack of preservatives.
- Natural cleaning and preservation agents are less potent against bacteria and fungi.
- In the absence of chemical disinfectants, microbial load on surfaces or equipment may increase spoilage rates.
- The absence of serious heat treatments may fail to eliminate all microorganisms.

Producers have to comply with the demands of the retailers and consumer preferences and implement organic standards and certifications despite them being more stringent than the EU standards. While organic standards contribute to initiatives to promote environmental sustainability, such as the European Green Deal (2019) and the Commission's Organic Action Plan (2021-2027), the standards may inadvertently contribute to food waste due to more rapid spoilage when compared to products that are subject to less stringent organic requirements, or are not organic. What is ultimately key is when and how the organic product is used, and this merits further study.

Table 13: Private Organic Production Standards and Food Waste

Topic	**Content**
Hypothesis	Stringent restrictions on production substances and practices in private organic standards contribute to food waste.
Data collection points	**Inventory** - Naturland • Prohibition of GMO and nanomaterials in all production and processing areas. • Prohibition of synthetic pyrethroids and chemical-synthetic inputs. • Restrictive use of copper salts in plant protection. • Ban on certain additives and enzymes. https://www.naturland.de/images/01_naturland/_en/Standards/Comparison_Naturland-EC-organic-regulation.pdf - Demeter • Limits on the usage of nitrogen and phosphorus as a method of pest control lower than officially recommended by the EU. • Restrictions on preservation substances to natural only (e.g. lemon juice concentrate, vinegar or lactic acid). • Allowing only minimal heat treatment of the products. • Restrictions to only natural cleaning substances (e.g. sodium carbonate, alcohol, citric acid). • No additive sweeteners. https://demeter.net/about/demeter-brand/ - Bio Coherence

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	• Prohibition of synthetic additives like nitrites, nitrates, and other non-natural preservatives. • Prohibition of mineral nitrogen fertilisers, fertilisers made outside the EU, and certain animal by-products like meat and fish meal. • Additional bans on specific food additives like talc and artificial vitamin C. • Absolute prohibition on storage, collection, and use of OGM-contaminated materials. • Farms and processing facilities must be 100% organic, with limited exceptions and strict traceability requirements. https://www.biocoherence.fr
	Survey - According to the survey results: a) A stringent private standard for organic production in the Netherlands was noted within the survey responses. The standard goes further than the already sustainable standards of organic farming, as legally established in the EU organic legislation (recognisable by the EU organic quality mark).
	Interviews - According to the interview results: a) The interviewees highlighted that residue levels set in private organic standards are more stringent than what is legally required. *"…the maximum residue level regulation specifies how many milligrams of a particular active substance is allowed. This is our basic standard. But it also involves a private standard where some say the regulation allows quantity x of the active substance, but we will allow 1/3 of that amount. The EU sets a requirement, but the private trade adds further specifications"* (Interview 5). *"And you can have one oil tested at one laboratory saying approved chemical, approved sensory. Then you can send the sample to another laboratory saying chemical approved / sensory not approved. And if the product ends up in a laboratory where it's not approved, you can choose to have it sent to a new laboratory. Then you have an illegal product, and you have to either change the label or discard the product because the product will be illegal"* (Interview 30). *"Many of these are based on public standards but with more restrictions. One of the main private marketing standards is related to the fruit production method; for example, a customer requests the use of fruit that has residues of plant protection products that are 50% lower than the legal limit"* (Interview 20).
	Literature Review (not exhaustive) - Bio Cohérence. (2024). "Tableau comparatif du cahier des charges Bio Cohérence et de la réglementation européenne en agriculture biologique." Last accessed December 2024.

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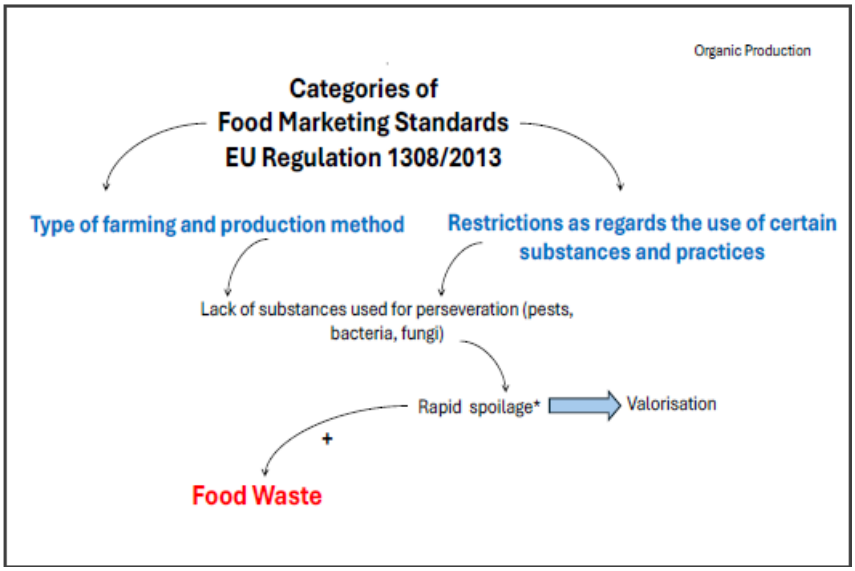
	https://www.biocoherence.fr - Giacomini, C., Mancini, M. C., and P. Modesti. (2010). "Large retailers and vertical control of the supply chain: Private labels and private certification standards." *International Journal of Applied Management Science*, 2(4), pp. 305-320. https://www.inderscienceonline.com/doi/abs/10.1504/IJAMS.2010.036588 - Henson, S., and T Reardon. (2005). "Private agri-food standards: Implications for food policy and the agri-food system." *Food Policy*, 30(3), pp. 241-253. https://doi.org/10.1016/j.foodpol.2005.05.002 - Naturland. (n.d.). "A one-to-one comparison of the Naturland standards with the EU organic regulation." Last accessed December 2024. https://www.naturland.de/images/01_naturland/_en/Standards/Comparison_Naturland-EC-organic-regulation.pdf
	Food waste estimates (if applicable / located) - N/A
Regulation 1308/2013	Category K - Restrictions as regards the use of certain substances and practices. Category G – Type of farming and production method.
Conceptual Framework Model	 *Spoilage of food and therefore unlikely to be donated or sold at a lower category/price, but depending on the food product, there might be valorisation options.

Source: Author, hypothesis template developed in the BREADCRUMB project (task 1.4).

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4.7.3 Meat cuts and food waste

Hypothesis: Stringent retailer standards for meat cuts contribute to food waste.

Summary: In the meat sector, consumer expectations, which drive retailer demands, play a crucial role but remain underexplored. One notable challenge lies in the variability of cut sizes. Cuts that are too small or too large deviate from the desired standards, making them less appealing for retail, where attributes like juiciness, nutrient composition, and visual uniformity are critical (Lebret, 2021). This issue became evident in the BREADCRUMB survey, which revealed that retailers establish specific requirements for products delivered by suppliers, with these criteria varying significantly. For instance, some retailers may mandate that pork tenderloins meet a minimum weight threshold, excluding smaller cuts from distribution. Consequently, undersized tenderloins must be repurposed and sold through less profitable channels. Given that pork is a natural product, some variability in size is unavoidable. However, retailers enforce such standards to ensure products are visually appealing and meet consumer expectations.

Another factor that needs to be considered is the quality of the incoming animals in the slaughterhouse. Quality attributes are not homogenous, and vary between the animals of one batch brought to the slaughterhouse. Also, only during the slaughtering process, the quality attributes (weight, lean meat percentage, fat distribution, etc.) become apparent, and only at the final slaughter stage a decision is made to link the individual carcass to a specific client based on his/her preferences. Seasonal variations, feed, pricing all have an impact on the availability (or not) of the ideal product satisfying customer demand. Client specifications should reflect this variation to allow a better match between availability and consumer demand. Consumers should also be informed that quality products such as meat cuts cannot come in standard portions and that sizes therefore can vary without compromising on pricing.

A lack of standardization in beef cuts also contributes to unnecessary trims and food loss and waste, as non-standard cuts fail to meet retailer or consumer expectations (Magalhães, 2021). Standardisation in the slaughterhouse is being implemented at the European level through what is called the SEUROP-classification in beef and pork identifying fat coverage, carcass meat conformity, sex, and carcass presentation. Because the context deals with live animals and a diversity of living conditions including feed and housing at the producer level, it is highly complicated to standardise the carcasses except for the parameters mentioned above because they provide a technical assessment and make abstraction of the primary production process at the farm level. The cutting plant receives goods based on visual and technical assessment but will treat each part individually based on client/consumer demand. The main issue is linked to pricing, where primary cuts that need substantial trimming will lose subsequent value (weight/price ratio). Trimmings are valued as low-grade products (= low-priced) which will ultimately be used in minced meat and preparations sold at lower cost.

Table 14: Meat Cuts and Food Waste

Topic	Content
Hypothesis	Stringent retailer standards for meat cuts contribute to food waste.
Data collection points	**Inventory** - A private Italian standard addressing the processing, storage, and packaging of bovine meat focuses on anatomical cuts and hamburgers/burgers. It also allows for customizable retail portions

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	(single, double, or multi-portion) with fixed or variable weights to meet customer requirements. This standard is not legally binding, applying exclusively to processing and manufacturing activities in Italy. It reflects best practices but functions as a private initiative rather than a public regulation.
	Survey - According to the survey results: a) In the survey, it was evident that retailers set specific requirements for the products delivered by suppliers, and these criteria can vary significantly. For example, some retailers may require that each pork tenderloin meets a minimum weight or size (to fit packaging). Suppliers cannot deliver smaller tenderloins, so those that fall short must be sold in a different and less profitable way. Since pork is a natural product, some variation in the raw material is inevitable. Retailers impose these standards to ensure the products are visually appealing and attractive to consumers.
	Interviews - The topic of meat cuts was not discussed in the interviews.
	Literature review (not exhaustive) - Hui, Y. H. (Ed.). (2012). *Handbook of meat and meat processing.* Boca Raton: CRC press. https://doi.org/10.1201/b11479 - Francis M., Simons D., and M. Bourlakis. (2008). "Value chain analysis in the UK beef foodservice sector." *Supply Chain Management: An International Journal,* 13 (1), pp. 83–91. https://doi.org/10.1108/13598540810850346 - Lebret, B., and M. Čandek-Potokar. (2022). "Pork quality attributes from farm to fork. Part I. Carcass and fresh meat." *Animal*, Volume 16, Supplement 1, pp. 1-12. https://doi.org/10.1016/j.animal.2021.100402 - Magalhães, V. S. M. (2021). *Framework development for the prevention of food loss and waste: an analysis along the fresh food supply chain* (Doctoral dissertation, 00500: Universidade de Coimbra). - Renouf, M., Messner, R., Hill, A., Mann, A., Hurst, B., & C. Richards. (2023). "Whole of meat supply chain food loss and waste mapping and interventions (Phase 1) – Final Report." Project V. MFS. 0457. *Meat and Livestock Australia (MLA)*, pp. 1-68. - Thies, A. J., Schneider, F., and J. Efken. (2021). "The meat we do not eat. A survey of meat waste in German hospitality and food service businesses." *Sustainability*, *13*(9), pp. 1-20. https://doi.org/10.3390/su13095059
	Food waste estimates (if applicable / located) - N/A

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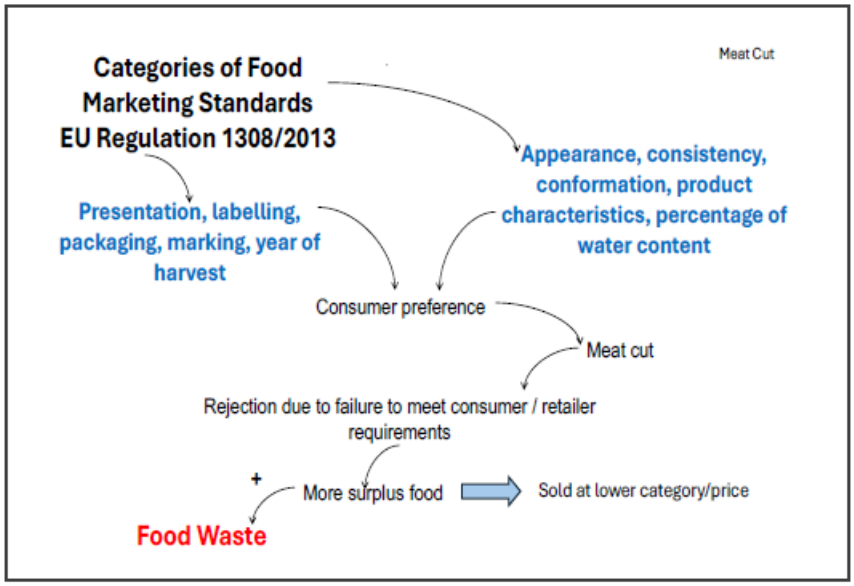
Regulation 1308/2013	Category E - Criteria such as appearance, consistency, conformation, product characteristics, percentage of water content. Category D – Presentation, labelling, packaging, marking, year of harvest.
Conceptual Framework Model	

Source: Author, hypothesis template developed in the BREADCRUMB project (task 1.4).

4.7.4 Regional production and food waste

Hypothesis: Food products that demonstrate local or regional production on their packaging abide by specific and systematic regional production requirements, which differentiate them from other similar products, thereby garnering consumer confidence, facilitating purchase at the retail level, and mitigating food waste.

Summary: In addition to garnering consumer confidence and subsequent purchase, local / regional products sold within their locale or region also have the added benefit of going through shorter supply chains to reach the end-consumer. Even if a product is shipped in the right conditions, the longer the distance and time required for travel, the higher the risk that some physical damage might come to the product. In this respect, shorter supply chains provide less risk of damage, as well as being able to provide the freshest food possible while promoting the origin of the product and supporting local industry. This also provides a chance to lower the product's carbon footprint.

Table 15: Regional Production and Food Waste

Topic	Content
Hypothesis	Food products that demonstrate local or regional production on their packaging (logo, brand for example) abide by specific and systematic regional production requirements, which differentiate them from other similar products, thereby garnering consumer confidence, facilitating purchase at the retail level, and mitigating food waste.

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Data collection points	**Inventory** Regulation (EU) 1143/2024 of the European Parliament and of the Council of 11 April 2024 on geographical indications for wine, spirit drinks and agricultural products, as well as traditional specialities guaranteed and optional quality terms for agricultural products. The EU geographical indications system protects the names of products that originate from specific regions and have specific qualities or enjoy a reputation linked to the production territory. The differences between PDO and PGI are linked primarily to how much of the product's raw materials must come from the area or how much of the production process has to take place within the specific region. https://eur-lex.europa.eu/eli/reg/2024/1143/oj/eng https://agriculture.ec.europa.eu/farming/geographical-indications-and-quality-schemes/geographical-indications-and-quality-schemes-explained_en#:~:text=The%20EU%20geographical%20indications%20system,linked%20to%20the%20production%20territory. - CSQA - Regional Quality Systems Some regions have set up so-called Regional Quality Systems, which presuppose the possibility of using a Regional Trademark on condition that specific specifications drawn up by the region are adhered to, and that the certification body passes the controls. https://www.csqa.it/it-it/certificazioni/agroalimentare/marchi-regionali - The Viandes et Oeufs de France The logo assures the consumer that the meat and eggs come from animals born, raised, slaughtered, cut and processed in France. It also guarantees a production method that respects the environment, animal welfare and animals fed with a healthy and sustainable diet. https://www.tests-et-bons-plans.fr/conso-reperer-les-logos-des-viandes-francaises-dans-l-alimentation.html - Produit en Île-de-France The brand certifies the territorial anchoring of its members and the traced origin of the products. Under this collective brand, producers benefit from national influence. Meeting the demand for local products, an idea that makes sense at a time when consumers are increasingly demanding about the origin of the products they buy. Produit en Île-de-France conveys strong values of authenticity, proximity, pride and accessibility. With this brand, the Region intends to encourage the maintenance of sustainable and qualitative agricultural activity in Île-de-France with identified products. https://produiteniledefrance.fr
	Survey - The impact of regional production on food waste was not addressed in the survey.
	Interviews

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	- Although regional production was not specifically discussed, according to the interview results: a) Standards that abide by specific requirements systematically provide predictability and thereby facilitate consumer confidence and trust in the product, needed for purchase. b) There is a shift towards the development of business-to-consumer (B2C) standards with a specific consumer orientation. Such standards offer consumers a consistent and transparent way to recognize products that align with particular values including information about the origin of the product. *"How a consumer views a product has become much more complex with sustainability, nutrition, allergens, environmental effects, aesthetics, place of origin of the food all coming into play"* (Interview 14).
	Literature review (not exhaustive) - Anglowski, Marek, and Aneta Jarosz-Angowska. (2020). "Importance of Regional and Traditional EU Quality Schemes in Young Consumer Food Purchasing Decisions." *European Research Studies Journal,* Volume 23, Issue 2, pp. 916-927. https://www.researchgate.net/publication/346894859_Importance_of_Regional_and_Traditional_EU_Quality_Schemes_in_Young_Consumer_Food_Purchasing_Decisions - Dias, Claudia, and Luis Mendes. (2018). "Protected Designation of Origin (PDO), Protected Geographical Indication (PGI) and Traditional Speciality Guaranteed (TSG): A bibliometric analysis." *Food Research International*, Volume 103, pp. 492-508. https://doi.org/10.1016/j.foodres.2017.09.059 - Menozzi, Davide, Ching-Hua Yeh, Elena Cozzi, and Filippo Arfini. (2022). "Consumer Preferences for Cheese Products with Quality Labels: The Case of Parmigiano Reggiano and Comté." *Animals,* Volume 10, Issue 10, pp. 1-20. https://www.researchgate.net/publication/360695294_Consumer_Preferences_for_Cheese_Products_with_Quality_Labels_The_Case_of_Parmigiano_Reggiano_and_Comte - Riivits-Arkonsuo, Iivi, Anu Leppiman, and Jelena Hartsenko. (2016). "Quality labels in Estonian food market. Do the labels matter?" *Agronomy Research,* Volume 14, Number 3, pp. 896-906. https://www.researchgate.net/publication/303787709_Quality_labels_in_Estonian_food_market_Do_the_labels_matter
	Food waste estimates (if applicable / located) - N/A
Regulation 1308/2013	Category J – Place of farming and / or origin. Category D – Presentation, labelling, packaging, marking, year of harvest.

