BREADCRUMB

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DELIVERABLE 4.1

Typology of Suboptimal Food Valorisations Options

BREADCRUMB

Project title	BRinging Evidence-bAseD food Chain solutions to prevent and RedUce food waste related to Marketing standards, and deliver climate and circularity co Benefits		
Project acronym	BREADCRUMB		
Call topic	HORIZON-CL6-2023-FARM2FORK-01		
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D4.1 – TYPOLOGY OF SUBOPTIMAL FOOD VALORISATIONS OPTIONS

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VERSION AND AMENDMENTS HISTORY

Version	Date (MM/DD/YYYY)	Created /Amended by	Changes
0.1	20/05/2025	MC (Catarina Mota)	First draft
0.2	16/06/2025	MC (Catarina Mota)	Addressed comments from reviewers and aesthetic points
1.0	24/06/2025	ILVO (Capwell F. Echo)	Final styling

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
BMC	Business Model Canvas
B2C	Business to Consumers
B2B	Business to Business
EU	European Union
FAO	Food and Agriculture Organization
FSC	Food Supply Chain
FMS	Food Marketing Standards
FW	Food Waste
R&D	Research and Development
SF	Suboptimal Food
VASP	Value Added Surplus Product
WP	Work Package

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EXECUTIVE SUMMARY

This deliverable presents a typology of valorisation options for suboptimal food products, developed within Task 4.1 of the BREADCRUMB project. Suboptimal foods—those that are safe to consume but fail to meet marketing standards; represent a significant share of food waste in the EU. This report identifies practical and economically viable alternatives for their valorisation, supporting circular economy principles and improving market access.

Using a structured methodology combining desktop research, stakeholder engagement, and the Business Model Canvas (BMC) approach, representative products were selected from six food categories: fruits, vegetables, meat, fish, eggs, and cereals. The deliverable explores feasible valorisation routes, including redirection to alternative marketing channels and transformation into Value-Added Surplus Products (VASPs). The findings provide both strategic insights and operational tools to support future work in WP4 and beyond, contributing to the EU's food waste reduction goals and fostering sustainable innovation in food systems.

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1 INTRODUCTION

1.1 BREADCRUMB project summary

As outlined in the Grant Agreement, the BREADCRUMB's goals are as follows: "BREADCRUMB aims to provide an empirical evidence-based understanding of the purpose and nature of food marketing standards and their impact on FW generation, to propose interventions that balance the objectives of reducing FW and other objectives of standards, and to help food chain actors increase the business potential of suboptimal foods". (Grant Agreement, Part B, p.3/41)

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 to 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" (Grant Agreement, Part B, p.7/41) (Figure 1).

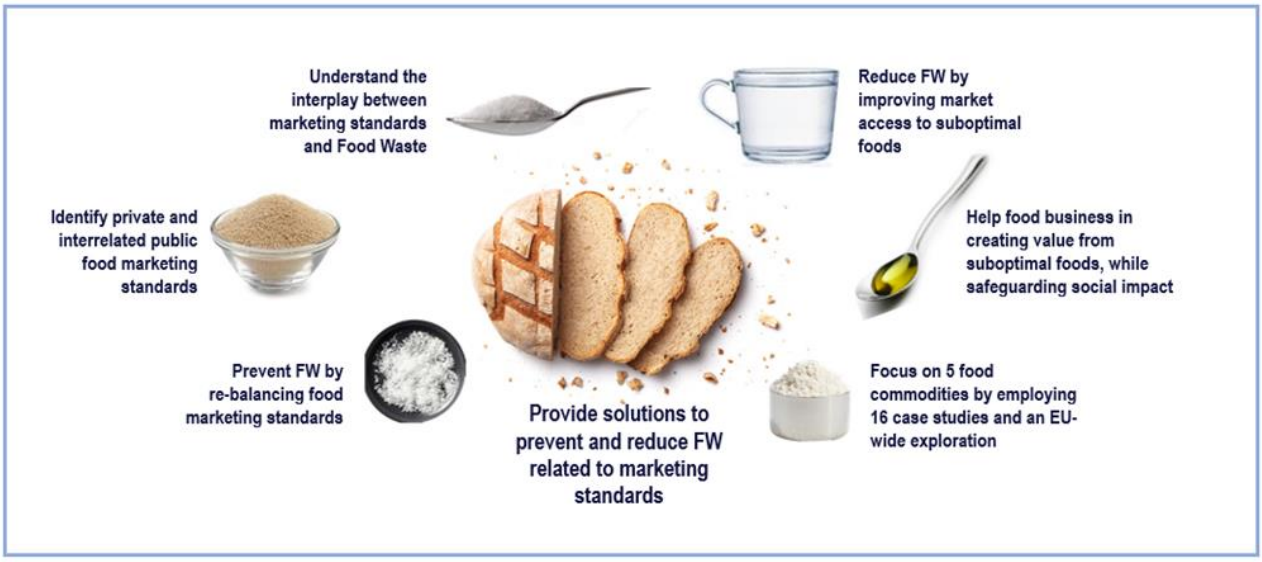

Figure 1: BREADCRUMB project at a glance (source: Grant Agreement, part B. pg5)

To achieve the goals and adhere to the project's methodological approach, BREADCRUMB will utilise existing research connecting marketing standards and FW, create new evidence on the impact of marketing standards on FW, employ advanced modelling methods to develop solutions that integrate behavioural and economic

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theories, use research findings to assess the business potential of non-optimal but still edible food, and incorporate research outcomes into innovative products (Grant Agreement, Part B, p.7/41) (Figure 1).

1.2 Overview of WP4: Summary and objectives

Work package WP4 – Improving market access and business potential for suboptimal foods, is divided into 4 tasks (T4.1, T4.2, T4.3 and T4.4), it is led by AINIA, and have 4 deliverables schedule – D4.1 Typology of suboptimal food valorization options; D4.2 Consumer acceptance and segmentation for suboptimal foods; D4.3 Suboptimal food, business assessment model and D4.4 Marketing cues for suboptimal foods. A short individual summary for each task is provided below, with T4.1 being the only one completed at this time (Figure 2).

- ✓ T4.1 Typology of "suboptimal" food valorization options: selected one specific food product from each of the targeted food commodities. The selection has been made based on:
  - the high influence of marketing standards, and
  - the food product's strong potential business value.

  Based on the use of desktop research, the project team identify current/good practices on the use of marketing channels for similar foods or food categories, they were assessed considering the limitations that each food marketing channel places considering the different types of food suboptimality. This assessment can lead into any of the following results:
  - I. there is no other alternative than the product being removed from human consumption, or be directed towards a valorization channel of lower priority;
  - II. the product can be directed into a different marketing channel and finally to human consumption;
  - III. the product can be transformed into a new Value Added Surplus Product, and then redirected to consumption. Further examination follow for the alternative marketing channels considered feasible, with the identification of business models that can contribute to increased market access and business potential. The business models were analyzed using Osterwalder's Business Model Canvas. The business value of suboptimal foods can extend beyond commercial exploitation.

  Early evidence suggests that only part of the surplus food can practically be redistributed, due to the nature of the food, due to legal accountability issues, or due to inherent difficulties of the marketing channels. Therefore, the project team also explores the practical limitations of socially responsible channels and try to justify that there is room for commercial exploitation of suboptimal foods while safeguarding the social role of food redistribution. The identification of good practices will be followed by a stakeholder co-creation process to finalize the typology of suboptimal food valorization options.

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- ✓ T4.2 Consumer acceptance and segmentation for suboptimal foods: For each of the products successfully assessed in T4.1, the project will examine the willingness and motivations of consumers and food businesses to purchase it. This will be achieved by:
  - undertaking a web-based survey to 500 consumers in 7 EU Member States, facilitated by the case study organizations;
  - by organizing focused groups with consumers and food businesses representatives;
  - by placing suboptimal foods at the retail stage, if local regulations permit it. Willingness to buy suboptimal foods will be measured either using a seven-item Likert scale, or by actual measurements of purchase food.