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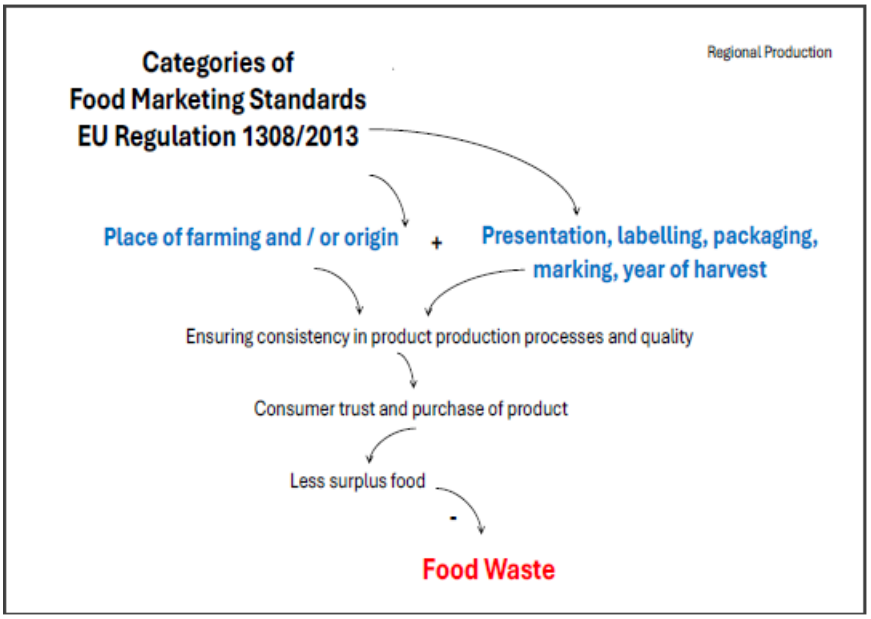
Conceptual Framework Model	

Source: Author, hypothesis template developed in the BREADCRUMB project (task 1.4).

4.7.5 Date marking and food waste

Hypothesis: Misunderstanding about date marking on food products causes confusion for consumers and leads to an increase of food waste at the retail, household, food services levels.

Summary: Consumers may be prone to discarding food due to misinterpretation of the date labelling – "best by" and "use by". Such date labels influence not only perceptions about product safety, but also quality, and may affect the purchasing and usage decisions. While it can be argued that more resources should be devoted to exploring the safety margins for food, it is a challenge however, involving complex risk analysis, and also depends on packaging and how the food is transported and stored throughout the supply chain process. If obliged to include the information, then manufacturers understandably don't want to take any risks and therefore may be conservative with dates put on the label, leading to food that is discarded while it could still be eaten. The European Commission is in the process of revising Regulation 1169/2011 and is due to come forth with a new proposal for a regulation revising the rules on date marking ("use by" and "best by" dates) for food products.[13]

[13] Legislative Train Schedule: Proposal for a regulation revising the rules on date marking ('use by' and 'best before' dates) on food products.
https://www.europarl.europa.eu/legislative-train/theme-a-european-green-deal/file-revision-of-eu-rules-on-date-marking-(-use-by-and-best-before-dates)

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Table 16: Date Marking and Food Waste

Topic	Content
Hypothesis	Misunderstanding about date marking on food products causes confusion for consumers and leads to an increase in food waste at the retail, household, and food services levels, via: a) the consumer may not buy the product in the store due to the misunderstanding about the date marking, leading to surplus food and possibly more food waste at the retail level; b) the consumer may buy the product in the store, but due to the misunderstanding about the date marking prematurely discard the product within the home or food services environment, leading to more food waste.
Data collection points	**Inventory** - Regulation (EU) No 1169/2011 on Food Information to Consumers ("FIC Regulation") requiring most pre-packed foods to display a date that indicates by when it should be used (i.e. "use by" related to safety of the food) or its quality ("best by"). https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32011R1169
	Survey - According to the survey results: a) A higher proportion of public standards (30.30%), when compared to private ones, were perceived as contributing to food waste. b) Public standards can contribute to food waste when they are overly rigid or misapplied / misunderstood – leading to the disposal of safe, consumable products.
	Interviews - According to the interview results: a) Several interviewees (4) noted that the "best by" date can be a source of confusion for consumers. The overall difficulty with the "best by" date is often defining in concrete terms what it entails in terms of the quality and safety of a product. Instead of two dates, the suggestion was made by one interviewee that just one date should be sufficient, and that more resources should be devoted to exploring the safety margins for food. *"There is movement in the industry and manufacturers are keen to do something about it…the aim is to get away from the "best by" date and the 'it is expired' mindset"* (Interview 7). b) The possibility of 'smart labelling' in the form of colour indicators for example to indicate the 'condition / freshness' of a product were raised during the interviews. c) The format of the date labelling on the food package was also highlighted as a cause for confusion by an interviewee.

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	"Sometimes when we see a product, many numbers appear excessively – the expiration dates, also with the date of production, and the batch number. That implies confusion that is not controlled by the consumer" (Interview 25). d) The two date-markings have ushered in a system of 'preferential consumption' where those selling the product and those consuming it are given the option of knowing when a product is at its optimal stage for consumption. However, according to data from the interviews, there exists confusion about the two dates which can generate more food waste with products being unnecessarily discarded. In response to this dilemma, those interviewees who raised concerns about confusion also noted that investment must be made by both the public and private sector to put forth clearer methods of indicating not only the lifespan of a product, but also what condition it is in during the different stages of that lifespan.
	Literature review (not exhaustive) - European Commission. (2015). *Flash Eurobarometer 425 – Food Waste and Date Marking – Survey Report.* Brussels: Directorate General for Health and Food Safety. https://op.europa.eu/en/publication-detail/-/publication/4c1e0070-7276-11e5-9317-01aa75ed71a1/language-en - European Food Safety Authority (EFSA). (2020). *European Food Safety Authority Scientific Opinion: Date marking and related food information in view of the application by food business operators of Regulation No. 1169/2011 on food information to consumers as an integrated part of their food safety management system (FSMS).* Italy: European Food Safety Authority. https://food.ec.europa.eu/document/download/4f5043f2-e728-4363-9a9f-3509668620a8_en?filename=fw_eu_actions_mandate-efsa-date-marking.pdf - European Food Safety Authority (EFSA). (2020). "Guidance on date marking and related food information: Part One." *EFSA Journal,* Volume 18, Issue 12, pp. 1-74. https://doi.org/10.2903/j.efsa.2020.6306 - European Commission. (2021). *Consumer Research Study to Identify new ways of expressing date marking that meet consumers' information needs whilst minimising food waste.* Brussels: Consumers, Health, Agriculture, and Food Executive Agency. https://food.ec.europa.eu/document/download/c4494fef-eae2-46d3-b0f9-9ada1037354d_en?filename=fw_eu_actions_dm_20211130_report_1.pdf - ICF, Anthesis, Brook Lyndhurst, and WRAP (corporate authors). (2018). *Market study on date marking and other information provided on food labels and food waste prevention.* Brussels: Directorate General for Health and Food Safety. https://op.europa.eu/en/publication-detail/-/publication/e7be006f-0d55-11e8-966a-01aa75ed71a1/language-en - Kavanaugh, Melissa and Jennifer Quinlan. (2020). "Consumer knowledge and behaviours regarding food date labels and food waste." *Food Control.* https://doi.org/10.1016/j.foodcont.2020.107285

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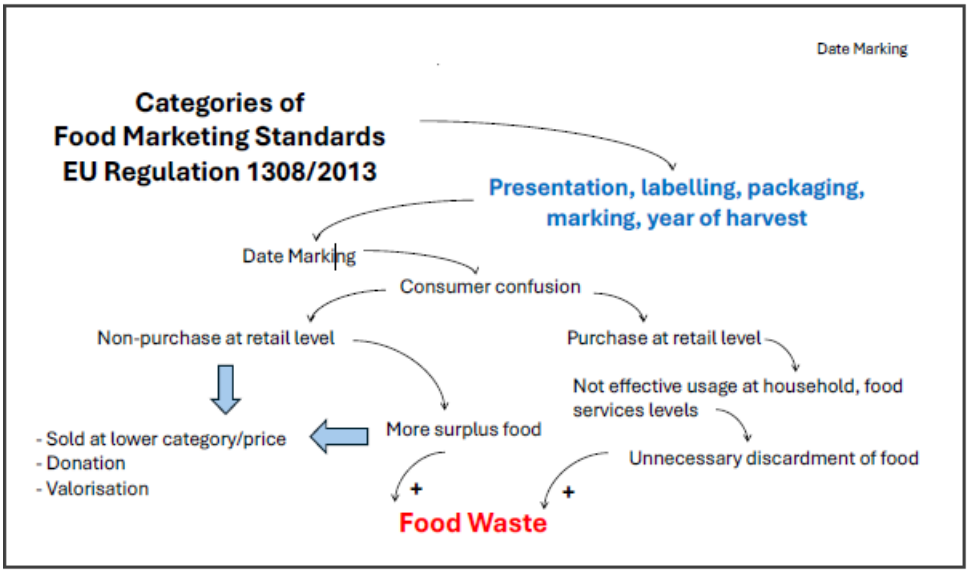
	- Newsome, Rosetta, Chris G. Balestrini, Mitzi D. Baum, Joseph Corby, William Fisher, Kaarin Goodburn, Theodore P. Labuza, Gale Prince, Hilary S. Thesmar, and Frank Yiannas. (2014). "Applications and Perceptions of Date Labelling of Food." *Comprehensive Reviews in Food Science and Food Safety,* Volume 13, Issue 4, pp. 745-769. DOI:10.1111/1541-4337.12086 - Patra, Debasmita, Shuyi Feng, and Jeff W. Howard. (2022). "Confusion of food-date label with food safety implications for food waste." *Current Opinion in Food Science.* https://doi.org/10.1016/j.cofs.2022.100917 - Wilson, Norbert L.W., Rickard Bradley, Rachel Saputo, and Shuay-Tsyr Ho. (2017). "Food waste: The role of date labels, package size and product category". *Food Quality and Preference,* Volume 55, pp. 35-44. https://doi.org/10.1016/j.foodqual.2016.08.004
	Food waste estimates (if applicable / located) - A 2018 study carried out by the ICF et al. estimates that up to 10% of food waste generated annually in the EU is linked to date marking (ICF et al. 2018: iii). ICF, Anthesis, Brook Lyndhurst, and WRAP (corporate authors). (2018). *Market study on date marking and other information provided on food labels and food waste prevention.* Brussels: Directorate General for Health and Food Safety. https://op.europa.eu/en/publication-detail/-/publication/e7be006f-0d55-11e8-966a-01aa75ed71a1/language-en
Regulation 1308/2013	Category D - Presentation, labelling, packaging, marking, year of harvesting.
Conceptual Framework Model	

Source: Author, hypothesis template developed in the BREADCRUMB project (task 1.4).

4.7.6 Product size & packaging and food waste

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Hypothesis: Retailer requirements for uniform size of fruits and vegetables within packaging augment food waste.

Summary: Standardized packaging requirements appear to play a significant role in food waste within the fruit and vegetable sector. Retailers enforce strict quality standards based on characteristics like size, shape, and appearance rather than focusing solely on edibility. As a result, produce that does not meet these specific standards is often discarded, despite being perfectly safe and nutritious.

Food marketing standards cover criteria such as presentation, labelling, and packaging, with specific rules on uniform sizing being particularly influential. This emphasis on uniformity means that fruits and vegetables that fall outside the approved size range are excluded from sale, contributing to substantial waste. Changing packaging practices could help reduce this waste. For instance, packaging produce by weight rather than enforcing exact size standards allows retailers to include items of varying sizes and shapes, helping to minimize unnecessary waste and create a more efficient supply chain.

Findings from the BREADCRUMB survey and follow-up interviews highlighted this issue. Respondents shared specific examples, such as strawberries needing to be of uniform size within a single package, with no mixture of large and small berries (survey), and similar strict size standards applied to peaches or potatoes (noted in in-depth interviews).

Currently, estimates of food waste resulting from these specific standards are lacking, making it difficult to fully assess the impact of uniform sizing requirements on waste levels. We propose that retailer requirements for consistent sizes in packaged fruits and vegetables may significantly contribute to increased food waste.

Table 17: Product Size & Packaging and Food Waste

Topic	Content
Hypothesis	Retailer requirements for uniform size of fruits and vegetables within packaging augment food waste.
Data collection points	**Inventory** - Standards that emphasize specific size requirements to ensure product uniformity in the global market. Standards from global trade and economic bodies, and those established by a global food safety commission, mandate that products should meet minimum size criteria to guarantee consistent quality and appearance. Examples include OECD and CODEX standards, such as: - Standard for Asparagus - CXS 225-2001 (CODEX) The document includes provisions for sizing by length and diameter, ensuring uniformity within packages. Packaging and presentation guidelines are provided to protect the asparagus during transport and storage. https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXS%2B225-2001%252FCXS_225e.pdf

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	- International Standards for Fruits and Vegetables - Fresh Figs (OECD) Size is determined by the maximum diameter of the equatorial section. The minimum size shall be 40 mm. https://read.oecd-ilibrary.org/agriculture-and-food/fresh-figs_9789264234086-en-fr - Also, private retailers in EU countries impose stringent size requirements through private standards. For example, a retailer's standard in Austria sets strict rules on the size of produce like potatoes, onions, and carrots. Another example exists in Belgium, where strawberries are classified into categories largely based on size and external characteristics, affecting their market classification and export suitability.
	Survey - According to the survey results: a) Growers and suppliers face strict quality standards imposed by retailers. e.g. "*strict quality standards regarding aspects like size*". (anonymous respondent) "*Even if the product is perfectly edible and of good quality, it can be rejected if it doesn't meet these precise standards (e.g., size uniformity, strawberries size in the package (all strawberries should be the same size, no mixing of big ones and small ones)". (anonymous respondent)*
	Interviews - According to the interview results: a) Retailers are increasingly requiring suppliers to deliver fruits and vegetables in specific sizes or offering higher payments for products of particular sizes: *"…we've often had situations where the farmer couldn't get rid of his potatoes because they were smaller than expected and weren't accepted by the retailer. And of course, that's very bad for the supplier because their entire livelihood is based on it, but it's also terrible from a food waste perspective because it is actually food that could still be good to eat"* (Interview 10). "*Normally, in peach production, size is one of the key factors. The big ones are usually more valued because it only takes two to make one kilo, and they are considered the most valuable. However, when a major retailer […] decided they wanted the smaller ones [they create a private standard], the price of those increased significantly"* (Interview 17).
	Literature review (not exhaustive): - Göbel, Christine, Nina Langen, Antonia Blumenthal, Petra Teitscheid, and Guido Ritter. (2015). "Cutting food waste through cooperation along the food supply chain." *Sustainability*, 7(2), pp. 1429-1445. https://doi.org/10.3390/su7021429

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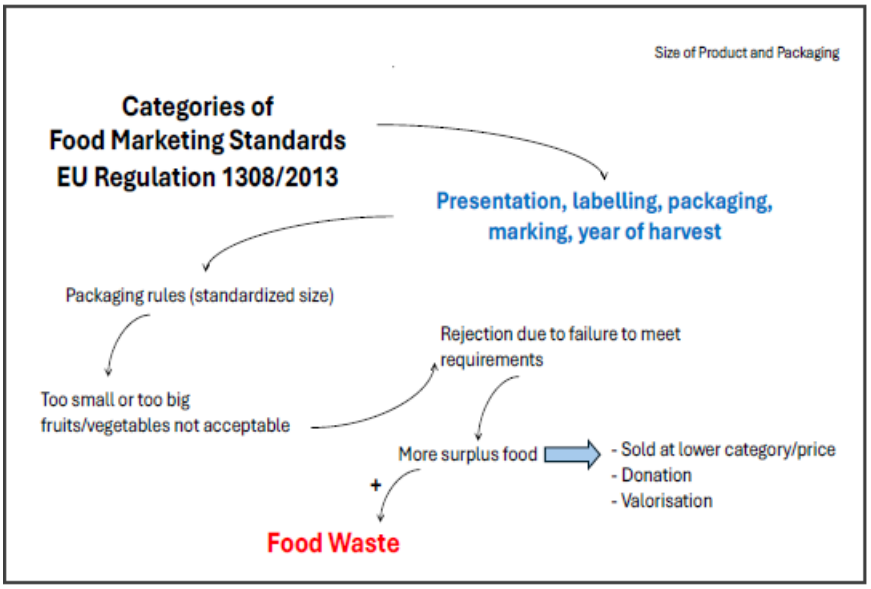
	- Gustavsson, Jenny, Christel Cederberg, Ulf Sonesson, Robert Van Otterdijk, and Alexandre Meybeck. (2011). "Global food losses and food waste – extent, causes and prevention." *Food and Agricultural Organization of the United Nations*, Rome, January 2011, pp. 1-29. https://www.fao.org/4/mb060e/mb060e00.pdf
	Food waste estimates (if applicable / located) - N/A
Regulation 1308/2013	Category D - Presentation, labelling, packaging, packaging rules.
Conceptual Framework Model	

Source: Author, hypothesis template developed in the BREADCRUMB project (task 1.4).