  A list of potential motivations will be formulated based on previous research, including for example, awareness of FW consequences, convenience orientation, price consciousness, and socio-demographic characteristics. Regression and cluster analysis will be used to identify:
  I. factors driving willingness to buy suboptimal foods;
  II. consumer segments with expected high levels of acceptance for suboptimal foods.

- ✓ T4.3 Suboptimal food, business assessment model: This Task will develop a model for food business to have a preliminary assessment of the business potential of suboptimal foods, called “Food Value Navigator”. It will integrate work results from the previous WP4 Tasks, and also from the simulations of the Agent-Based model (WP3). It is aimed as an easy-to-use model that will be created for the food products assessed in T4.2 and T4.3, but will allow its expansion with additional ones as well. It will guide its user in:
  I. selecting alternative marketing channels;
  II. estimating potential market size for a suboptimal product, considering consumer acceptance;
  III. comparing options, considering quantitative and qualitative factors.

  It will be developed as a freemium product, with the free version as a guidance for the user to add his own data, and further advanced versions with embedded intelligence from the project results (e.g. consumer acceptance levels, clustering capabilities, etc.). the model will be verified by the project case study members.

- ✓ T4.4 Marketing cues, targeting change in consumers attitudes towards suboptimal foods: This Task will develop and validate marketing cues to increase consumer and food businesses acceptance of suboptimal foods and improve their market access and business potential. The work will initiate with identifying cues from relevant food categories or sustainability related contexts and will formulate a set of the underlying messages and corresponding marketing cues to:
  i. convey the identity of suboptimal foods as a new food category with its own social and sustainability properties;
  ii. provide appealing and convincing nudging for the specific food products selected in T4.1, considering the characteristics of the food commodity they are part of, and the specific marketing standards not

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being met. Depending on the results of T4.2, the project will decide on whether the focus would be on extrinsic cues, on intrinsic ones, or on both. The cues will be tested and validated by:

- the case study partners;
- focus groups with external stakeholders, consumers, and food businesses.

The main objectives are to improve market access and business potential of foods that do not meet marketing standards but are still safe to eat (suboptimal foods), by guiding food business in selecting appropriate marketing channels and business models, and assisting them in quantifying their business value and fostering change in consumers and "business" attitudes towards suboptimal foods, through nudging marketing cues.

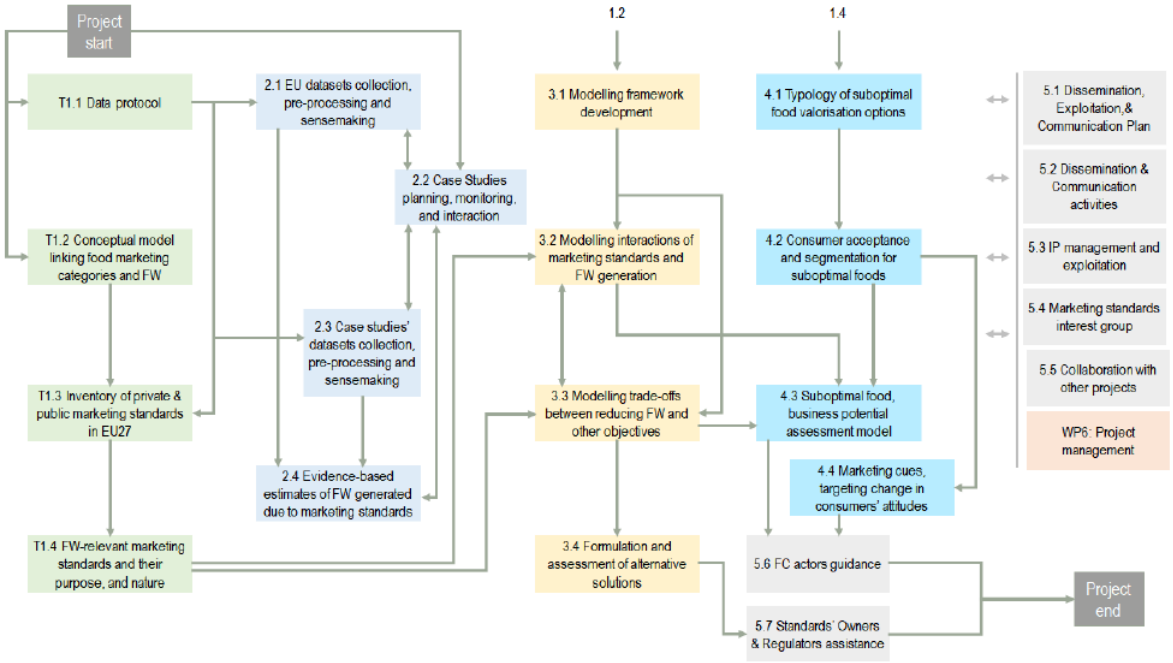

Figure 2 - Interrelations between the different work components – Overview (source: Grant Agreement, part B. pg31)

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1.3 Key definitions

In this section, we provide definitions for key terms used throughout Deliverable 4 to ensure a common understanding among all project stakeholders.

- ✓ Breadcrumb: The name of the Horizon Europe project focused on Guiding food business in selecting appropriate marketing channels and business models and assisting them in quantifying their business value.
- ✓ Valorisation: The process of transforming by-products or waste materials into valuable products or ingredients.
- ✓ Suboptimal food: Food products that deviate from ideal standards in terms of appearance, size, or other non-safety-related characteristics, yet remain safe for consumption or processing.
- ✓ Functional ingredients: Bioactive compounds or components extracted or developed from food products or by-products that provide health benefits beyond basic nutrition.
- ✓ Circular economy: An economic system aimed at minimizing waste and making the most of resources through reuse, recycling, and upcycling.
- ✓ Stakeholders: Individuals, organizations, or institutions involved in or affected by the project outcomes, including food manufacturers, researchers, consumers, and policymakers.

1.4 Deliverable overview and report structure

This deliverable (D4.1 – Typology of suboptimal food valorisation options) is the first of four deliverables under WP4 – Improving market access and business potential for suboptimal foods, as outlined in the Grant Agreement of the BREADCRUMB project. It corresponds to Task 4.1, which aims to define and classify potential valorisation pathways for selected suboptimal food products—those that do not comply with marketing standards but are still safe for consumption. The deliverable builds on previous results (notably from Tasks 1.4, 2.5, and 3.2), and sets the foundation for the upcoming work in WP4, including consumer studies (T4.2), business modelling tools (T4.3), and communication strategies (T4.4). It also supports the integration of findings into subsequent work packages focused on research and innovation scale up (dissemination, communication, exploitation plan - WP5).

The report is organised as follows:

- ✓ Section 1 and 2 – Introduction Provides the context, objectives, and alignment of WP4 with the overall goals of the BREADCRUMB project.

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- ✓ Section 3 – Methodology of Task 4.1: Describes the approach taken to select case study products and develop the typology of valorisation options, including desktop research, product selection criteria, stakeholder workshops, and mapping of good practices.
- ✓ Section 4 – Business Model Canvas: Applies the Osterwalder BMC framework to each selected product, exploring viable business models based on the valorisation options identified.
- ✓ Section 5 – Practical Limitations of Socially Responsible Channels: Discusses the limitations of donation-based redistribution and argues for the complementary role of commercial exploitation of suboptimal foods, ensuring that business approaches do not undermine but rather reinforce the social mission.
- ✓ Section 6 – Conclusions and Remarks: Summarises the key findings and reflects on the implications for future work, highlighting open challenges and opportunities.
- ✓ Section 7 – Literature Review: Presents the bibliographic basis supporting the methodological and conceptual framework of the deliverable.
- ✓ Section 8 – Appendices: Includes supporting figures, templates, and methodological guidelines, particularly for the BMC application.

This structure ensures that the deliverable addresses both the strategic objectives defined in the Grant Agreement and the operational needs of the case study partners, providing a solid basis for further exploration and implementation of valorisation strategies within and beyond the BREADCRUMB project.