4.7.7 Fish size specifications and food waste

Hypothesis: Public food marketing standards related to size specifications augment food waste in the fish industry by discarding fish that do not meet size requirements.

Summary: Public food marketing standards, particularly those concerning fish size, have significantly contributed to food waste in the fisheries sector. The survey respondents mentioned that public food marketing standards regulating fish sizes are linked to food waste. These standards aim to ensure uniformity, appeal, and marketability of fish products. However, they inadvertently lead to the discarding of large quantities of fish, exacerbating food waste.

Public food marketing standards often dictate that fish must meet specific size criteria, resulting in the acceptance of only fish within a narrow range. Smaller or larger fish that fall outside these parameters are typically discarded, even if they are edible and nutritious, although there may be efforts to sell them at a lower price. This practice is wasteful and contributes to the depletion of fish populations. Undersized fish are often returned to the sea, where their survival rates are low.

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This phenomenon is closely linked to overfishing and bycatch. Fish caught unintentionally or which are too small to meet market requirements are frequently discarded. The landing obligation policy in the European Union has further highlighted this issue, as fish that do not meet size specifications must be brought ashore, even if they are unwanted. Consequently, substantial amounts of fish are wasted throughout the supply chain.

Table 18: Fish Size Specifications and Food Waste

Topic	Content
Hypothesis	Public food marketing standards related to size specifications augment food waste in the fish industry by discarding fish that do not meet size requirements.
Data collection points	**Inventory** - General outline of marine capture fisheries legislation and regulations in the Adriatic Sea countries - Size categorization. (Italy) Covers licenses, sizing, conservation and management measures. https://www.faoadriamed.org/html/Legislation/ - Fish - Establishes the minimum conservation reference sizes for species relating to the conservation of fishery resources and the protection of marine ecosystems through technical measures (Portaria n.º 255/2022 de 26 de outubro). (Portugal) https://www.dgrm.pt/documents/20143/46482/Portaria+255-2022+Tamanhos+m%C3%ADnimos.pdf/0a33a10a-f393-d561-ab46-33470129c231 - Legal sizes, minimal freshness required and legal species at Primary production level are established by the Council Regulation (EC) No 2406/96 of 26 November 1996 laying down common marketing standards for certain fishery products. https://eur-lex.europa.eu/eli/reg/1996/2406/oj/eng - Regulation (EU) No 1379/2013 of the European Parliament and of the council on the common organization of the markets in fishery and aquaculture products. https://eur-lex.europa.eu/eli/reg/2013/1379/oj/eng
	Survey - According to the survey results: a) Survey respondents mentioned that public food marketing standards on fish size are linked to food waste. b) The analysis of the survey data, controlling for commodity type, shows that public standards adhered to by respondent entities have a stronger effect on increasing food waste compared to private standards. Both means were above zero indicating that both types of standards generally contributed to increasing food waste. However, the impact of public standards was significantly greater.
	Interviews

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	- The topic of fish sizes was not discussed in the interviews.
	Literature review (not exhaustive) - European Commission. (2018). *The state of fisheries and aquaculture in the European Union*. Brussels: European Commission. https://ec.europa.eu/fisheries/cfp_en - Food and Agriculture Organization (FAO). (2022). *The state of world fisheries and aquaculture 2022: Towards blue transformation*. Rome: Food and Agriculture Organization. https://www.fao.org/state-of-fisheries-aquaculture - Garske, Beatrice, Katherine Heyl, Felix Ekardt, Lea Moana Weber, and Wiktoria Gradzka. (2020). "Challenges of food waste governance: An assessment of European legislation on food waste and recommendations for improvement by economic instruments." *Land*, 9(7), 231, pp. 1-23. https://doi.org/10.3390/land9070231 - Gasco, Laura, Francesco Gai, Giulia Maricchiolo, Lucrezia Genovese, Sergio Ragonese, Teresa Bottari, and Gabriella Caruso. (2018). "Fishery Discard as a Source of food for reared or wild fish? The bottom trawling in the Mediterranean Sea as a case study." In *Feeds for the Aquaculture Sector: Current Situation and Alternative Sources*, 29-48. Switzerland: SpringerBriefs in Molecular Science. https://link.springer.com/chapter/10.1007/978-3-319-77941-6_2 - Hedley, Chrstopher, Tom Catchpole, and Ana Ribiero Santos. (2015). *The landing obligation and its implications on the control of fisheries.* Brussels: European Parliament. - Keledjian, Amanda, Gib Brogan, Beth Lowell, Jon Warrenchuk, Ben Enticknap, Geoff Shester, Michael Hirshfireld, and Dominique Cano-Stocco. (March 2014). Wasted Catch: Unsolved Problems in U.S. Fisheries (PDF). *Oceana.org* (Report). Oceana. Archived from the original (PDF) on March 23, 2021. - World Economic Forum, MarFish Eco, Friends of Ocean Action, World Resources Institute. (April 2024). *Investigating Global Aquatic Food Loss and Waste*. Switzerland: World Economic Forum. https://www.weforum.org/publications/investigating-global-aquatic-food-loss-and-waste/ - Storup, Kim, Katja Mattfolk, Diana Voinea, Bettina Jakobsen, Michael Bain, Maria Eulalia Reverté i Casas, Els Brems, Klaus Stern, and Paulo Oliveira. (2016). *Combating food waste: An opportunity for the EU to improve the resource-efficiency of the food supply chain.* Luxembourg: European Court of Auditors. https://www.eca.europa.eu/lists/ecadocuments/sr16_34/sr_food_waste_en.pdf
	Food waste estimates (if applicable / located)

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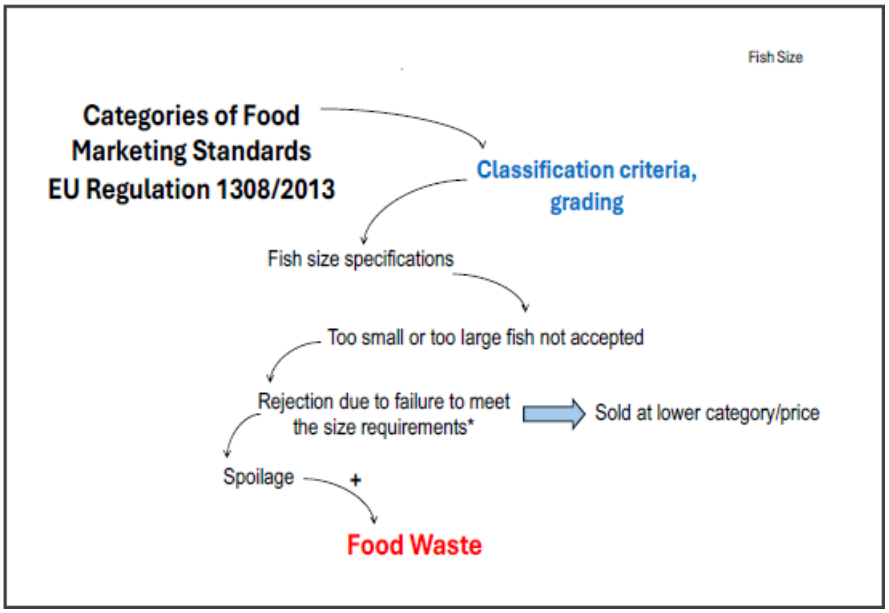
	- According to a report led by the World Economic Forum: "The analysis reveals global edible aquatic FLW totalled approximately 23.8 million tonnes (MT) in 2021, equating 14.8% of total aquatic food produced that year. Globally, processing on land and production of wild-capture fisheries (discards) accounted for 39.08% and 35.38% of aquatic FLW…" (page 4). World Economic Forum, MarFish Eco, Friends of Ocean Action, World Resources Institute. (April 2024). *Investigating Global Aquatic Food Loss and Waste*. Switzerland: World Economic Forum. https://www.weforum.org/publications/investigating-global-aquatic-food-loss-and-waste/
Regulation 1308/2013	The fish sector is not governed by Regulation 1308/2013; however, if using the categories from this regulation, the most applicable is Category B - Classification criteria, grading.
Conceptual Framework Model	 * Valorization is difficult for fresh fish due to the short shelf-life and logistical difficulties.

Source: Author, hypothesis template developed in the BREADCRUMB project (task 1.4).

4.7.8 Animal by-products and food waste

Hypothesis: EU public food marketing standards on animal by-products contribute to food waste due to the categorization process related to the by-product.

Summary: Regulation (EC) No. 1069/2009 establishes the health rules for animal by-products and derived products not intended for human consumption. Animal by-products (ABPs) are parts of animals, products of animal origin or other products obtained from animals which are not intended for human consumption. It is legislation which essentially contributes to the prevention and control of animal diseases by establishing the requirements for the collection, storage, transport, treatment, use and disposal of animal by-products.

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Category 3 material defined in the regulation is considered low risk for public or animal health and includes parts of animals that have been deemed unfit for human consumption but still approved for animal consumption or fit for human consumption in a slaughterhouse, but which are not intended for human consumption due to either commercial reasons (such as consumer preferences), or manufacturing / packaging defects although they do not pose a risk to public or animal health.

Article 10 within the regulation requires that in order for a product to be classified as a category 3 by-product, it should not show any signs of diseases communicable to humans or animals, without specifying what "signs" mean. Not specifying what those “signs” should be, can lead to some interpretation by the veterinary authorities. Understandably authorities want to be cautious when it comes to public and animal health, and not take any risks. Consequently, the by-product is often classified as category 2 (i.e. higher-risk and therefore of lower value), when perhaps the product could be treated to become category 3, and even be fit for human consumption.

The regulation establishes that the checks to determine whether a product is fit for human consumption is done solely through an ante-mortem inspection of the animal, and not a post-mortem inspection. Post-mortem inspections can show that products thought to not be fit for human consumption are actually fine for humans to consume, reducing the amount of products that are not used for food but rather are revalorized as by-products.

While large-scale companies more often have the resources to send leftover animal by-products to alternative markets, rendering plants, or for biogas production, those produced at small abattoirs often end up being discarded. However, the major players in the meat industry seem to be using most, if not all, of the edible by-products they generate. The real issue lies with small abattoirs, which are being put aside by the industrialised meat industry when it comes to by-products, because of insufficient quantities enabling further commercialisation, hence discarding the product rather than seeking alternative valorisation. Where small abattoirs once earned money for their by-products, many now pay for those same products to be removed and incinerated - and this is where the “waste” is being wasted. The reason for this lies in the downgrading of category 3 material to for example category 2 to reduce transport cost for waste hauling.

Table 19: Animal By-Products and Food Waste

Topic	Content
Hypothesis	EU public food marketing standard on animal by-products contributes to food waste due to the categorization process related to the by-product – i.e. often classified as category 2 (i.e. higher-risk and therefore of lower value), when perhaps the product could be treated to become category 3, and even be fit for human consumption.
Data collection points	**Inventory** - Regulation (EC) No. 1069/2009 of the European Parliament and of the Council of 21 October 2009 laying down the health rules as regards animal by-products and derived products not intended for human consumption. https://eur-lex.europa.eu/eli/reg/2009/1069/oj/eng
	Survey The animal by-products regulation was not specifically discussed in the survey.
	Interviews

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	- The animal by-products regulation was not specifically discussed in the interviews.
	Literature review (not exhaustive) - Lange, Dirk. (2021). "The relation between EU food safety policy, Codex Alimentarius and WTO: Evolution and Current Challenges." *Ernaehrungs Umschau International,* 68 (10), pp. 204-209. - Klaura, Juliane, Gerard Breeman, and Laura Scherer. (2023). "Animal lives embodies in food loss and waste." *Sustainable Production and Consumption*, Volume 43, pp. 308-318. https://doi.org/10.1016/j.spc.2023.11.004 - Pinto, Joao, Rui Boavida-Dias, Henrique A. Matos, and Joao Azevedo. (2022). "Analysis of the Food Loss and Waste Valorisation of Animal By-Products from the Retail Sector." *Sustainability,* Volume 45, pp. 1-27. https://doi.org/10.3390/su14052830 - Lipinski, Brian. (2020). "Why does animal-based food loss and waste matter?" *Animal Frontiers*, Volume 10, Number 4, pp. 48-52. https://doi.org/10.1093/af/vfaa039 - Ominski, Kim, Tim McAllister, Kim Stanford, Genet Mengistu, E G Kebebe, Faith Omonijo, Marcos Cordeiro, Getahun Legesse, and Karin Wittenberg. (2021). "Utilization of by-products and food waste in livestock production systems: a Canadian perspective." *Animal Frontiers*, Volume 11, Issue 2, pp. 55-63. https://doi.org/10.1093/af/vfab004 - Blonk, Hans, and Roline Broekema. (2018). *The environmental impact of the categorisation of poultry by products*. Gouda: Blonk Consultants. https://blonksustainability.nl/tools-and-databases/agri-footprint#methodology - Blonk Agri-footprint BV. (2017a). *Agri-footprint 3.0 - Part 1: Methodology and basic principles.* Gouda: Blonk Consultants. http://www.agri-footprint.com/users/#methodology - Blonk Agri-footprint BV. (2017b). *Agri-footprint 3.0 - Part 2 - description of data.* Gouda: Blonk Consultants. http://www.agri-footprint.com/users/#methodology - European Commission. (n.d.) "European Platform on LCA/EPLCA Homepage". Last accessed January 2025. https://eplca.jrc.ec.europa.eu/ - Berends, B.R. (n.d.). *Risico inventarisatie en evaluatie van categorie 2 en 3 materialen in Nederlandse pluimveeslachterijen: Rapport No. 1103.* Utrecht: Institute for Risk Assessment Sciences (IRAS).
	Food waste estimates (if applicable / located) - N/A

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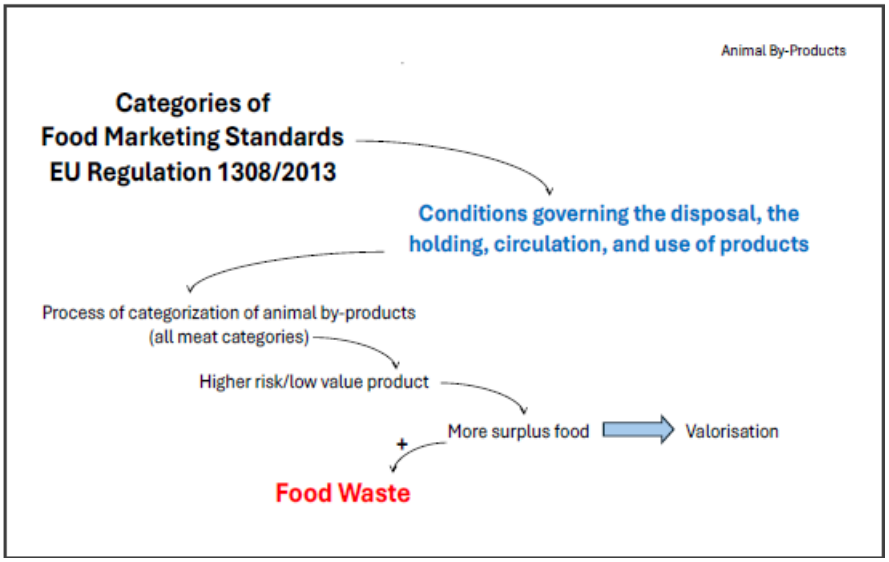
Regulation 1308/2013	Category M – Conditions governing the disposal, the holding, circulation and use of products.
Conceptual Framework Model	

Source: Author, hypothesis template developed in the BREADCRUMB project (task 1.4).

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5. CONCEPTUAL FRAMEWORK MODEL

5.1 Overview of Deliverable 1.2

A crucial outcome of the investigation in task 1.2 was the **development of a preliminary conceptual framework model**, presented in deliverable 1.2. This model illustrates how each category of standards listed in Regulation (EU) No 1308/2013 can contribute to or mitigate food waste. While aesthetic requirements for fresh produce are often associated as contributors to food waste, this narrow focus overlooks the potential influence of other marketing standards. Therefore, it was essential to explore underexplored research areas, particularly those examining the less well-established connections between marketing standards and food waste.

Task 1.2 delved into the connections between various food marketing standards categories and the likelihood of food waste generation. Drawing from scholarly research and insights gained from project collaborators in agricultural economics, supply chain management, and food policy, the analysis explored the potential implications of these standards on food waste. More specifically, the preliminary model illustrated a range of different relationships (mitigation and augmentation) between food marketing standards and food waste, such as:

- Technical definitions and sales descriptions influence consumer preferences, potentially reducing FW through informed choices.
- Classification criteria may increase FW by rejecting otherwise acceptable products or encouraging overproduction.
- Indications of specific species, varieties, or breeds can drive overproduction of certain items while underutilizing others, exacerbating FW.
- Packaging has mixed effects on FW by protecting products but also potentially increasing costs and waste.
- Labeling influences consumer perceptions of freshness and quality; accurate labeling reduces FW, while misleading labels increase it.
- Appearance criteria, while enhancing consumer trust, can lead to the rejection of otherwise edible products, increasing FW.
- Standards for substances in production enhance consumer trust, reducing FW, but may also create waste in the supply chain if unmet.
- Farming and production method standards optimize resource allocation and align with consumer preferences, reducing FW.
- Handling and preservation standards reduce spoilage, mitigating FW across supply chain stages.
- Restrictions on substances and practices enhance product safety and trust, minimizing FW.