1.5 Linkages of the deliverable with other tasks and work packages

Deliverable D4.1 is a foundational component of WP4 and establishes critical input for subsequent tasks and work packages across the BREADCRUMB project. As the first deliverable under WP4, it consolidates technical, contextual, and strategic elements necessary to guide future efforts in improving the market access and business potential of suboptimal foods.

The main linkages are as follows:

- ✓ With Task 1.4 (Marketing standards and business limitations): The selection of representative case study products for Task 4.1 was based on the findings of T1.4, which identified how current marketing standards restrict the commercialisation of certain suboptimal foods. This connection ensures that valorisation strategies are grounded in real regulatory and market challenges.

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- ✓ With Task 2.5 (Characterisation of suboptimal foods): The typology developed in D4.1 is informed by the physical and compositional characterisation of suboptimal products carried out in WP2, helping to assess their suitability for various valorisation routes.
- ✓ With Task 3.2 (Technology mapping and valorisation potential): Information from T3.2 on available processing technologies supports the evaluation of feasible transformation strategies into VASPs, feeding directly into the typology of valorisation pathways.
- ✓ Feeds into Task 4.2 (Consumer willingness and motivations to purchase suboptimal food/products): The products successfully assessed in T4.1. that is, with existence of feasible marketing channels included in this deliverable will serve as the basis for consumer studies that will explore attitudes, willingness to pay, and communication strategies related to suboptimal foods.
- ✓ Feeds into Task 4.3 (Development of a model for business): The results described in D4.1 lay the groundwork for more detailed modelling/tool in T4.3.
- ✓ Feeds into WP5, research and innovation scale up (dissemination, communication, exploitation plan): The typology and business models from D4.1 contribute to identifying scalable, commercially viable solutions that can be exploited beyond the project timeline.

These interlinkages ensure that the work developed in D4.1 is well-integrated with the broader project structure, maximising coherence, knowledge transfer, and long-term impact across the consortium.

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1.6 Objectives of task 4.1

The main objective of Task 4.1 is to develop a structured typology of valorisation pathways for suboptimal food products - i.e., products that are safe for consumption but do not comply with market standards due to aesthetic or physical imperfections. These products are often excluded from conventional distribution channels, contributing to significant food loss.

Task 4.1 seeks to explore how such products can be better integrated into the food value chain by identifying innovative, economically viable, and socially responsible alternatives to current disposal or redistribution practices.

Specifically, the task aims to:

- ✓ **Select representative products** from different food categories affected by marketing standards, based on findings from Task 1.4 and stakeholder input from case studies.
- ✓ **Map and assess valorisation options**, including redirection to alternative markets or transformation into VASPs.
- ✓ **Identify and benchmark good practices** related to the commercialisation of suboptimal food, either directly or through reprocessing.
- ✓ **Engage stakeholders** (e.g. food manufacturers, retailers, social actors) in validating the proposed typologies and valorisation strategies through participatory processes.
- ✓ **Apply the BMC** methodology to selected product cases, to define the key elements of viable business models that could support commercial exploitation of suboptimal food products.

  This task serves as a cornerstone for WP4 by combining a conceptual framework (valorisation typology) with practical BMC, thereby enabling the development of realistic and scalable solutions for reducing food waste while generating economic and social value.

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2 METHODOLOGY OF TASK 4.1

2.1 Overview of task 4.1 methodology

Task 4.1 aims to develop a typology of valorisation options for suboptimal food products that do not meet standard marketing requirements but remain fit for human consumption. The task is coordinated by MC, with contributions from EV-ILVO, ITC, AINIA, MCH, and PNO, and is scheduled between March 2025 (M15) and June 2025 (M18). The methodology is structured around the following steps:

Figure 3: Structure of the methodology

- ✓ **Selection of Representative Products:** One representative food product is selected from each of the target categories identified in the project. Selection is based on:
  - The level of marketing constraints previously identified (Task 1.4), and
  - The assessed business potential through stakeholder engagement in case studies.
- ✓ **Desk Research and Good Practices Mapping:** A thorough desk-based review is conducted to identify current practices and successful examples of marketing or revalorising products in similar food categories. These are assessed for their applicability to suboptimal foods, considering the specific limitations imposed by their condition.
- ✓ **Classification of valorisation pathways:** Three main valorisation scenarios are explored:
  - Exclusion from the food chain, with redirection to low-priority channels (e.g. energy recovery, feed).
  - Alternative marketing approaches, where the product remains in the food chain (e.g. discounting, direct-to-consumer channels).
  - Transformation into VASPs, involving reprocessing into new, marketable food formats.
- ✓ **Feasibility Assessment and Stakeholder Engagement:** The practical feasibility of each valorisation scenario is analysed through consultation with relevant case study partners, including food producers, retailers, and innovators. Co-creation methods are applied to validate the typology and ensure real-world relevance.
- ✓ **Business Model Canvas Application:** For each viable valorisation scenario, BMC is used to assess the underlying business logic and strategic potential.

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This structured methodology ensures that valorisation options are not only theoretically sound, but also viable, scalable, and aligned with real market and policy conditions. The outcomes of Task 4.1 are consolidated in Deliverable D4.1 and provide a foundation for downstream sustainability and impact assessments in subsequent tasks.

2.2 Development of methodology

As mentioned above, the methodology developed for Task 4.1 is grounded in previous analytical work from the BREADCRUMB project, notably, not only in Tasks 1.4, but also, in deliverables 2.5, and task 3.2, and enhanced through extensive desktop research and stakeholder engagement.

- ✓ **Task 1.4**, insights were gathered regarding the impact of food marketing standards on the food supply chain, identifying how these standards can lead to the exclusion of food products that, despite being safe for consumption, deviate in appearance, size, or other non-safety parameters. This informed the selection of case study products most affected by such standards.
- ✓ **Task 2.5** contributed with detailed characterisation of suboptimal foods, particularly in terms of physical and compositional properties, which helped determine suitability for different valorisation routes, such as reprocessing into new products or redirection into alternative markets.

The methodology included for product selection:

1. **Selection of Representative Products**: from each of the targeted food commodities, the following criteria were defined and are presented below:

- ✓ **High Influence of Marketing Standards**
  - Products with higher FW due to FMS (T2.5 and T1.4);
- ✓ **Representativeness of the Data**
  - Covers most of the FSC;
  - Data collection based on a higher number of interviews/surveys;
- ✓ **High Applicability**
  - The product is versatile and can be used in many different ways;
  - High Geographical Coverage*
- ✓ **High Impact**
  - Rebalancing existing marketing standards would positively contribute to FW reduction and there is an opportunity to increase sales of suboptimal food by exploring new marketing channels (existence of feasible marketing channels for product valorisation);
  - There is room to explore new marketing channels for suboptimal products;

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- ✓ **Capacity of Partners to Carry Out Studies Per Type of Product**
  - The capacity of partners to carry out studies for following WP task will be considered and assessed during workshops per food commodity with case study partners.

2. **Desktop Research**: A literature and market review were conducted to identify good practices in suboptimal food valorisation and current alternative uses (e.g., energy recovery, animal feed, direct discount sales, or transformation into new products).
3. **Classification of Valorisation Pathways**: Three main routes were considered:
   - ✓ Exclusion from the food chain (e.g., composting, bioenergy);
   - ✓ Alternative marketing channels (e.g., discounted sales, direct-to-consumer);
   - ✓ Transformation into VASPs.
4. **Feasibility Assessment and Stakeholder Engagement**: Stakeholders were involved in validating the selected case studies and valorisation scenarios through co-creation sessions, ensuring practical relevance.
5. **Application of the BMC**: For each product and viable valorisation scenario, the BMC framework was used to outline the key elements of a potential business model. This includes value propositions, customer segments, channels, revenue streams, and cost structures.

This integrated methodology allows BREADCRUMB to build a robust typology of valorisation options for suboptimal foods, supporting market access strategies that align with both **economic opportunity** and **food waste prevention goals**.