The preliminary conceptual framework model presented as a causal loop diagram (CLD) in Figure 11 includes only those categories and standards with identified links to food waste (FW), based on a literature review. Connections supported by previous research are shown with continuous lines, while speculative or less-studied connections are represented with dashed lines. Arrows (→) indicate the causal relationships between food marketing standards categories and food waste, with a plus sign (+) for positive relationships (increased FW) and a minus sign (-) for negative relationships (decreased FW). The conceptual framework model served as a valuable and guiding tool in identifying key pathways that warrant further investigation.

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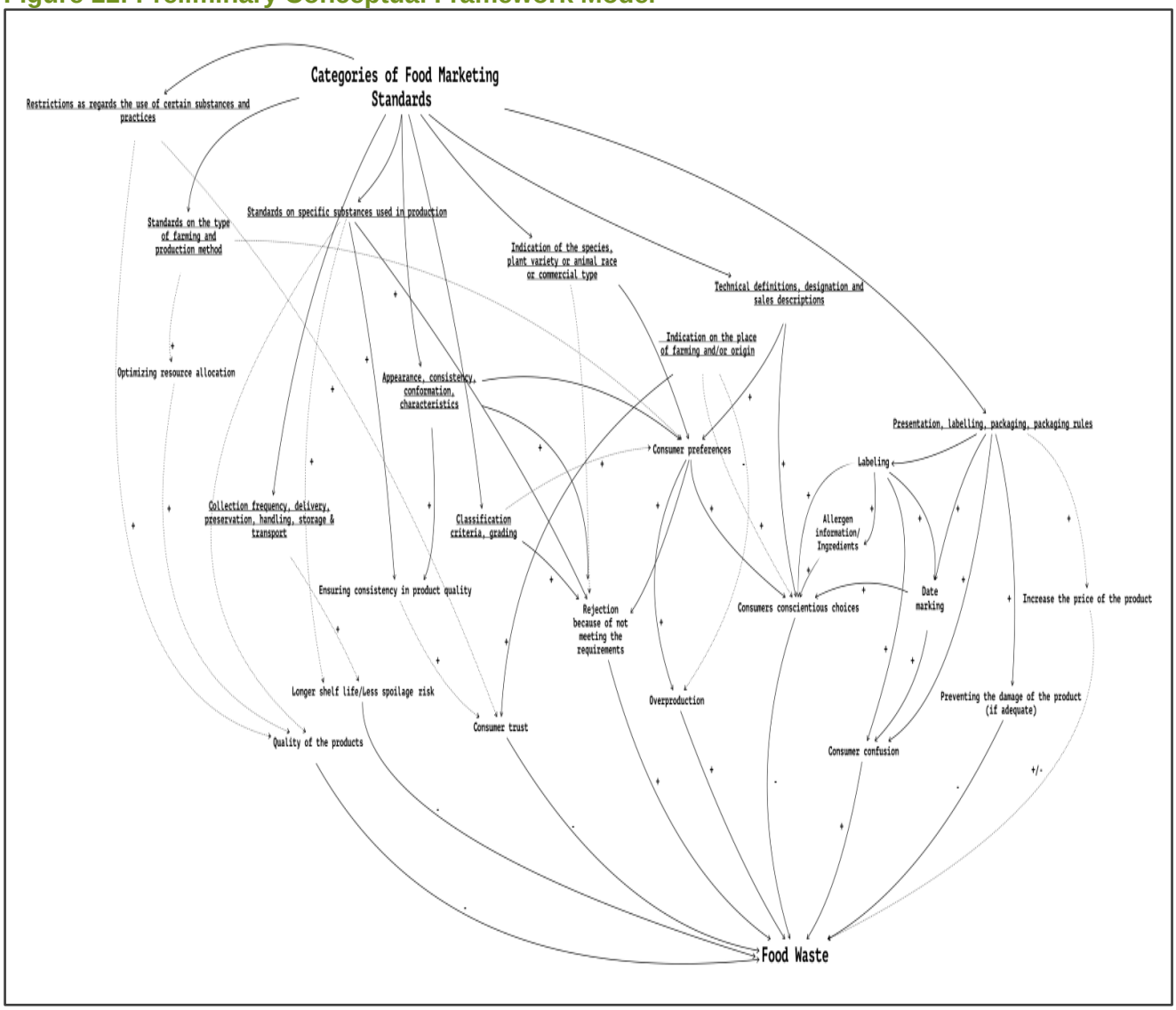
Figure 11: Preliminary Conceptual Framework Model



Source: Author, developed in the BREADCRUMB project (WP1).

5.2 Key Changes made to the Preliminary Conceptual Framework Model

Task 1.4 involved formulating hypotheses on the relationship between food marketing standards and food waste, utilizing the model as guidance, along with data (inventory, survey, interviews) carried out in task 1.3. Input on the hypotheses was given by the project's Food Marketing Standards Interest Group, as well via a workshop involving external stakeholders from operations, policy, and research. As the previous chapters (3 and 4) of this report highlight, analysis conducted brought to light valid **hypotheses related to specific food marketing standards and their connections to food waste**.

Building on the insights of the hypotheses and the iterative process throughout task 1.4, an updated **conceptual model** was developed to reflect both the **reinforcing** and **balancing** effects of food marketing standard on food waste. A Python script with the **Graphviz** library was used to generate a revised **causal loop diagram (CLD)**. The diagram illustrates how FMS can lead to **surplus** (and subsequently **food waste**) when they are overly strict or unclear, resulting in overproduction or rejection of items that do not meet requirements (Reinforcing Loop R1). However, improved

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labelling (particularly for **date marking** and **origin information**) **valorization, and food recovery** efforts can **counteract** these negative impacts. **(B1)** emphasizes how **consumer trust** increases purchases, thereby reducing surplus, while **(B2)** indicates how surplus that does arise can be utilized more effectively, thereby **mitigating food waste**. Ultimately, food waste can be viewed as the result of **reinforcing** drivers (strict standards) minus the **balancing** interventions (clear labelling, consumer trust, valorization, food recovery initiatives). Figure 12 provides the updated and consolidated causal loop diagram merging insights from hypotheses diagrams on food marketing standards and food waste mapped in T1.4.

The updated causal loop diagram (CLD) starts with the '**Food Marketing Standards'** node (the large blue box at the top). This node encompasses the key provisions under Regulation 1308/2013. These provisions include **organic production**, **animal by-products**, **size & packaging requirements**, **appearance standards**, **cuts fish size, date marking**, and **regional production labeling**. All of these provisions can become either overly strict or ambiguous, prompting overproduction to ensure compliance and frequent rejection of items that fail to meet the criteria. Consequently, overly rigid or unclear guidelines can amplify food waste through feedback loops. The **Reinforcing Loop (R1)**, illustrated by red arrows, illustrates how strict or unclear standards drive overproduction and rejection, leading to surplus. Unused surplus, such as produce that fails size requirements, often ends up as food waste if not otherwise utilized. This reinforcing (or self-amplifying) cycle means that the stricter or more confusing the standards, the greater the surplus and waste. Elevated waste levels may in turn reinforce the need for "quality control", further perpetuating those same standards. At the bottom of the diagram is the '**Food Waste'** node (in orange), representing the outcome of discarded products. Since sustainability and resource management efforts focus on reducing this end state, the diagram shows how surplus may be exacerbated (as in R1) or diverted to alternative uses through balancing loops (**B1** and **B2**). In the '**Balancing Loops'**, marked in green, **(B1) consumer trust** emphasizes how clear labelling and transparent origin information increase consumers' willingness to purchase, thereby reducing unsold stock. When customers understand date markings and origin details, they are less likely to reject or discard items prematurely, counteracting the trend toward surplus and waste. Meanwhile, **(B2) valorization / recovery** highlights pathways such as donation, discounting, composting, or animal feed that can salvage surplus after it has already been formed. By diverting usable products away from disposal, B2 again balances the reinforcing effect of R1, acting as a safety net for products that might otherwise become waste.

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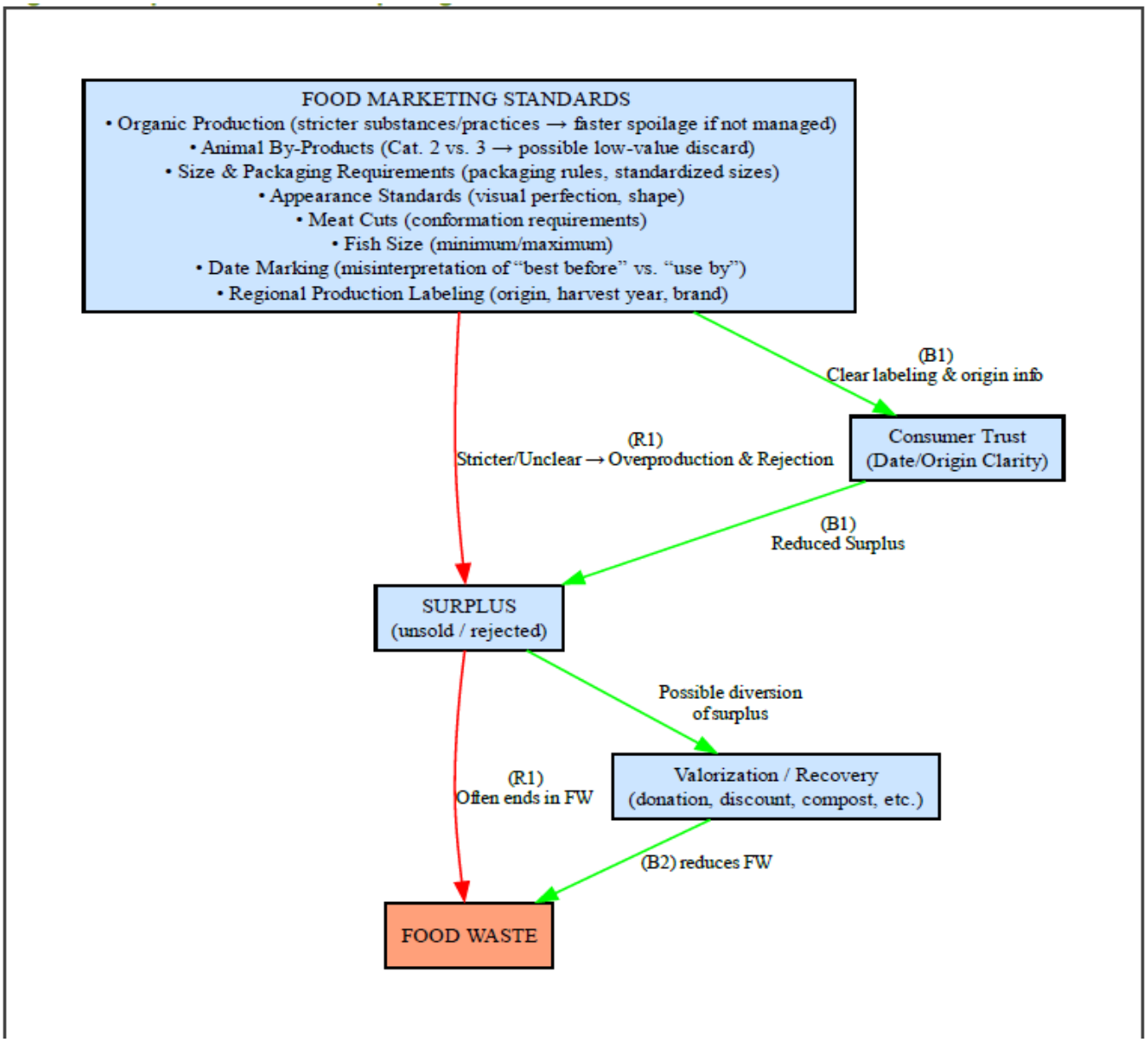
Figure 12: Updated Causal Loop Diagram



Source: Author, developed in the BREADCRUMB project (WP1).

5.3 Final remarks

Presented in this chapter is an updated causal loop diagram that provides a holistic view of how standards, consumer behavior, and market dynamics interact to shape food waste. Instead of attributing waste to a single cause, it highlights the feedback loops that either drive or contain it. By distinguishing reinforcing loops (e.g., R1) from balancing loops (e.g., B2), the diagram reveals leverage points where decision-makers can effectively intervene. The impact of these standards can either lead to an increase in waste (when they are overly rigid or unclear) or a reduction (when they promote transparent information and resource optimization). Ultimately, food waste results from the sum of reinforcing drivers minus the influence of balancing interventions, emphasizing the

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significance of balancing strategies when implementing standards that have the potential to reduce food waste.

6. KEY FINDINGS

This chapter provides an overview of the key findings and hypotheses that have come out of the data in regards to the relationship between public and private food marketing standards, and the relationship between food marketing standards and food waste.

6.1 Relationship Between Public and Private Food Marketing Standards

Research results point to a **predominantly complementary relationship** between public and private food marketing standards. This is highlighted in the inventory of food marketing standards, as well as the interviews and in responses to the survey, where private food marketing standards examined in this study were largely (70%) considered complementary to public standards. The standards were not only considered complementary to each other, but results demonstrated examples of where **private standards built / expanded upon the public ones**. These standards often exceed public requirements, especially for niche markets or firms seeking a competitive edge. Some private standards can be **highly influential** if widely adopted across a sector, especially if retailers require their suppliers to comply with them. Adhering to these standards allows an entity to differentiate its products by responding to a growing consumer demand for a particular quality and, often, mode of production practice. Examples include the appearance of a product (colour, shape, firmness), organic production, as well as requirements related to animal welfare, environmental sustainability, labour rights. However, there was also evidence in the research, although rather minimal, that there exists a **lack of clarity** and understanding about standards among food supply chain actors. Nearly 11% of private food marketing standards identified in the survey were perceived as having **unclear relationships** with public standards due to vagueness or lack of available information. This survey finding was bolstered in the interviews, where several interviewees called for **more transparency** about how private standards are created and implemented. The lack of transparency and clarity can create confusion for supply chain actors, especially for small and medium sized enterprises that struggle to comply with multiple standards.

As regards **hypotheses** on the relationship between public and private food marketing standards, **5** were formulated based on the overall research results.

- Three of the hypotheses related to **category G 'Type of farming and production method',** with one of them also related to **category K 'Restrictions as regards the use of certain substances and practices'.**
- One hypothesis related to **category I 'Frequency of collection, delivery, preservation and handling, conservation method, and temperature storage and transport'**.
- One hypothesis was indicative of **category D 'Presentation, labelling, packaging, marking, year of harvest'.**

Hypothesis: Private food marketing standards refer to public marketing standards, such as those outlined by the World Organization for Animal Health (WOAH), as a basis to build upon to ensure that production methods and controls are put in place that assure adequate welfare for farmed animals (category G). Enforcing **animal welfare standards** addresses consumer demands for more ethical and cruelty-free production. According to Eurobarometer research across the EU member states (2023), 84% of Europeans believed that the welfare of farmed animals should be better

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protected in their country, and similarly, 90% of respondents considered that farming and breeding practices should meet basic ethical requirements.[14]

Hypothesis: Private **organic** standards not only build upon but significantly exceed the EU requirements in terms of allowed processes, substances used, and number of audits (category G and K). Private organic requirements go beyond the EU organic regulation (Regulation (EU) No. 848/2018) in terms of farm conversion, preservation of local species (not specifically outlined by the EU), usage of substances such as pesticides, herbicides, fungicides, and fertilisers (EU allows some usage under certain conditions, while some private organic standards do not), promotion of shorter supply chains, and regular audits.

Hypothesis: EU public standards on **fish stock management** are used as a basis for private standards to address conservation and sustainable fishing (category I). Private standards utilize as a basis EU regulations on fish management and conservation, such as EU Regulation 1380/2013 (Common Fisheries Policy) to put forth complementary requirements that promote the sustainability of fish stocks, and careful management of other species and habitats within the ecosystem affected by fishing activities.

Hypothesis: Private food marketing standards build upon the general **sustainable production** requirements outlined in public standards, such as EU Regulation 1308/2013 on the common organisation of the markets in agricultural products (category G). At the EU level, the European Green Deal first introduced in 2019, the 8th Environment Action Programme (8EAP) of 2022, and the Farm to Fork Strategy, are examples which demonstrate the EU's commitment to environmental and climate goals. There is also growing consumer demand for products that are produced in an environmentally friendly manner. According to Bassi (2023), analysis of responses from 27,498 European citizens across different social and demographic groups in EU member states demonstrates that 90% of the respondents recognized protecting the environment as important and climate change as a serious problem (Bassi, 2023: 6).

Hypothesis: Private **labelling standards for traceability** align with public standards due to their shared emphasis on product safety but complement public standards by providing additional information for consumers (category D). Food labelling plays a critical role in connecting producers and consumers (Corallo et al., 2021; Sayogo et al., 2021; Change et al., 2023). Labelling is not only legally mandatory but also influences consumer choices by providing essential information about food quality, safety, and origin. The additional assurances outlined in these private labelling standards can include but are not limited to issues such as enhanced quality control (systematic and periodic inspections of all certified operations), detailed record-keeping, and verification processes for feed and housing conditions of the animal.

6.2 Relationship Between Food Marketing Standards and Food Waste

Evidence from the research highlights that food marketing standards (private and public ones) **can mitigate or augment food waste**. Standards in the study related to **perceived quality** – such as appearance, size, labelling, specific ingredients and allowable quantities used during production, all had the effect of contributing to food waste generation. In particular, when requirements within a standard were more stringent than what was required by baseline public standards - such as

[14] The Eurobarometer in-person interviews were conducted between March 2-26, 2023, with a total of 26,376 respondents across the EU, including different social and demographic groups. https://ec.europa.eu/commission/presscorner/detail/en/ip_23_4951

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aesthetics and production methods - not adhering to the standard entailed rejection of the product by the buyer even though the food would still be safe to consume. Such standards have a definite effect on the upstream stages of the supply chain, with **over-production** and an increase in costs ensuing to attain the necessary quantity of a product in accordance with the standard. While there may be other market options for rejected food (i.e. **surplus food does not per se equate to food waste**), **donation**, **sale at a lower category and price**, or **valorisation** are possibilities, but such initiatives are dependent on the motivations and resources available to the entity that is left with the surplus food.

Conversely, there were a few examples in the research where food marketing standards could **mitigate** food waste. During the interviews, it was noted that standards provide **standardization in perceived quality** and **predictability,** thereby **facilitating purchase**. The perceived quality of the product (such as appearance or production process) is key because, according to the research results (in-depth interviews), **perceived quality** directly affects the ability to gain the **consumer's trust**. While ensuring food safety is an essential requirement necessary to access the market and an issue that cannot be compromised, according to the research results, the concept of "quality" includes not only food safety but also other factors, such as appearance (colour, shape, size) and production processes. Via the conversations with interviewees, several of them noted that the past decade has seen a shift in food marketing standards, in large part attributed to meeting customer demands. Consumers want to know **where the food product is coming from (origin)** and the **production process**. In this respect, while trade and revenue are key factors, **environmental and social** concerns have come more to the forefront as regards food production.

In regards to the relationship between food marketing standards and food waste, **8 hypotheses** were put forth. These hypotheses demonstrated that **category D, 'Presentation, labelling, packaging, marking, year of harvest'**, and **category E, 'Appearance, consistency, conformation, product characteristics, and percentage of water content',** of Regulation 1308/2013 were **most prevalent** (category D evident in 4 hypotheses, and category E evident in 2 hypotheses). In each of these hypotheses the standard was hypothesized to **augment food waste**. The exceptions were standards related to regional production, which were hypothesized to **mitigate food waste**, and standards related to appearance, which were hypothesized to either **augment or mitigate food waste**, depending on the stage of the supply chain.

Hypothesis: Retailer requirements for **uniform size of fruits and vegetables within packaging** augments food waste (category D). Retailers enforce strict quality standards based on characteristics like size, shape, and appearance rather than focusing solely on edibility. As a result, produce that does not meet these specific standards is often discarded, despite being perfectly safe and nutritious.

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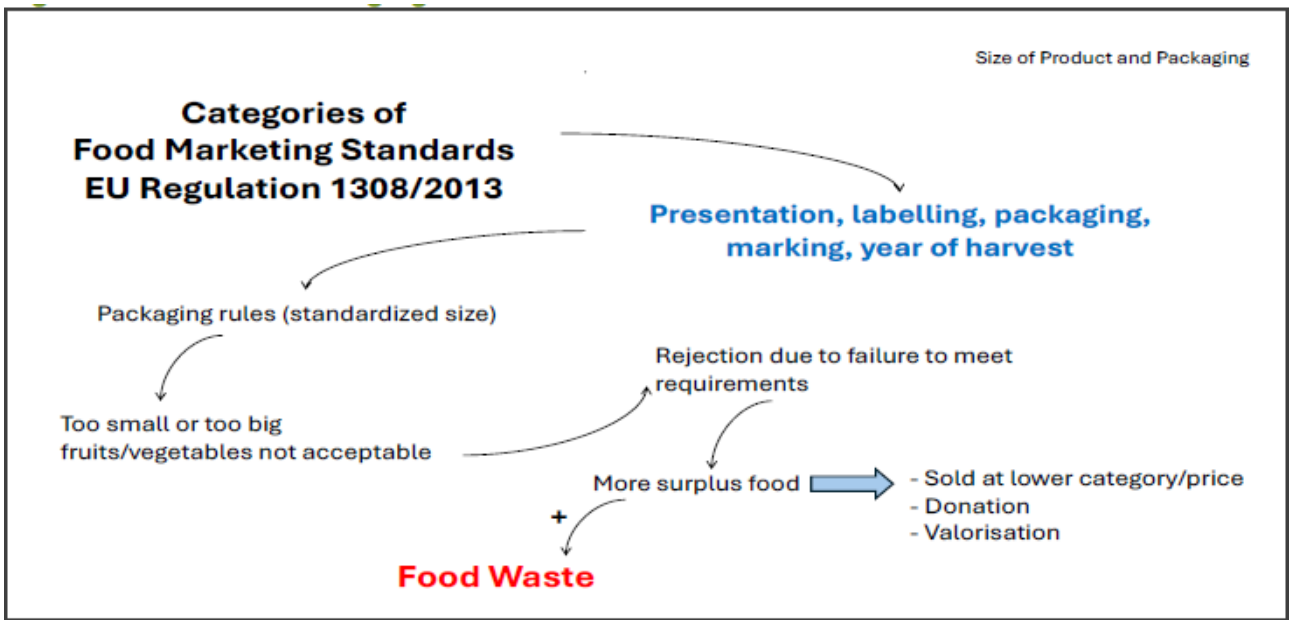
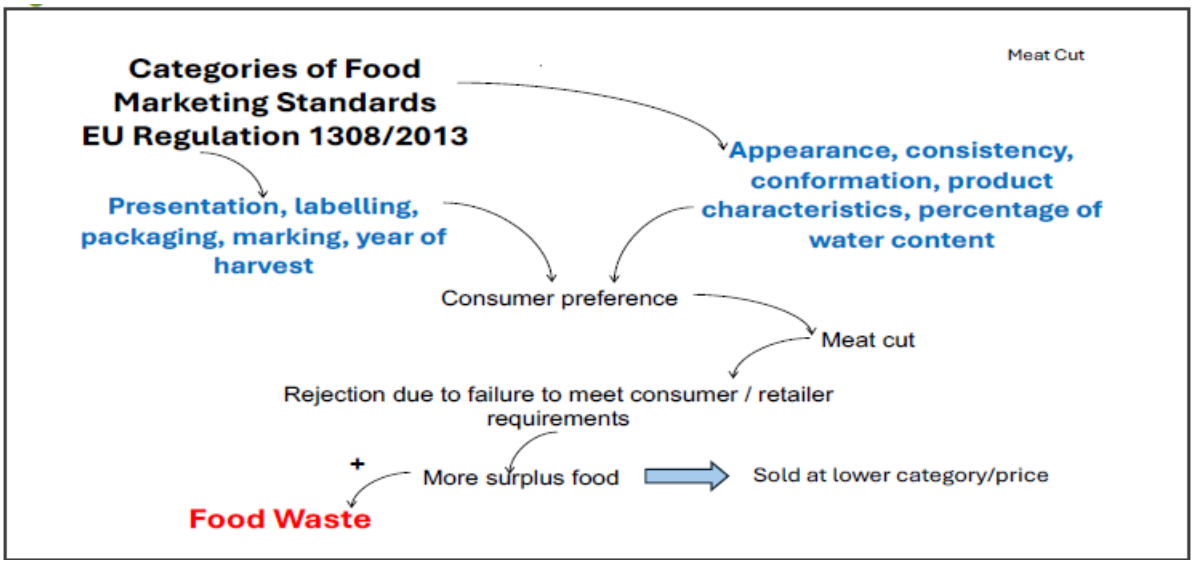
Figure 13: Size and Packaging and Food Waste



Source: Author, based on hypothesis formulation in work package 1.

Hypothesis: Stringent retailer standards for **meat cuts** contribute to food waste (categories D and E). Retailers, in order to meet consumer expectations, establish specific requirements for products delivered by suppliers, with these criteria varying significantly. For instance, some retailers may mandate that pork tenderloins meet a minimum weight threshold, excluding smaller cuts from distribution. Consequently, undersized tenderloins must be repurposed and sold through less profitable channels. Given that meat is a natural product, some variability in size is unavoidable.

Figure 14: Meat Cut and Food Waste



Source: Author, based on hypothesis formulation in work package 1.

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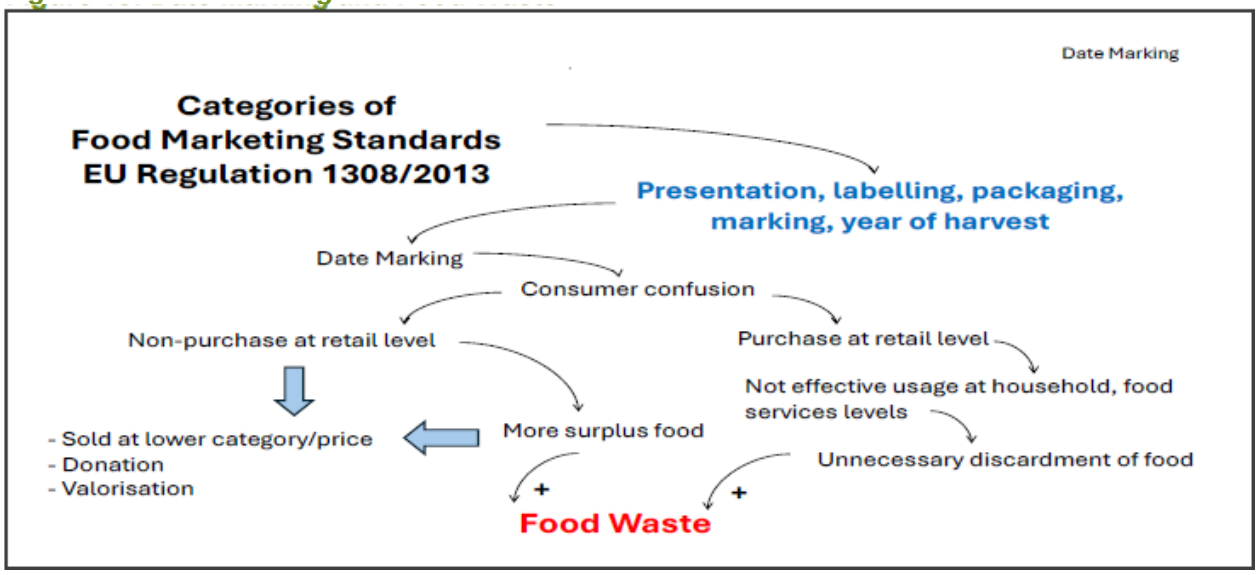
Hypothesis: Misunderstanding about **date marking** on food products causes confusion for consumers and leads to an increase in food waste at the retail and household level (category D). Such date labels influence not only perceptions about product safety, but also quality, may drive lack of purchase at the retail level, or unnecessarily discarding of the food in the home or food services domain.

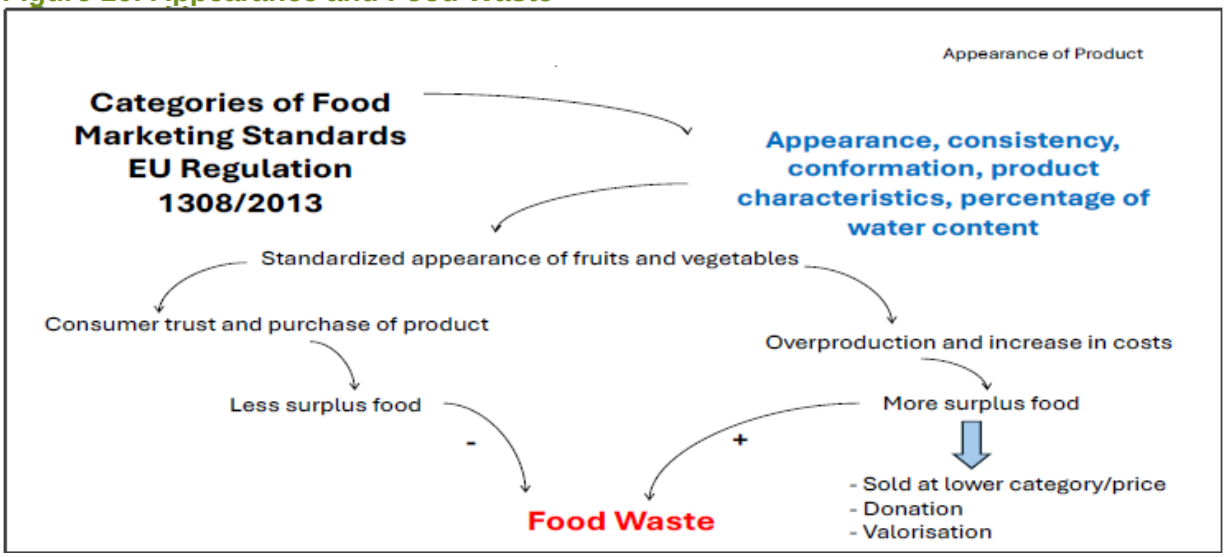
Figure 15: Date Marking and Food Waste



Source: Author, based on hypothesis formulation in work package 1.

Hypothesis: Standards related to the **appearance** of a food product, in particular for fresh produce, put forth stringent requirements that must be adhered to, which augments or mitigates food waste, depending on the supply chain stage (category E). The supply of aesthetically pleasing products helps to reduce waste by ensuring that products meet consumer expectations, leading to purchases and less surplus food at the retail level. However, at the primary production level, such predictability can be hard to achieve, resulting in over-production.

Figure 16: Appearance and Food Waste



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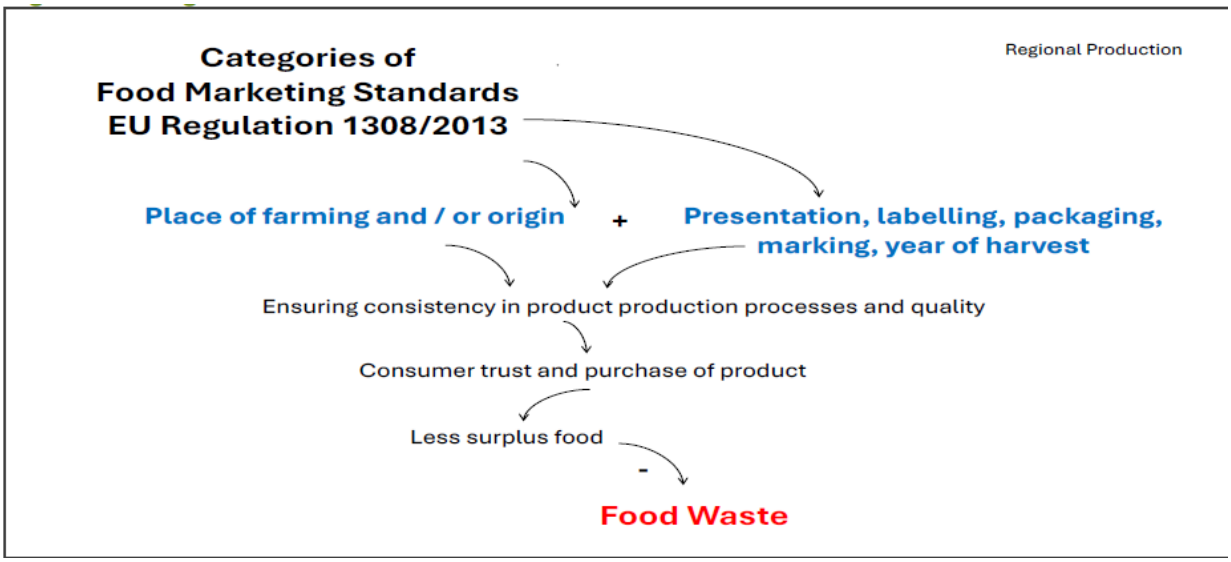
Source: Author, based on hypothesis formulation in work package 1.

Hypothesis: Food products that demonstrate local or **regional production** on their packaging abide by specific and systematic regional production requirements (category D and J).[15] These requirements differentiate them from other similar products, and thereby garner consumer confidence, facilitate purchase at the retail level, and mitigate food waste.

Figure 17: Regional Production and Food Waste



Source: Author, based on hypothesis formulation in work package 1.

The remaining 3 hypotheses all referred to an **augmentation of food waste**. The evident categories of Regulation 1308/2013 evident in the hypotheses were category K 'Restrictions as regards the use of certain substances', category B 'Classification criteria', category M 'Conditions governing the disposal, the holding, circulation, and use of products', and category G 'Type of farming and production method'.

Hypothesis: Stringent restrictions on production substances and practices in private **organic** standards contribute to food waste (category K and G). They contribute to food waste since:

- Ban on synthetic pesticides can lead to greater vulnerability to pest damage.
- Organic food typically spoils faster due to a lack of preservatives.
- Natural cleaning and preservation agents are less potent against bacteria and fungi.
- In the absence of chemical disinfectants, microbial load on surfaces or equipment may increase spoilage rates.
- The absence of serious heat treatments may fail to eliminate all microorganisms.