*Regarding the **geographical coverage**, products widely consumed and produced at the European level were considered most relevant. For that, the top 10 most products vegetables, fruits, meat, cereals and fish in Europe were assessed according with the most recent data provided by Eurostat, as presented below:

According to the latest data from Eurostat (Fruit and vegetable production in 2022), the top 10 most produced **vegetables** in Europe are:

1. **Tomatoes**: 15.4 million tonnes
2. **Onions**: 6.2 million tonnes
3. **Carrots**: 4.4 million tonnes
4. **Cucumbers and Gherkins**: 3.1 million tonnes
5. **Cabbages**: 2.8 million tonnes
6. **Peppers**: 2.5 million tonnes
7. **Lettuce and Chicory**: 2.3 million tonnes
8. **Pumpkins, Squash, and Gourds**: 1.9 million tonnes
9. **Spinach**: 1.5 million tonnes
10. **Cauliflowers and Broccoli**: 1.4 million tonnes

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According to the latest data from Eurostat (Agricultural production – crops, 2024), the top 10 most produced **fruits** in Europe are:

1. **Apples**: 12.6 million tonnes
2. **Pears**: 2.1 million tonnes
3. **Citrus Fruits**: 10.5 million tonnes
4. **Stone Fruits**: 6.3 million tonnes (including peaches, nectarines, apricots, cherries, and plums)
5. **Sub-tropical and Tropical Fruits**: 2.6 million tonnes (including figs, kiwis, avocados, and bananas)
6. **Nuts**: 1.1 million tonnes
7. **Berries**: 0.7 million tonnes
8. **Grapes**: 1.5 million tonnes
9. **Melons**: 1.2 million tonnes
10. **Strawberries**: 0.9 million tonnes

According to the latest data from Eurostat (Agricultural production – crops, 2024), the top 10 most produced **cereals** in Europe are:

1. **Wheat**: 126.6 million tonnes
2. **Barley**: 52.3 million tonnes
3. **Maize**: 67.2 million tonnes
4. **Oats**: 8.1 million tonnes
5. **Rye**: 7.8 million tonnes
6. **Triticale**: 4.2 million tonnes
7. **Sorghum**: 1.1 million tonnes
8. **Rice**: 2.9 million tonnes
9. **Spelt**: 1.5 million tonnes
10. **Millet**: 0.8 million tonnes

According to the latest data from Eurostat (Fisheries Database, 2024), the top 10 most produced or consumed **fish** in Europe are:

1. **Atlantic Salmon**
2. **Rainbow Trout**
3. **European Sea Bass**
4. **Gilthead Sea Bream**
5. **Common Carp**
6. **Blue Mussel**
7. **Pacific Oyster**
8. **European Eel**

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9. **Herring**
10. **Cod**

According to the latest data from Eurostat (Agricultural production - livestock and meat, 2025), the top 10 most produced or consumed **meats** in Europe are:

1. **Pigmeat**: 20.6 million tonnes
2. **Poultrymeat**: 13.3 million tonnes
3. **Beef and Veal**: 7.8 million tonnes
4. **Sheepmeat**: 0.9 million tonnes
5. **Goatmeat**: 0.2 million tonnes
6. **Horsemeat**: 0.1 million tonnes
7. **Rabbitmeat**: 0.1 million tonnes
8. **Duckmeat**: 0.1 million tonnes
9. **Turkeymeat**: 1.9 million tonnes
10. **Other Poultry meat**: 0.3 million tonnes. This category includes less common poultry such as ostriches and quails, which are not statistically significant in terms of overall production

Methodology for product selection:

- ✓ After the definition of the selection criteria presented above, 2 different methodologies were followed for the final selection of the products to be studied within WP4, depending on the number of case study partners involved in each food commodity and the complexity of them (number of products studied within WP2).
- ✓ For the food commodities “fish”, “eggs” and “cereals” straight 1:1 communication with case study partners was carried out.
- ✓ For more complex food commodities, “fruits and vegetables” and “meat” which involved larger number of products and case study partners involved, 30 minutes workshops were carried out to define the final products selected. During the workshop sessions, each case study partner was asked to suggest a product within each food commodity to be studied, according to the selection criteria defined. The impact and feasibility were assessed for each of the products suggested, and the product(s) with higher impact and feasibility will be chosen to be studied within WP4.

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The final selection, is presented on the, Table 1 – Selected products, from each food commodity:

Table 1 – Selected products, from each food commodity

Food Commodity	Responsible	Selected product/s	Support Partner (Case Study Partners)
F&V (FRUITS)	AINIA	Citrus fruit (oranges and yellow limes) Apples	ANECOOP CSCP-LN NN
F&V (VEGETABLES)	ILVO	Carrots Onions	MC/MCH ITC-MENSANA-ZT
CEREALS	ITC	Wheat Oat	ITC-MENSANA-ZT-VILA NATURA
MEAT	MCH	Cooked pork ham	FENAVIAN/FEBEV/AVEC
FISH	PNO	Bogue	CREDA/OPPB
EGGS	MC	EggShells	UCPH-LF

2.3 Identification of good practices on the use of food marketing channels of similar foods or food categories

2.3.1 Fruits and vegetables

- ✓ **Fruits (oranges, limes and apples) and vegetables (onions and carrots)**

The commercialization of Suboptimal Food (SF) has been identified as one way to tackle food waste as part of a prevention strategy. SF is defined here, in accordance with Aschemann-Witzel, De Hooge, Amani, Bech-Larsen, and Oostindjer (2015), as food products with an abnormal appearance and/or other deviating product attributes (e.g. feel, smell) as well as products that are close to or have passed their expiration date but which are still unreservedly consumable. However, the results of many studies have shown that consumers tend to reject SF (Rohm et al., 2017). Moreover, as with many ethical values, a considerable attitude-behavior gap has been revealed: Even those consumers who are aware of the problem of food waste often choose not to buy SF (Aschemann-Witzel et al., 2017, De Hooge et al., 2017, Symmank et al., 2018). Although consumers

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have the final purchasing power, the retail sector is responsible for shaping and influencing consumer behavior in the first place. Wholesalers and retailers operate as powerful gatekeepers between production and consumption, thereby either hindering or encouraging the successful commercialization and consumption of SF. As a consequence of the overall situation, SF products are either left in the fields (Porter et al., 2018, Stuart, 2009) or are thrown away by retailers (Cicatiello, Franco, Pancino, Blasi, & Falasconi, 2017). At the farm level, up to 40% of fruits and vegetables can become food waste as a result of the demanding internal trading standards of retailers (De Hooge, Van Dulm, & Van Trijp, 2018). At retail level, SF is likely to account for almost all food wasted in retail stores.

Nowadays, a third of all produced fruits and vegetables is thrown away even before it reaches the consumer (Parfitt at al., 2010) This amount of food waste is contradictory with the world population growing towards nine billion people by 2050, people who all need food to survive (Gustavsson, 2011). The most wasted fruits according to data presented previously in the EU were apples and citrus fruits (which includes oranges and limes).

One of the findings of European project, REFRESH (eu-refresh.org) finished in 2019, which aimed at bringing together stakeholders from all stages of food supply chain towards the goal of reducing food loss and waste, was that “second class” fruits and vegetables are often not sold by retailers as it is believed that consumers prefer “perfect” products. This fact has also been identified in D1.4 as one of the main hypotheses confirms that one the most important reasons for product rejection is aesthetic defects.

Amongst different food marketing channels identified to contribute to the reduction of food waste it is highlighted the development of processed products, from damaged oranges, such as juice, marmalades, components extracted from different parts of the oranges for the food sector or cosmetics. Also, the obtention of puree from suboptimal apples, and work with consumers behaviour to show them that there are no safety risks in buying what so called “ugly foods” due to aesthetic damages, deformed or small or too big sizes as it happens with yellow limes, which are expected to be green but still acceptable to be consumed.

The development of food products by using suboptimal is a very interesting way of reducing food waste, nevertheless it implies investment in technology and resources. Many retailers are changing their view and offering such products to reduce food waste at lower prices. This is an opportunity rather than a failure, since it is a way to boost sales of products that otherwise would be unsaleable products. Vegetables (onions and carrots)

Regarding vegetables, two different products were chosen. One the one hand suboptimal onion, on the other hand suboptimal carrots.