[15] Category J of Regulation 1308/2013 refers to 'Place of farming and / or origin'. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R1308

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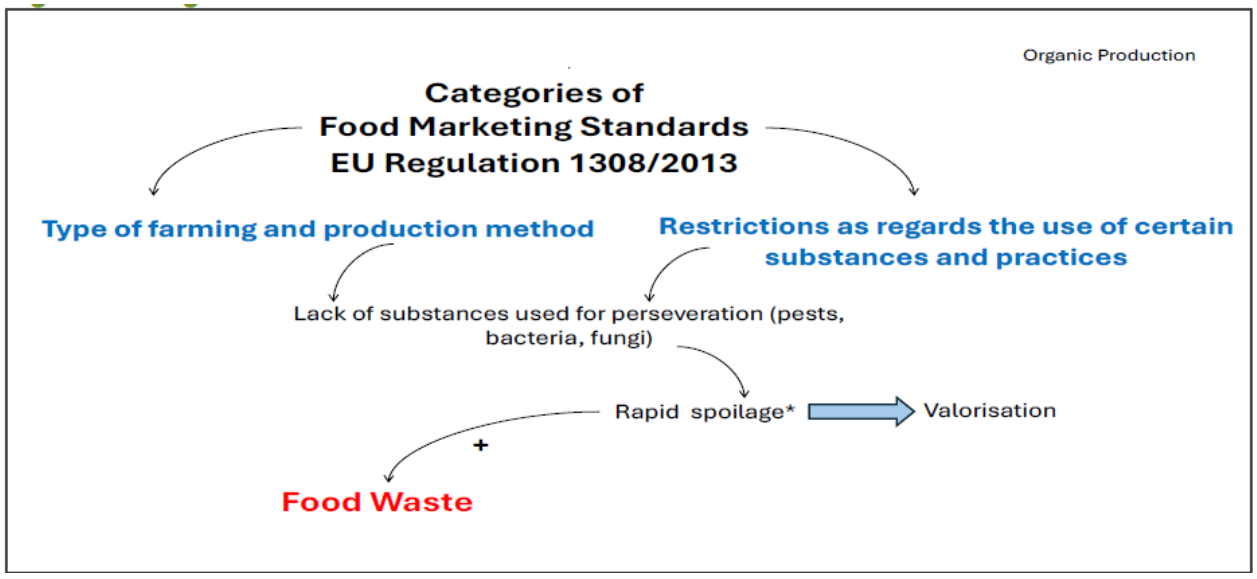
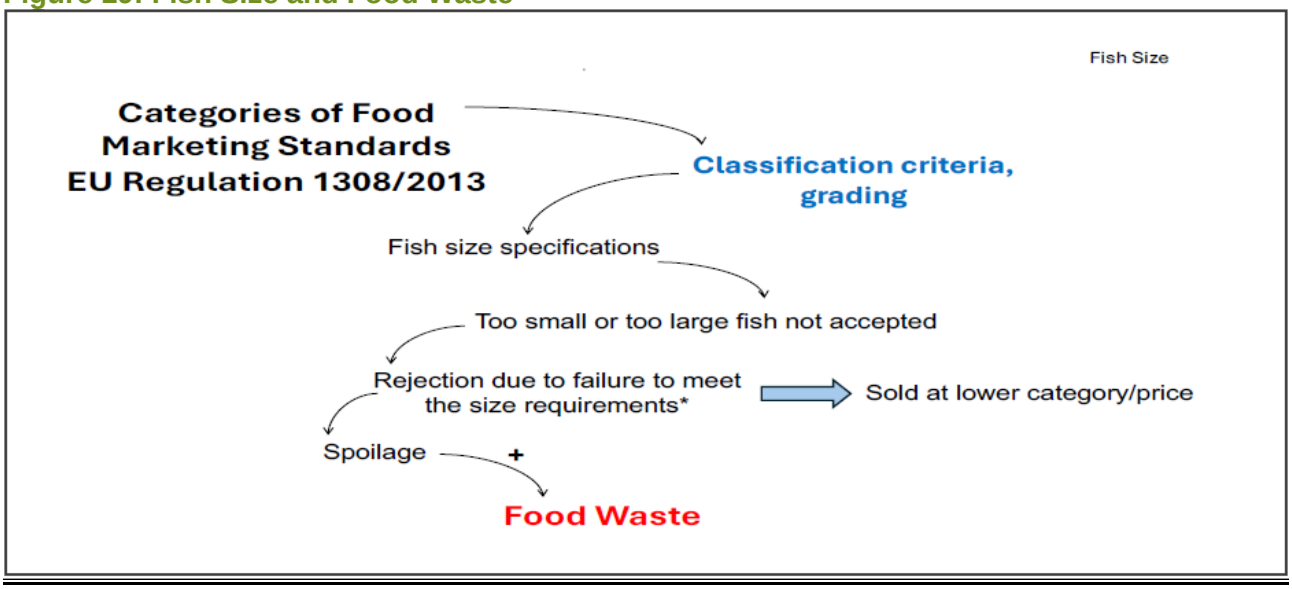
Figure 18: Organic Production and Food Waste



Source: Author, based on hypothesis formulation in work package 1.

Hypothesis: Public food marketing standards related to **size specifications** augment food waste in the **fish industry** by discarding fish that do not meet size requirements (category B). These standards aim to ensure uniformity, appeal, and marketability of fish products. However, they inadvertently lead to the discarding of large quantities of fish, exacerbating food waste. Public food marketing standards often dictate that fish must meet specific size criteria, resulting in the acceptance of only fish within a narrow range. Smaller or larger fish that fall outside these parameters are typically discarded, even if they are edible and nutritious, although there may be efforts to sell them at a lower price. This practice is not only wasteful but also contributes to the depletion of fish populations. Undersized fish are often returned to the sea, where their survival rates are low.

Figure 19: Fish Size and Food Waste



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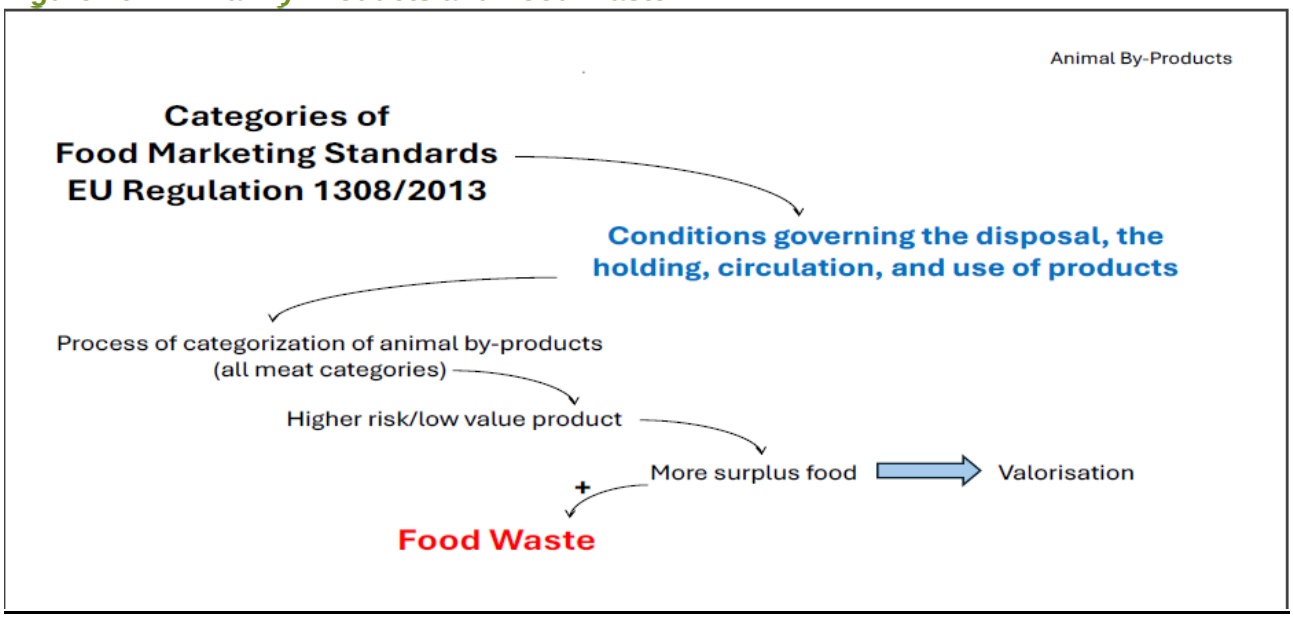
Source: Author, based on hypothesis formulation in work package 1.

Hypothesis: EU public food marketing standards on **animal by-products** contribute to food waste due to the categorization process related to the by-product (category M). Regulation (EC) No. 1069/2009 establishes the health rules for animal by-products and derived products not intended for human consumption. Animal by-products (ABPs) are parts of animals, products of animal origin or other products obtained from animals which are not intended for human consumption. It is legislation which essentially contributes to the prevention and control of animal diseases. Category 3 material defined in the regulation is considered low risk for public or animal health and includes parts of animals that have been deemed unfit for human consumption but still approved for animal consumption or fit for human consumption in a slaughterhouse but which are not intended for human consumption due to either commercial reasons (such as consumer preferences), or manufacturing / packaging defects although they do not pose a risk to public or animal health. Article 10 within the regulation requires that in order for a product to be classified as a category 3 by-product, it should not show any signs of diseases communicable to humans or animals, without specifying what "signs" mean. Not specifying what those “signs” should be can lead to some interpretation by the veterinary authorities. Understandably, authorities want to be cautious when it comes to public and animal health and not take any risks. Consequently, the by-product is often classified as category 2 (i.e. higher-risk and therefore of lower value) when perhaps the product could be treated to become category 3 and even be fit for human consumption. The regulation establishes that the checks to determine whether a product is fit for human consumption are done solely through an ante-mortem inspection of the animal, and not a post-mortem inspection. Post-mortem inspections can show that products thought to not be fit for human consumption are actually fine for humans to consume, reducing the amount of products that are not used for food but rather are revalorized as by-products.

Figure 20: Animal By-Products and Food Waste



Source: Author, based on hypothesis formulation in work package 1.

6.3 The Conceptual Framework Model, Hypotheses, and the Final Causal Loop Diagram

The conceptual framework model developed during the early stages of work package 1 outlined how categories of standards within Regulation 1308/2013 were possibly related to food waste, based on

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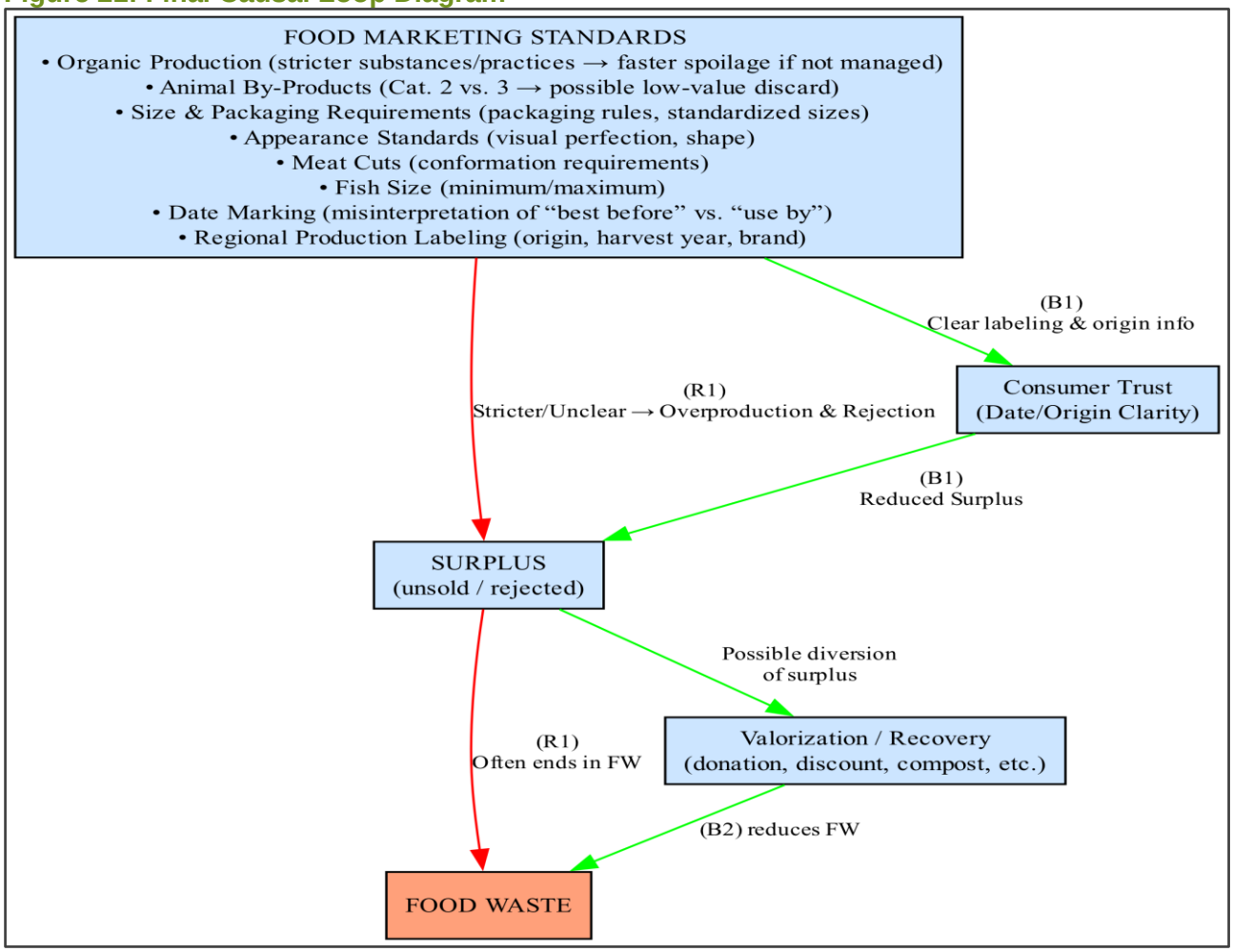
desktop research, including literature review. The formulation of hypotheses later in the work package was done utilizing this conceptual framework model as guidance, combined with the results from further desktop research and literature review, the inventory of identified food marketing standards, survey responses, and in-depth interviews. The **final causal loop diagram** formulated in chapter 5 of this report is a cohesive one in that it incorporates all the hypotheses related to food waste. The diagram illustrates how food marketing standards lead to **surplus** (and subsequently **food waste**) when they are overly strict or unclear, resulting in overproduction or rejection of items that do not meet requirements. Improved **labelling** (particularly for date marking and origin information) garnering **consumer trust, valorization** as well as **food recovery** efforts (such as donations), can **counteract** these negative impacts. Food waste can be viewed as the result of **reinforcing** drivers (strict standards) minus the **balancing** interventions (clear labelling consumer trust, valorization, food recovery efforts).

Figure 21: Final Causal Loop Diagram



Source: Author, based on the research results in work package 1.

6.4 The Broader Context

The research results demonstrate a number of reasons (including economic, environmental, and social) why a standard is put in place. A predominant underlying factor for all standards is to facilitate trade in the supply chain while ensuring that the product is safe and meets consumers' expectations. These expectations refer to wanting to know more about **where the food product is coming from**

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(origin), the **production process**, and, in particular if and how **environmental and social** concerns have been taken into account. Supply chains and the respective standards influencing them are **complex.** Effective management of a supply chain necessitates adhering to food marketing standards, as well as the ability to not only address trade but to have a **balance** between the three pillars of **economic, environmental, and social benefits** to ensure the longevity of a supply chain and the businesses operating within it. Within this context, it can become a challenge to also address food waste.

There does need to be made a **distinction between surplus food and food waste**, since not all surplus food becomes food waste. A variety of different efforts are taking place to utilize surplus food so that it does not become waste. There is a systematic process that all food goes through when coming onto the market, and there are options available so that surplus food can still be consumed. A variety of activities were noted in the research, such as alternate markets to sell the food at a **lower price**, **donation**, and **valorisation**.

The **consumer** also plays an important role. Several of the standards – such as those related to appearance, production methods, and date marking – affect how a product is perceived by the consumer and whether or not it is bought. Moreover, such standards may also affect how the consumer utilizes the product in the home or food services environment, affecting food waste levels.

Food marketing standards, consumer behavior, and market dynamics all **interact** to shape food waste. Food waste cannot be attributed to simply a single cause. The impact of standards can either lead to an increase in waste (when they are overly rigid or unclear) or a reduction (when they promote transparent information and resource optimization). Ultimately, food waste results from the sum of reinforcing drivers minus the influence of balancing interventions. Emphasizing the significance of balancing strategies when implementing standards has the potential to reduce food waste.

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7. CONCLUDING REMARKS AND NEXT STEPS

Developing sustainable food systems refers to meeting not only the food needs of today but also those of the future. The European Green Deal (2019) and Farm to Fork Strategy (2020) demonstrate the EU's commitment to a resilient and sustainable food system. In this respect, the need to address food waste is key, to ensure that as much nutritious food as possible is being consumed and not discarded and subsequently wasted. In an effort to better understand at which points along the supply chain food waste is created, this report has focused on the relationship between food marketing standards and their effect on food waste.

The results of the research demonstrate that there is a predominantly complementary relationship between public and private food marketing standards. Often, private standards were built upon or expanded upon the public ones.They also shown that standards can either lead to an increase in food waste (in particular when they are overly rigid), or they can mitigate food waste, such as when they promote transparent information, provide predictability, and garner consumer trust in a food product. The impact of standards is **not static** in that their impact on food waste can vary based on the food supply chain stage, as well as consumer behavior and market dynamics. Food waste cannot be attributed to merely one cause but rather is affected by various **reinforcing drivers** and **counterbalancing interventions.** Which emphasizes the significance of striking a balancing strategies when implementing or adhering to standards to reduce food waste.