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The total onion waste generated in European countries, such as Spain, the Netherlands, and the United Kingdom, where onion production is significant, is as high as 500,000 tons per year (Sharma et al. 2016). Approximately 37% of fresh onions are discarded during industrial processing, mainly as peel and skin, but this figure also includes onions lost due to sprouting and decay (Zhang et al., 2024).

Sprouting (Figure 4) is a common cause of onion waste, particularly during storage. Studies show that after 9 months of storage, up to 18.1% of some onion cultivars stored in air (without sprout suppression treatments) developed visible sprouts (Forney et al., 2022). Sprouted onions are often discarded if they are considered unsuitable for sale or consumption, especially in commercial supply chains. Other examples of suboptimal onion are misshapen or irregular shapes or discolored outer skins, while inner layers are still fine

Sprouted onions in Europe typically occur in late winter or early spring (February to April). This is linked to the storage and harvest cycles of onions.

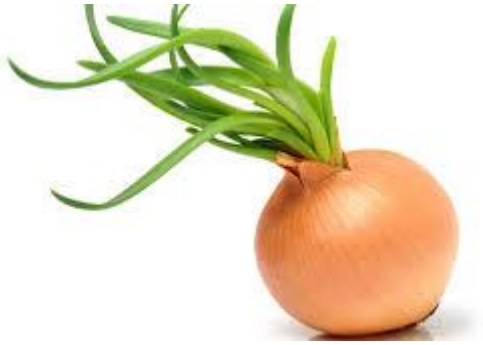

Figure 4: Sprouted onion

Precise EU-wide figures for suboptimal carrot waste are not available, but different sources highlight that sorting losses can be substantial. Examples of suboptimal carrots are forked carrots (leading to odd shapes), size of carrots, cracked carrots or hair roots. The European Statistics Handbook (2024) notes that, despite a significant carrot harvest, '*sorting losses were high right from the start*' due to adverse harvest conditions. The effects of unfavorable weather on the quality of stored carrots mean that a notable proportion of the harvest does not reach the market and is wasted, though exact tonnage is not specified. In EU, the most carrot waste happens just after the main harvest (late summer to autumn (August to November), additionally in the winter and early spring (February to April) due to storage.

Small-sized carrots are classified as suboptimal food in Europe due to strict marketing standards on size. A significant share-over a third-of carrots are downgraded or wasted because they do not meet retailer requirements, with small size being a major factor (Pietrangeli et al., 2024). A recent study from Pietrangeli et al. (2024) found that 34.64% of carrots processed by mass are downgraded due to non-compliance with retailer standards, which includes small size, odd shape, or minor defects. Additionally, 12.57% is lost at the farm level

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due to similar reasons. While some downgraded carrots may be redirected for processing or animal feed, a significant proportion is wasted, especially when there is no alternative market or use.

Regulatory changes may reduce this waste in the future, but currently, small carrots represent a substantial portion of suboptimal and wasted product.

2.3.2 Meat

It is estimated that around 59 million tonnes of food are wasted annually in the EU, with the food manufacturing and processing sector accounting for approximately 20% of this total. In the specific sector of cooked ham, particularly some premium products, losses can reach up to 10% during the industrial slicing process, due to strict quality standards and microbiological challenges. (European Commission, 2023)

The management of by-products represents a significant challenge for the food processing sector (Mirabella et al., 2014), particularly within the meat-processing industry. This is due to the potential of such materials to serve as protein sources for food or animal feed applications. These by-products exist either in solid form—such as carcasses and skins—or in liquid form, often recovered from wastewater streams that require treatment because of their elevated chemical and biological oxygen demand (Bull et al., 1982). Solid residues can be valorised as energy carriers through anaerobic digestion (Hejnfelt and Angelidaki, 2009), or converted into functional proteins via chemical hydrolysis (Selmane et al., 2008) or enzymatic processes (Rafieian et al., 2015). Regarding liquid waste, proteins derived from red blood cells (Gomez-Juarez et al., 1999) or blood plasma (Penteado et al., 1979) have demonstrated valuable functional properties. Since slaughtering is the primary contributor to waste in the meat sector, it has attracted significant research interest concerning the treatment and reuse of its by-products (Arvanitoyannis and Ladas, 2008). Nonetheless, limited attention has been given to the potential of by-products originating from further processing stages—such as the cooking of hams in the delicatessen industry.

Based on the literature review, it is clear that the meat industry has been making efforts to add value to materials that would otherwise be discarded as suboptimal products of cooked ham production. There is noticeable potential for the use of suboptimal cuts and trimmings to create a range of products such as sausages, pâtés, and other processed meats. Additional pathways include the incorporation of suboptimal ham into ready-to-eat meals, canned goods, and even pet food. The transformation of ham waste products into protein powders, animal feed, and bioenergy is already a reality. New product lines, such as diced ham for salads and pizzas, or ham-based snacks, are further examples of valorisation. Still, many of these initiatives inherently involve some level of waste generation, with the main goal being to reduce it.

Cooked ham processing residues, such as trimmings from slicing or units failing to meet visual or quality standards, present particular challenges:

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High perishability: These residues are extremely vulnerable to microbiological spoilage and therefore require rapid processing to prevent further loss.

Microbiological contamination: The presence of pathogens such as *Listeria monocytogenes* may restrict reuse options from a food safety perspective.

Regulatory constraints: Food safety regulations impose strict limits on the reuse of meat-based by-products.

On the other hand, the valorisation of solid residues from cooked ham production represents a significant opportunity to promote circular economy practices and reduce food waste in the meat processing sector. During industrial operations 2% up to 10% of material may be discarded due to non-compliance with slicing precision, texture requirements, or aesthetic marketing standards, even when the raw material is safe and of high sensory quality.

A promising reuse pathway is the production of natural flavouring powders. These can be incorporated into various food applications—such as sauces, soups, ready meals, broths, snacks, and seasonings—enhancing flavour profiles in a more natural and sustainable way, without the need for artificial flavourings.

In addition to enabling the recovery of fractions that would traditionally be discarded or incinerated (which bears both economic and environmental costs), this approach contributes to:

The replacement of synthetic additives with natural ingredients, responding to the growing market demand for clean label products.

Reducing food waste, in alignment with the European Union's goal of cutting manufacturing and processing stage food waste by 10% by 2030 (European Commission, 2023).

Creating new revenue streams for the meat processing industry through innovation in functional food ingredients.

The feasibility of this solution depends on strict food safety control—particularly in the sorting of batches potentially contaminated with *Listeria monocytogenes*—and the implementation of appropriate stabilisation and sanitation technologies, such as thermal treatment and rapid drying.Moreover, this valorisation strategy is in line with approaches already implemented in other segments of the food industry, such as the use of bones and meat trimmings for the production of natural flavourings and extracts, widely applied in concentrated broths and industrial seasonings. (Esra Capanoglu et al, 2022)

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2.3.3 Eggs

Greater consumption and utilization of chicken eggs worldwide prompts an expanded amount disposed of egg waste, mainly eggshell and eggshell membrane. The significant challenge with the generation of these massive waste products is the environmental impact. From an industrial point of view, when the production of chicken eggs tempts to rise, the quantity of eggshell residue is also increased. Being rich in organic and inorganic compounds, the eggshell wastes, which are primarily considered waste and of no value, could be utilized in various forms. Based on the literature review, cheaply available and easier to extract eggshell calcium can provide an ideal alternative source of natural calcium in an environmentally safe way.

Eggshell waste has the potential to be converted into a bioavailable source of calcium for food fortification. Bioavailable salts can be used to fortify food products like cakes, yogurt, sausages, biscuits, and coffee. Besides, eggshells can be used as soil enhancers and also as animal feed. All the products and processes suggested in this paper present high economic, health, and environmental benefits.

Eggshell constitutes around 10% of a hen's egg by weight (Laca et al., 2017). Vast amounts of chicken eggs are produced annually, with a significant proportion (30%) processed in food industries, lead to a massive accretion of eggshell waste (Ahmed et al., 2019). Almost all of it is treated as waste and is directly disposed of in landfills with minimal or no pre-treatment (Gao & Xu, 2012; Oliveira et al., 2013). The rotting of eggshells is a source of environmental pollution, and hence disposal of egg waste is not a pleasant function (Tsai et al., 2008). Some efforts have been made towards the value addition of eggshells. However, major applications are in agriculture (pH correction of acid soil), cattle feed (calcium source), and a biodiesel catalyst (Park et al., 2007). Tonnes of these discarded eggshells contribute to food wastage which causes significant damage to the environment by increasing global carbon footprint (3.3 Gtonnes of CO_2 equivalent in 2007) when buried (Scialabba et al., 2013), which is one of the prime greenhouse gases contributing to the global warming (Waheed et al., 2019).

Meanwhile, calcium is the most abundant mineral in the human body. It ultimately plays a significant role in bone formation, accounting for 99% of bones and teeth (Fayet-moore et al., 2019). A small fraction (1%) of the calcium is found outside the skeletal tissue, which performs a wide range of various functions. Intake of calcium from dairy sources is suitable for satisfying the body's calcium requirements (Fayet-moore et al., 2019). However, people do not intake a sufficient amount of calcium as per the clinical guidelines (Waheed et al., 2019), leading to the weakening of bones, which is considered significant (Fewtrell et al., 2013). There has been an increase in dietary calcium supplement intake due to calcium deficiency in postmenopausal women and osteoporosis patients (Daengprok et al., 2002).

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Existing supplementation with crustacean shells (Suguro et al., 2000) in tablets is expensive and sometimes involves difficulties in adherence of calcium in our system to targeted treatments (Fewtrell et al., 2013), besides that, shellfish allergy is one of the most common food allergies affecting about 2% of the population. Shellfish allergy is an IgE antibody-mediated reaction to proteins found in crustacean or mollusk family shellfish and is a common cause of anaphylaxis of foods (FAACT – Food Allergy and Anaphylaxis Connection Team).

On the other hand, these poultry wastes act as an excellent alternative source of dietary calcium because the primary component present in them is calcium carbonate (Schaafsma & Beelen, 1999), which has been found useful in increasing bone mineral density (BMD). Although these applications are of economic importance, eggshell remains under-utilized and more research is needed for its value addition (Neunzehn et al., 2015). The development of adequate technologies for valorisation remains a challenge for the food industry, which concerns environmental protection due to a large amount of waste generated and microbial proliferation (Kim et al., 2016). Moreover, disposal of eggshell waste is also a challenge as it adds up to costs and takes up landfills. Thus, the value addition of eggshells and their utilization should focus on the food processing industries.

A considerable amount of work has already been done to utilize this waste and incorporate it into our daily diet as a source of calcium. Some of the products with the incorporation of eggshells are calcium-fortified pork sausage (Daengprok et al., 2002), nano-powdered eggshell (NPES) supplemented yogurt (Al Mijan et al., 2014), dietary calcium biscuits (Hassan, 2015), calcium-fortified roasted and ground coffee (de Paula et al., 2014), calcium-fortified chocolate cake (Ray et al., 2017) and other homemade food products like pizza and pasta (Brun et al., 2013).

2.3.4 Cereals

It is estimated that around 59 million tonnes of food are wasted annually in the EU, with the manufacturing and processing sectors accounting for approximately 20% of this total (European Commission, 2023). While cereals are often considered shelf-stable and less prone to waste, significant losses do occur—especially in the form of downgraded grains, broken kernels, expired products, and contaminated batches rejected due to mycotoxins or moisture issues (FAO, 2019; Parfitt et al., 2010).

Cereal by-products—including bran, germ, brewer's spent grain, and defective or surplus flour—are often redirected to animal feed, but a large proportion remains underutilised. According to Mirabella et al. (2014), valorising these streams represents both a sustainability opportunity and a technological challenge.

Recent literature highlights diverse valorisation routes for cereal waste and by-products:

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Food use: Bran and germ fractions from wheat, oats, and corn can be refined into fibre- and micronutrient-rich ingredients for bakery and snack applications (Dhingra et al., 2012). Fermented cereal extracts are increasingly explored in functional beverages due to their prebiotic properties (Martins et al., 2011).

Bio-based materials and packaging: Cereal residues are being converted into bioplastics, films, and paper alternatives, contributing to sustainable packaging innovations (Elmekawy et al., 2013).

Fermentation and bioenergy: Damaged or expired cereal products serve as fermentation substrates for bioethanol (Sadh et al., 2018), lactic acid, and enzymes. Brewer's spent grain (BSG), a by-product of beer production, has been studied for its suitability in biofuel and protein extraction (Mussatto, 2014).

Natural flavouring and functional ingredients: Out-of-spec cereal batches can be processed into umami-rich or roasted flavour powders, or enzymatic hydrolysates used as nutritional supplements (Galanakis et al., 2021).

However, several barriers must be addressed:

Mycotoxin contamination: Mycotoxins such as deoxynivalenol (DON) and aflatoxins are common in cereals and limit food or feed use. Although decontamination techniques exist (e.g., ozonation, microbial degradation), regulatory approval and cost remain hurdles (Berthiller et al., 2013; Karlovsky et al., 2016).

Processing limitations: Many small- and medium-scale cereal processors lack the capacity for stabilisation (e.g., drying, pasteurisation), leading to avoidable spoilage.

Market and regulatory challenges: Consumer concerns and legal restrictions on using downgraded cereals in food require transparency, certification, and standardisation (Galanakis et al., 2021).

Nonetheless, valorisation of cereal waste streams contributes directly to the EU's goals under the **Farm to Fork Strategy** and **Circular Economy Action Plan**, both of which encourage waste reduction, secondary resource use, and innovation in sustainable food systems.

Successful business cases are emerging. For instance, upcycled cereals are now used in high-protein cookies, granolas, energy bars, and meat alternatives. Partnerships between breweries and bakeries are repurposing Brewer's spent grain (BSG) into sourdough and pizza dough products. In parallel, R&D projects have demonstrated that fibre-enriched breads made from cereal waste are both nutritious and consumer-acceptable (Galanakis et al., 2021; Zingale et al., 2023).

To realise full potential, future efforts must focus on risk-based sorting systems, technological scalability, and incentivising collaboration between the food, feed, packaging, and biotech sectors.

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2.3.5 Fish

Europe faces a significant challenge in managing fish waste and the underutilization of suboptimal seafood. Estimates suggest that up to 35% of fish and seafood in Europe is lost or wasted throughout the value chain—from catch to processing, distribution, and consumption. This waste not only results in economic losses for producers and retailers but also contributes to environmental degradation and undermines efforts toward a more sustainable and circular food system.

One particularly overlooked area is suboptimal fish—products that do not meet standard aesthetic or size criteria for sale in conventional markets, or surplus fish that remains unsold at daily auctions. **Bogue** (*Boops boops*), for example, is a nutritious, abundant Mediterranean species often excluded from the premium seafood market due to its perception as low-value or "inferior" and even due to its unknown existence and properties. However, a number of innovative marketing strategies are emerging across Europe to valorise such products, reduce waste, and increase consumer acceptance through rebranding, processing, and new sales channels.

Two primary marketing strategies have emerged to reduce this waste: (1) redirecting products into alternative marketing channels, and (2) transforming them into new value-added products. Below is a synthesis of current good practices and entrepreneurial strategies identified in different European countries, divided in these two marketing routes:

Strategy 1: Redirection to New Marketing Channels for Human Consumption

Some companies have focused on changing how fish is sold and distributed to better align supply with demand and reduce waste. These models allow suboptimal or surplus fish to find new markets—often with altered pricing, presentation, or target consumer groups.

Virtual Fish Counter: Rockfish in the UK developed an innovative online platform where customers can purchase freshly caught fish directly from boats. This model bypasses traditional supply chains, reducing delays and overstocking. By tailoring supply to actual customer demand, it minimizes the waste of unsold fish and creates a fresher, more responsive seafood system.