7.1 Limitations of the Study

This research provides crucial insights into the relationship between food marketing standards and food waste in the EU. However, there were some limitations of the study, which are mentioned here below and should be taken into consideration by the reader.

- **Five food commodities:** There are numerous food marketing standards being implemented across the EU. This report and the overall BREADCRUMB project focus on five main commodity groups: fruits and vegetables, meat, cereals, eggs, and fish. Consequently, the hypotheses are based on standards related to only these food commodities.

- **Trade-offs:** The hypotheses formulated in this report need to be seen within their respective contexts. In particular, when looking at the relationship between standards and food waste, even though a standard may augment or mitigate food waste, there are always trade-offs that need to be taken into account, such as environmental factors.

- **Food waste estimates:** There was a clear challenge in locating data on food waste amounts specifically related to food marketing standards. Where possible, estimations were found and indicated, however, there is a gap in such data, which could help to further develop hypotheses.

- **Consumer angle:** The task was not geared towards systematically investigating the role of consumers and food waste. While the Grant Agreement called for a focus on industry in this task, consumers cannot be forgotten. The research shows that food marketing standards affect if a product may be purchased, but further investigations should be made to determine how that food is actually utilised in the food services and home domains.

- **Gender:** While research on gender and food marketing standards is limited, as well as conflicting (some studies suggesting women waste less than men, and other studies

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indicating the opposite), it is clear that food purchasing, preparation, and waste management, coupled with societal expectations and marketing influences are influencing factors on food waste levels. More systematic inclusion of a gender dimension into the discussions is key to providing a deeper understanding of the context in terms of how food marketing standards are perceived and utilised by differing genders and what effect this has on food waste.

7.2 Next Steps

The main objective of this report was to formulate hypotheses demonstrating the relationship between food marketing standards and food waste. **Within the project,** the research results will be used to inform work in other work packages and their respective tasks. In particular, the hypotheses generated are important for the modelling efforts in work package 3, as well as the overall objective in work package 4 to improve market access and the business potential for foods that do not meet food marketing specifications but are still safe to consume. In this respect, the consumer angle, when it comes to food waste, will be more thoroughly explored in work package 4.

Externally, this research contributes to international and EU data and debate on how to continue transitioning to a more sustainable food system, and what part food marketing standards play in this respect. While this report does not aim to pinpoint standards that need to be altered or eliminated, the report is relevant for all stakeholders in the food supply chain and, in particular, for public and private sector initiatives related to food marketing standards. The information provided in this deliverable is meant to complement European Union (EU) research initiatives in this field. It can be built upon as more knowledge about food marketing standards and their effect on food waste is accumulated over time

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9. APPENDICES

Appendix 9.1: Key Definitions

FOOD SUPPLY CHAIN STAGES		SOURCE
Primary Production: The production, rearing or growing of primary products including harvesting, milking and farmed animal production prior to slaughter. It also includes hunting and fishing and the harvesting of wild products. Please note that the majority of material lost in primary production (pre-harvest losses, losses at harvest, animals dead before slaughter) is not regarded as food waste, as it has not been regarded as "food" yet.		Eurostat. (version of June 2022). Guidance on reporting of data on food waste and food waste prevention according to Commission Implementing Decision (EU) 2019/2000. Luxembourg: Publications Office of the European Union (p. 36).
Processing & Manufacturing: This stage of the food supply chain refers to the first processing and manufactoring of food after the primary production and before the retail and other distribution stage of the food supply chain. It is usually the only phase where the slaughtering of animals is foreseen and admitted by law. It is also the phase in which food is transformed, canned, packed and finally made available for retail and distribution.		Eurostat. (version of June 2022). Guidance on reporting of data on food waste and food waste prevention according to Commission Implementing Decision (EU) 2019/2000. Luxembourg: Publications Office of the European Union (p. 36).
Valorisation: Any processing activity whereby food is transformed into a range of value-added products.		European Commission. (version 2020) Brief on food waste in the European Union. Brussels: The European Commission's Knowledge Centre for Bioeconomy (p. 1).
Retail and Other Distribution: This is a stage of the food supply chain concerning the handling of food and its storage at the point of sale or delivery to the final consumer, and includes distribution terminals, shops, supermarket distribution centres and wholesale outlets.		Eurostat. (version of June 2022). Guidance on reporting of data on food waste and food waste prevention according to Commission Implementing Decision (EU) 2019/2000. Luxembourg: Publications Office of the European Union (p. 36).
Food services: This is a stage of the food supply chain concerning the processing of food at the point of sale or delivery to the final consumer, and includes catering operations, factory canteens, institutional catering, restaurants and other similar food service operations.		Eurostat. (version of June 2022). Guidance on reporting of data on food waste and food waste prevention according to Commission Implementing Decision (EU) 2019/2000. Luxembourg: Publications Office of the European Union (p. 36).
Households: This is a stage of the food supply chain concerning the processing and consumption of the food in the households or small residential facilities which are processing the food themselves.		Eurostat. (version of June 2022). Guidance on reporting of data on food waste and food waste prevention according to Commission Implementing Decision (EU) 2019/2000. Luxembourg: Publications Office of the European Union (p. 36).

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FOOD MARKETING STANDARDS & FOOD WASTE		SOURCE
Food marketing standards: Obligatory rules or optional reserved terms aiming to address the expectations of consumers and to improve the economic conditions for the production and marketing as well as the quality of agricultural products.[16] They establish rules regarding product characteristics and other requirements that must be met for products to circulate within in the EU market.		BREADCRUMB Grant Agreement, Annex I, Part A, page 2; electronic version page 98. Regulation (EU) No 1308/2013 of the European Parliament and of the Council of 17 December 2013 establishing a common organisation of the markets in agricultural products and repealing Council Regulations (EEC) No 922/72, (EEC) No 234/79, (EC) No 1037/2001 and (EC) No 1234/2007.
Private food marketing standards are defined as not EU or national legislation, but rather food marketing standards developed and operated by entities other than government bodies - this can include individual companies, food manufacturers, non-governmental organisations, industry associations, and retailers. They operate within the legal framework but are voluntary in nature.		BREADCRUMB Deliverable 1.3
Public food marketing standards are defined as standards established by government agencies or inter-governmental bodies. The standards are often mandatory baseline (minimum) criteria needed for food products in order to legally access the market.		BREADCRUMB Deliverable 1.3
Food waste is defined in accordance with the EC definition[17] as any food and its associated inedible parts (such as bones or fruit cores) that do not find their way to human consumption and rather become discarded. This can occur at all stages of the food supply chain, from farm to fork. In BREADCRUMB, if food products are returned to the land, utilised as animal feed, composted, subjected to anaerobic digestion, or left unharvested, they are considered food waste.		BREADCRUMB Deliverable 1.3 Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (OJ L 312, 22.11.2008, p. 4, point 4a).

[17] Directive 2008/98/EC stipulates that food waste is "All food as defined in Article 2 of Regulation (EC) No 178/20023 of the European Parliament and of the Council that has become waste".

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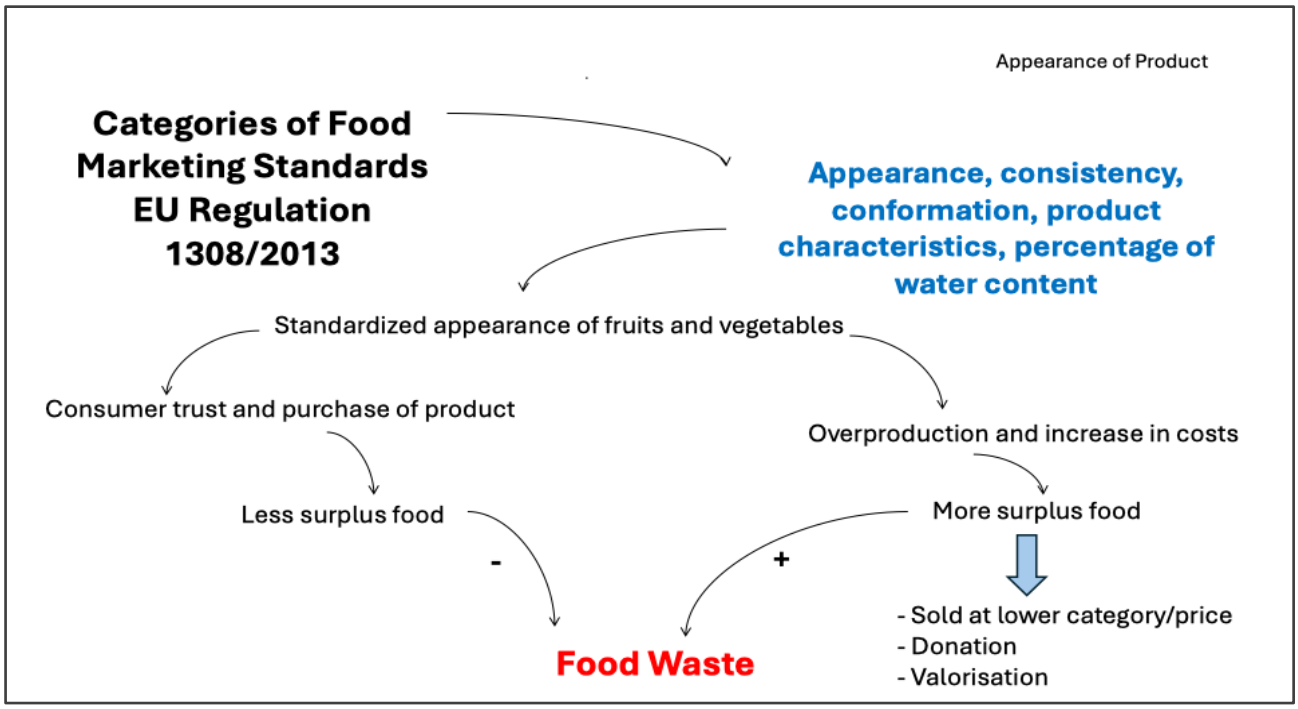
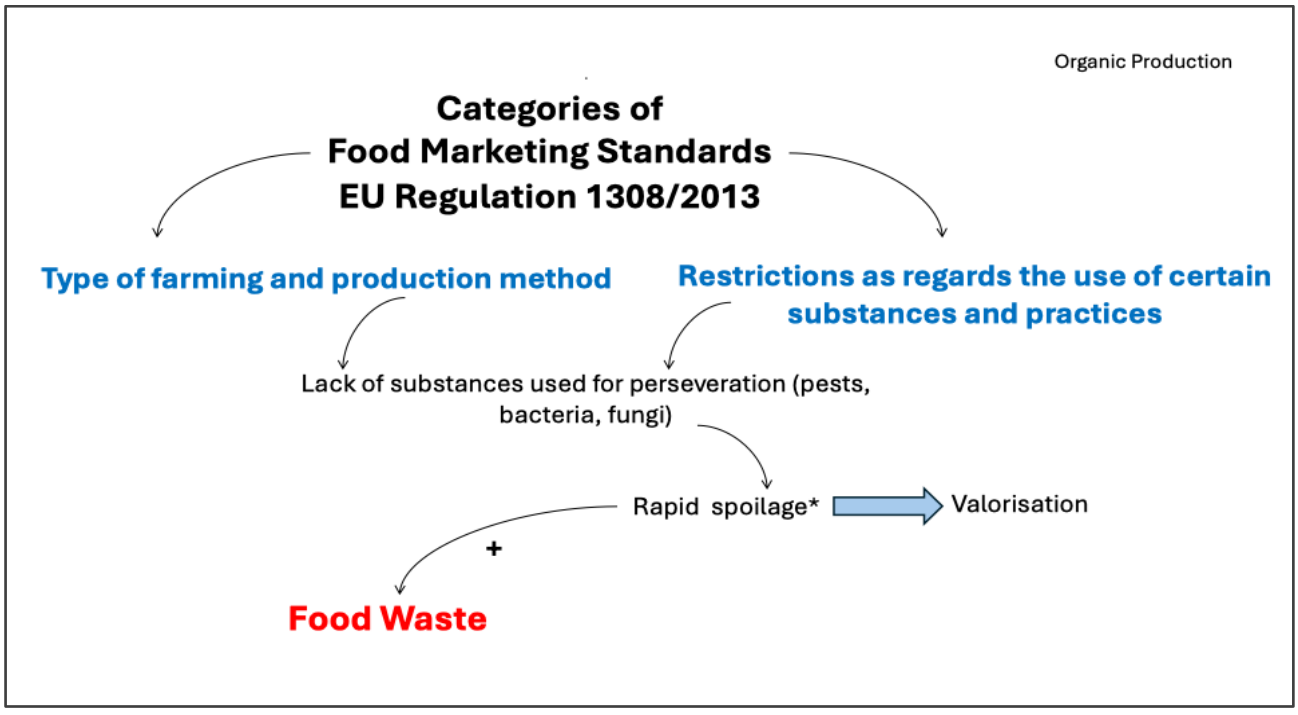
Appendix 9.2: Diagrams - Hypotheses on Food Waste





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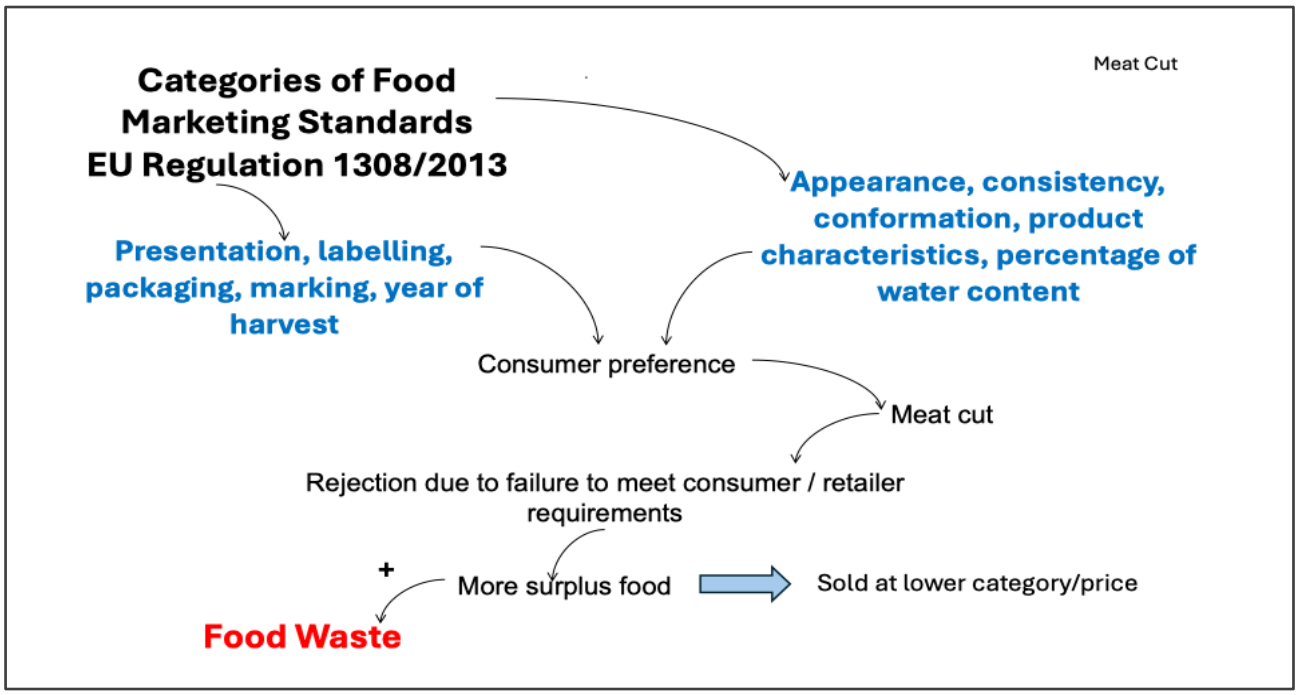