Fish Box Deliveries: The Fish Society has implemented a subscription-based business model, where fish is ultrafrozen immediately after catch and delivered in portions directly to consumers. This method significantly enhances shelf life and ensures the quality of the product, allowing fish that might otherwise be wasted to be marketed over a longer period. It's particularly effective for managing daily surplus.

Pre-Ordered Catch: French company Poiscaille empowers consumers to pre-order fish boxes directly from small-scale fishermen. The catch is tailored to demand, ensuring that only what is needed is fished. This

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approach not only prevents waste but also helps rebalance market dynamics in favour of more sustainable practices and less selective fishing.

These examples demonstrate how rethinking sales channels—by introducing digital platforms, subscriptions, or pre-order models—can ensure that suboptimal or surplus fish products still reach consumers, often in more sustainable and appealing ways.

Strategy 2: Transformation into Value-Added Surplus Products

Other businesses have taken a different approach, focusing on transforming fish waste or suboptimal species into new, high-value products for both food and non-food markets. These strategies not only prevent waste but create entirely new revenue streams:

- ✓ **Biodegradable Packaging**: UK-based MarinaTex has created a biodegradable plastic made from fish skins and scales—materials normally discarded during processing. This material serves as a sustainable packaging solution and highlights how even non-edible fish waste can be valorised through circular economy principles.
- ✓ **Concentrated Fish Soups**: Companies like Honest Catch and Aquafrais in France and the EU have embraced traditional Mediterranean recipes like fish soup to valorise lesser-known or suboptimal species. By processing and branding fish soups using local catches—including bogue—they offer a commercial route for products that often remain unbranded or locally consumed without added value.
- ✓ **Marine Collagen**: In Norway, Seagarden has tapped into the booming health and wellness market by producing marine collagen peptides from fish by-products. These supplements are marketed with a focus on sustainability, traceability, and health benefits, leveraging consumer trends and scientific credibility.
- ✓ **Certified Fish Gelatine**: French company Weishardt produces fish-based gelatine certified by Friend of the Sea. This product serves the food, pharmaceutical, and technical sectors, turning what would have been waste into a standardized and profitable ingredient aligned with market trends in traceability and ethical sourcing.
- ✓ **Fish Gelatine for Health and Beauty**: Jellice Europe in the Netherlands uses fish by-products to create gelatine for the pharmaceutical and cosmetics industry, including for soft capsules and health supplements. This illustrates the potential of suboptimal or non-commercially viable fish to generate high-value bio-based products for other sectors.

These marketing strategies—whether through redistribution to new sales channels or transformation into novel products—demonstrate the untapped potential of suboptimal and surplus fish. They also underline the importance of consumer education, logistics innovation, and product development in reducing waste and promoting the circular use of marine resources. For stakeholders in fisheries, food innovation, and

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sustainability, these examples offer replicable models to valorise fish waste, improve economic resilience, and contribute to the broader goals of food system sustainability.

2.4 Stakeholders' co-creation process

A continuous stakeholder co-creation process has been integrated throughout Task 4.1, involving both food business partners and scientific partners from the BREADCRUMB project. This process began with the collaborative definition of selection criteria for identifying representative suboptimal food products and extended to the discussions held to finalise the products to be analysed. These activities were carried out through bilateral exchanges and dedicated workshops, enabling partners to assess the feasibility and impact of various valorisation pathways based on their experience and operational context. Moreover, the co-creation process continued during the General Assembly (GA), where all partners were involved in the review and discussion of the developed BMCs. Feedback collected during this session contributed to refining the models and aligning them with real-world constraints and opportunities. This participatory approach ensures that the strategies developed are both grounded in practical experience and tailored to the needs and capacities of the stakeholders involved. The co-creation process will remain a key element in the next stages of the project. The co-creation process will remain a key element in the next stages of the project.

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3 BUSINESS MODEL CANVAS FOR SUBOPTIMAL PRODUCTS

3.1 What is a Business Model Canvas (BMC)?

Proposed by Osterwalder and Pigneur (2010), is a strategic tool that allows for the description, visualization, and analysis of business models in a simple and structured way. Within the BREADCRUMB project, the BMC is used to explore and assess the economic viability of valorisation options for suboptimal food products—i.e., food that is safe to consume but does not meet conventional marketing standards.

The main purpose of using the BMC in Task 4.1 is to define and characterise viable business models for the selected case study products (table 1), based on the different identified valorisation pathways. These include redirecting to alternative marketing channels (such as direct-to-consumer, discount retail); processing into Value-Added Surplus Products (VASPs) (such as new food formats) or integration into socially responsible redistribution models (such as donation schemes). This approach helps assess how suboptimal food products can be effectively valorised and brought to market.

For each studied product in table 1, nine building blocks of the BMC were completed (Value Propositions, Customer Segments, Channels, Customer Relationships, Revenue Streams, Key Resources, Key Activities, Key Partnerships, Cost Structure). This analysis provides a holistic understanding of how suboptimal food can be reintroduced into the market in an economically viable way, creating value for consumers, businesses, and society. [Osterwalder, A. & Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. Wiley.]

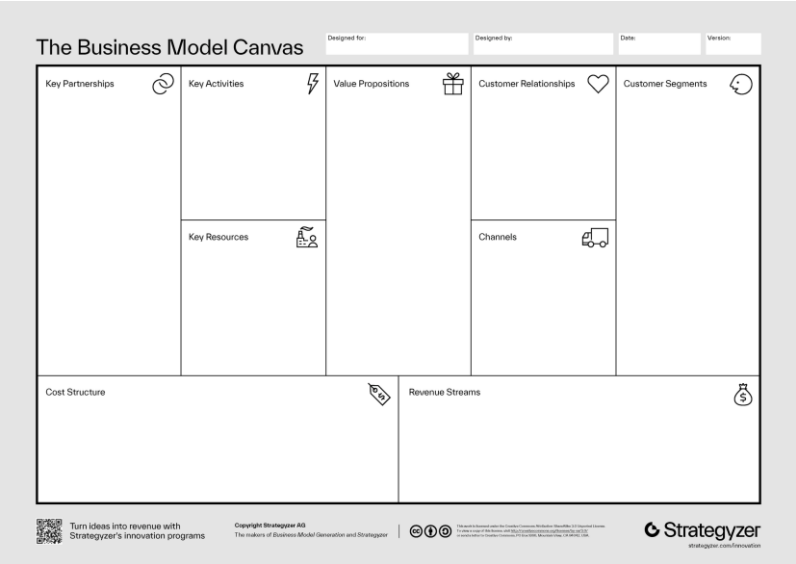

Figure 5 Original BMC by Osterwalder and Pigneur (2010)

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The BMCs developed in D4.1 will serve as input for:

- ✓ The business assessment model (T4.3), to be made available as an interactive tool (the “Food Value Navigator”);
- ✓ Marketing strategies (T4.4), which will use the BMC data to support consumer acceptance;
- ✓ Research and innovation scale up (dissemination, communication, exploitation plan) (WP5), taking into the exploitation and scaling up of the most promising solutions.

3.2 BMC Fruits

3.2.1 BMC for suboptimal oranges

At AINIA we have developed a business model that we have called “BioExtract Pro Ingredients”. This model detailed in the following BMC, transforms citrus fruits discarded because they do not meet aesthetic standards into high-value ingredients for the food, cosmetic and nutraceutical sectors. Instead of discarding these "suboptimal" products, the model proposes collecting them directly from farmers and cooperatives and applying environmentally friendly extraction processes (such as ultrafiltration or supercritical CO_2 techniques) and obtaining powders, oleoresins and liquid extracts with antioxidant, vitamin and phytochemical properties. These extracts can be marketed as functional, 100% natural, traceable raw materials, so that food manufacturers, cosmetic laboratories, and supplement companies can enrich their formulations with sustainable ingredients that would otherwise be lost in the production chain.