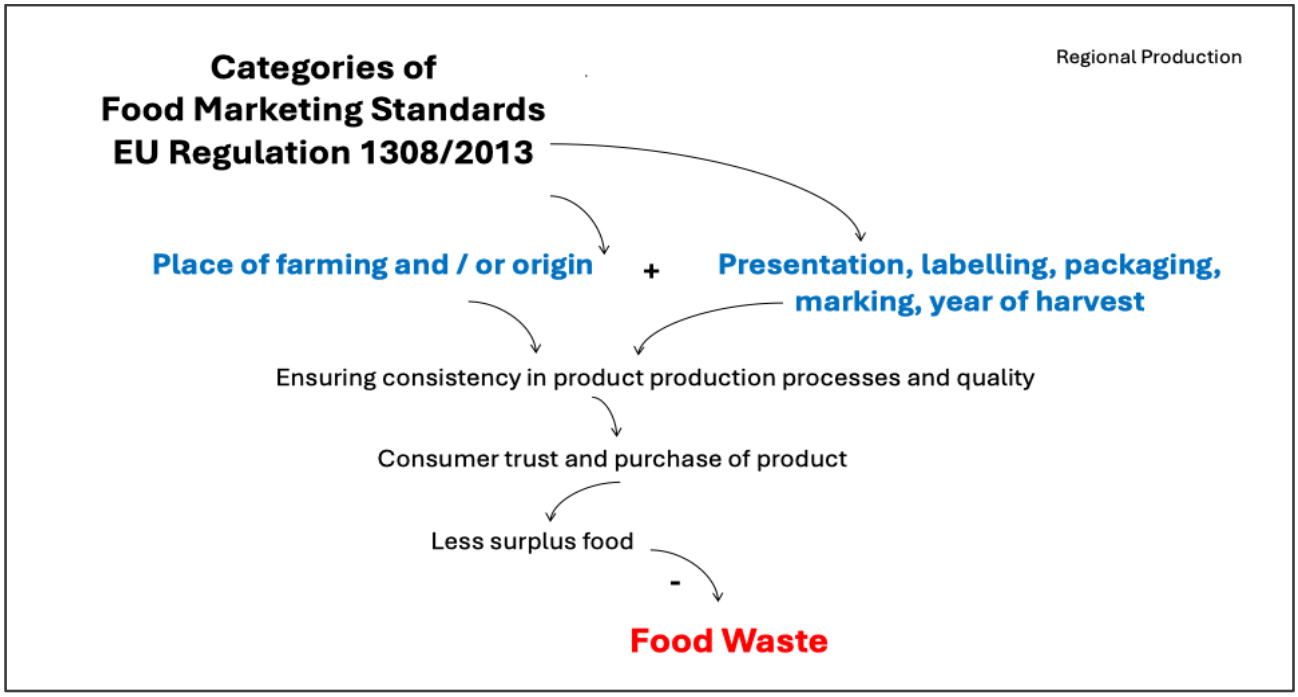

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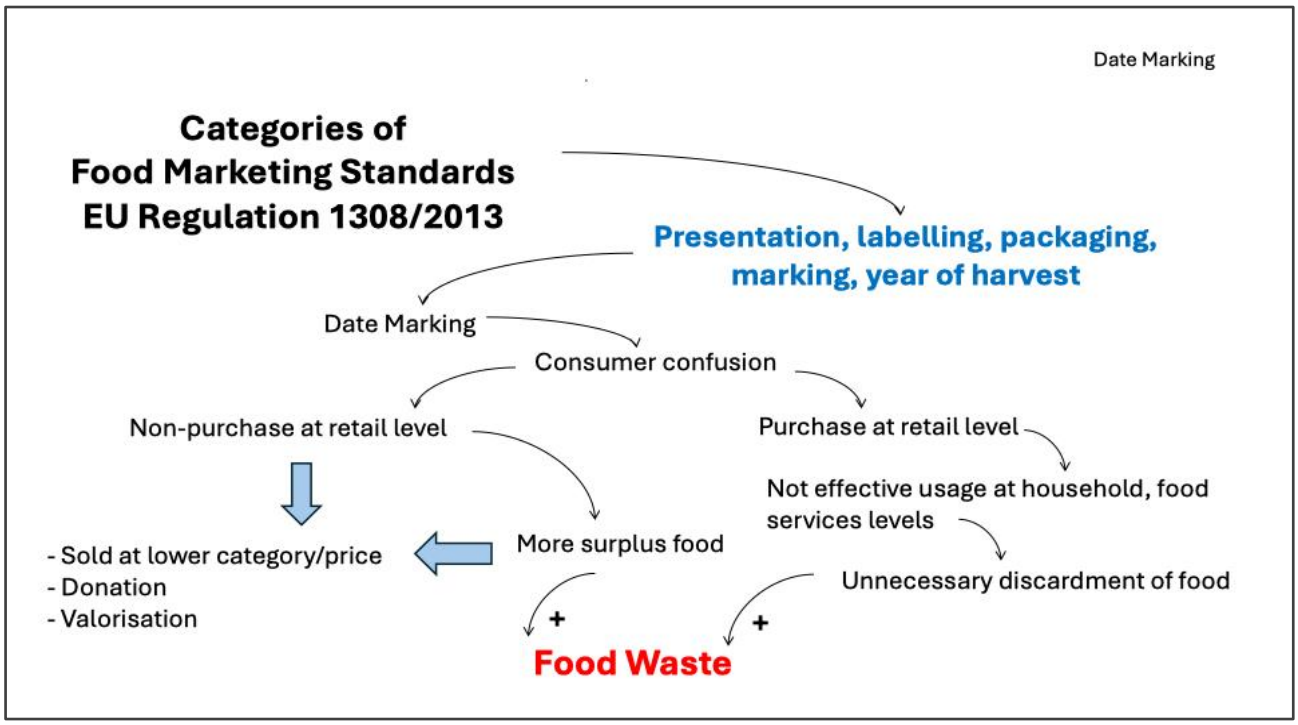

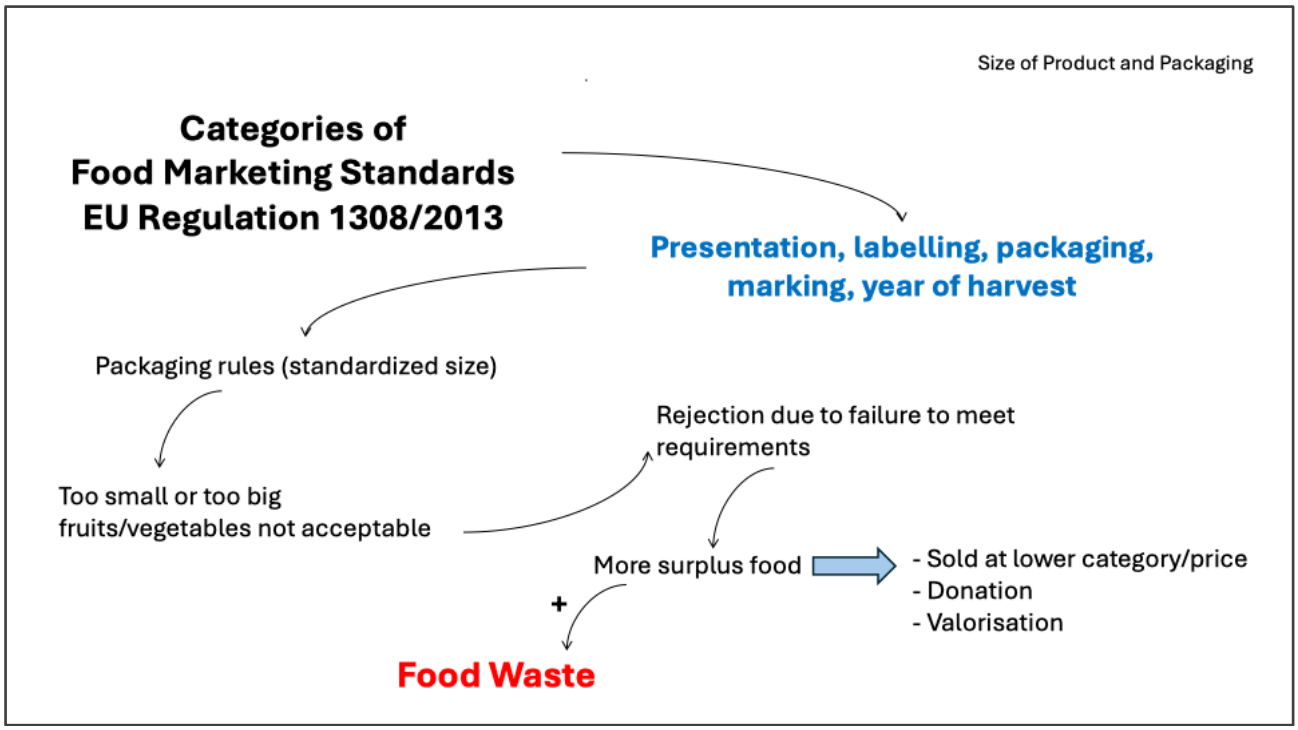

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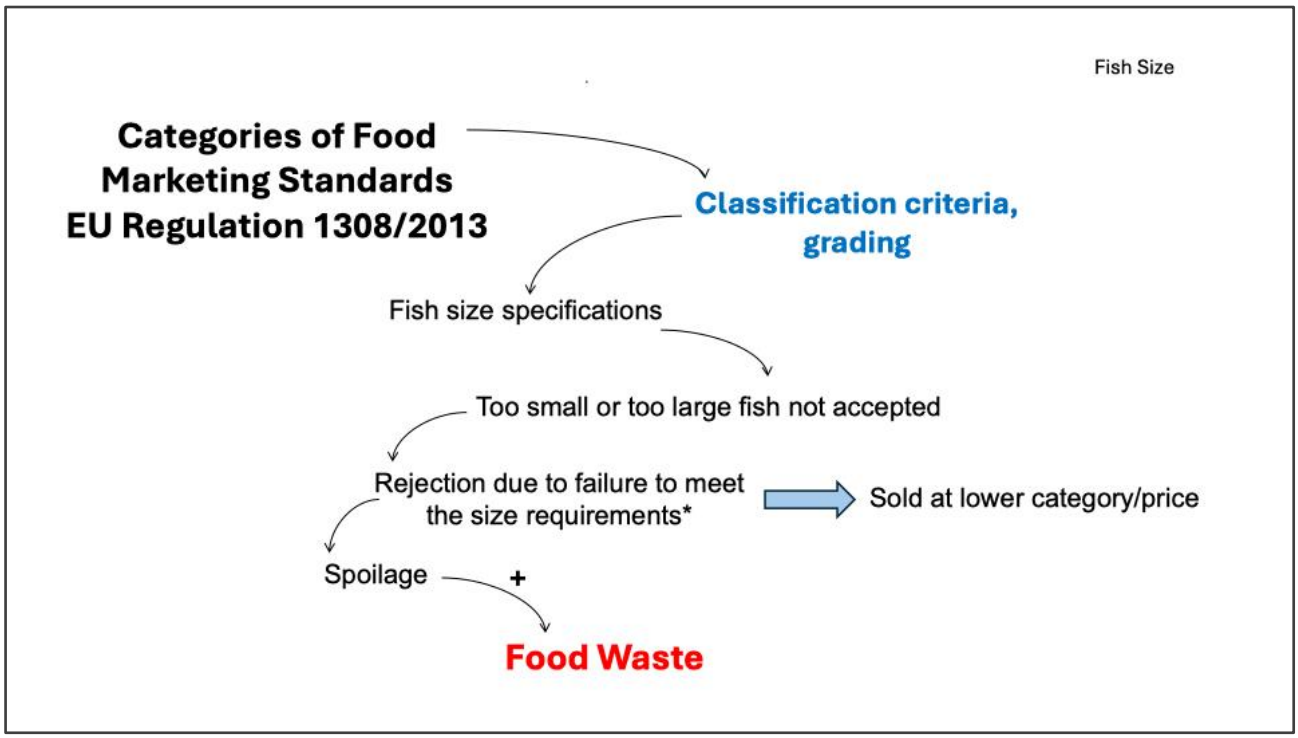

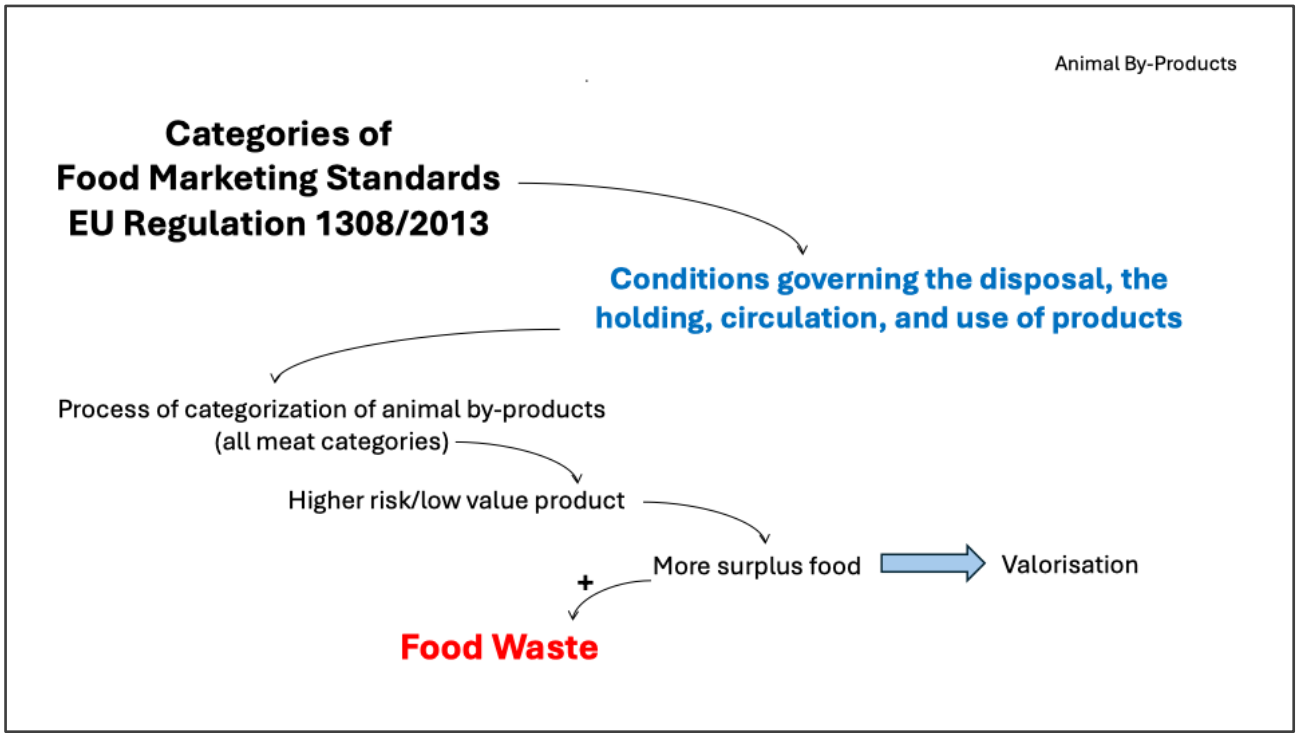

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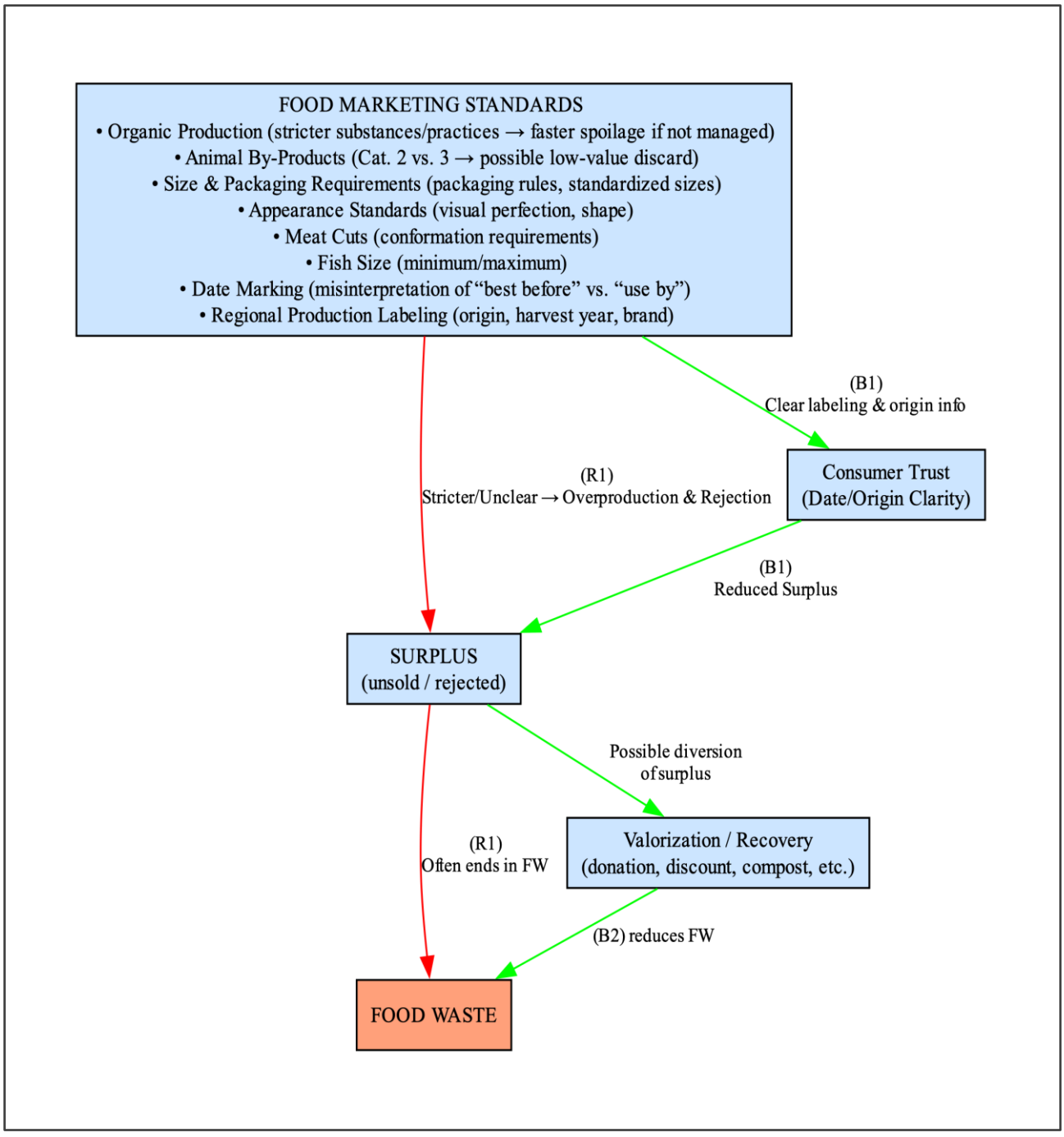
Appendix 9.3: Final Causal Loop Diagram



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