BioExtract Pro Ingredients

1. Value propositions

- ✓ Customer offer: 100% natural, organic and traceable citrus concentrate ingredients ("essential oils" and "peel powders"), ready to formulate cosmetics and gourmet applications.
- ✓ Combination of products and services:
  - Standardized catalog of extracts and powders with complete technical sheets.
  - Technical consulting services to optimize formulations and processes.µ
  - Development of limited editions in co-creation with laboratories and chefs.
- ✓ Needs and problems we solve:
  - Shortage of pure and consistent raw materials in the market.
  - Uncertainty in quality and traceability of organic ingredients.
  - Long R+D times due to lack of specialized technical support.
- ✓ Coverage of the target's needs:
  - We ensure a stable supply and certifications (organic, clean-label).
  - We provide analytical reports and stability data to accelerate releases.
- ✓ Obstacles we eliminated:

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- Logistical and bureaucratic complexity of extraction and certification.
- Reliance on traditional suppliers with opaque processes.

✓ How we help the customer:

- We manage the entire cycle: extraction (pressing, distillation, freeze-drying), quality control and delivery.
- We accompany with personalized advice and after-sales troubleshooting.

✓ Differentiators from the competition:

- Circular approach: zero waste thanks to the use of imperfect citrus fruits.
- Full transparency of origin (blockchain optional).
- Hybrid product+service model, positioning ourselves as a strategic partner for innovation.

2. Customer segments

✓ Key customers and their needs

- Natural and organic cosmetics brands: require traceable essential oils and peel powders, with organic certifications and guaranteed functional activity.
- Gourmet restaurants and hotels: they are looking for aromatic ingredients with a differentiating flavor for cocktails, desserts and high-level presentations.
- Cosmeceutical R+D and food service laboratories: they need standardized raw materials, analytical reports and technical support to accelerate the development of new products.

✓ Desired vs. unwanted customers

- Wanted: Companies with a budget for premium ingredients that value transparency, innovation, and sustainability.
- Unwanted: low-cost distributors or end consumers with no interest in industrial volumes or specialized certifications.

✓ Acquisition channels and origin

- Sectoral fairs and congresses (Cosmopack, Biofach, Sirha)
- Online B2B platform with digital catalog and downloadable technical sheets
- Networking in high-level natural cosmetics and hospitality associations
- Technical publications and webinars in trade journals and LinkedIn

✓ Purchase Decision-Makers

- Purchasing managers in B2B companies
- R+D managers and chemical formulators who test and validate raw materials
- Chief Innovation Officers Choosing Strategic Partners

✓ Determinants of Buying Behavior

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- Technical requirements: purity, batch consistency, stability data and certifications (organic, clean-label).
- Purchasing power: ability to invest in high-end ingredients and co-creation services.
- Spending pattern: recurring contracts (frame agreements) to ensure continuous supply and stable prices.
- Focus on innovation: priority given to suppliers that provide added value (consultancy, proofs of concept, limited editions).

3. Customer relationships

✓ Establishment and maintenance
- Technical account manager assignment for each B2B customer.
- 24/7 online portal with catalogue, orders and certificate downloads.
- Periodic workshops and webinars for co-creation and training.

✓ Relationship Type by Segment
- Cosmetics & food service: personal assistance (account manager) + co-creation.
- R+D and laboratories: technical self-service (portal) + after-sales support.
- Gourmet (restaurants/hotels): automated digital contact for orders + ad hoc service.

✓ Contact channels
- B2B platform (web) and automated email.
- Virtual/face-to-face meetings and sector fairs.
- Technical support hotline (phone/chat).

✓ Contact Moments
- Pre-sale: demos, samples and initial briefing.
- Order: immediate confirmation with technical sheet.
- After-sales: quality monitoring and troubleshooting.
- Quarterly cycle: review of KPIs and planning of new releases.

4. Channels

✓ Scope: Online B2B portal + technical sales team at fairs and visits.

✓ Generating interest: Free samples and technical dossiers; webinars and success stories.

✓ Prospecting, sales and delivery: Segmented email/LinkedIn; 24/7 web ordering; certified air-conditioned logistics.

✓ Accessibility conditions: High availability website and intuitive interface; showroom-lab by appointment; warehouse with vehicle access.

✓ Projected image: Premium, innovative and sustainable, via clean design and traceability narratives.

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- ✓ Brand style: Minimalist logo (citrus drop), modern typography, slogan "Citrus purity, innovation to the maximum".

5. Revenue streams

- ✓ Sale of concentrated ingredients (essential oils and peel powders) with price per kilo/liter, scaled according to volume.
- ✓ Technical consulting and co-creation of formulations, charged on a per-project or hourly basis.
- ✓ Limited editions collaborative with chefs or laboratories, at a premium price per batch.
- ✓ Regular supply frame agreements, with periodic payment (monthly or quarterly) to ensure discount and stock priority.

Customers are willing to pay for:

- Spending pattern: recurring contracts (frame agreements) to ensure continuous supply and stable prices.
- Purity, traceability and certifications (organic, clean label).
- Technical support that reduces your R+D times and guarantees quality.
- Exclusivity of limited editions.

They don't pay for:

- Standard logistics costs (included in the sales price).
- Initial samples (offered free of charge), beyond sampling packs.

The hybrid model (product sales + consulting services) fits with:

- Premium brands, which value recurring contracts and risk reduction.
- R+D laboratories, which prefer rates per project for innovation.

6. Activities

- ✓ R+D: Optimize extraction processes and stability testing
- ✓ Production: extraction, concentration, certification and technical packaging
- ✓ Marketing & Sales: technical dossiers, trade fair demos and digital prospecting
- ✓ Logistics: air-conditioned storage and specialized transport
- ✓ Customer relations: account management, technical support and workshops
- ✓ Essential processes:
  - Deliver Bid: Rigorous QC & Shipping
  - Engage and convince: free samples and personalized presentations
  - Loyalty: co-creation of formulations and continuous monitoring

7. Key resources

- ✓ Human team
  - Chemists and Process Engineers (R+D and QC)
  - Laboratory technicians and plant operators
  - Account managers and B2B sales team

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- Logistics and warehouse staff

✓ Infrastructure and assets
- Extraction laboratory (pressing, distillation, freeze-drying) with analytical equipment
- Air-conditioned production plant and warehouse with batch traceability
- B2B digital platform (web, CRM)

✓ Other Resources
- Partnerships with Imperfect Citrus Growers
- Organic and clean-label certifications
- Capital for R+D investment and capacity expansion

8. Strategic partners

✓ Imperfect citrus growers
- What they provide: stable supply of raw materials (peels and juices) at low cost and in volumes adjusted to demand.
- Why they're key: They enable our circular approach and ensure traceability of origin.

✓ Certification and external analysis laboratories
- What they contribute: issuance of organic seals, clean-label and purity analysis, antimicrobial activity and stability studies.
- Why they are key: they validate quality and compliance with regulatory requirements for cosmetics and food service.

✓ Suppliers and maintainers of extraction equipment
- What they provide: supply, installation and technical service of cold presses, steam distillers and freeze dryers.
- Why they are key: they ensure production efficiency and uptime of the processing plant.

✓ Specialized logistics operators
- What they provide: air-conditioned transport, technical packaging and end-to-end traceability (batch tracking).
- Why they're key: They preserve the integrity of sensitive assets and meet B2B delivery times.

✓ Technical marketing and sector communication agencies
- What they contribute: creation of dossiers, case studies, organization of webinars and management of stands at fairs (Cosmopack, Biofach).
- Why they're key: They amplify our reach and credibility among formulators and B2B buyers.

✓ External R+D centers and universities
- What they contribute: development of advanced methodologies (nanoencapsulation, in vitro test) and scientific co-publications.
- Why they're key: They reinforce our reputation as an innovative partner and open doors to new segments.

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- ✓ External vs. internal capabilities
  - Expertise: regulatory validations and advanced analysis techniques.
  - Infrastructure: laboratories with state-of-the-art equipment for stability and bioactivity tests.
  - Channels and visibility: access to global trade fairs and academic research networks.
- ✓ Partner Delegated Activities
  - Organic and clean-label certified.
  - Long-term compatibility and stability tests.
  - Preventive maintenance and calibration of extraction machinery.
  - Cold logistics and technical packaging.
  - Organization and execution of technical demonstration events.

9. Cost structure

- ✓ Development costs:
  - Commissioning of the laboratory and extraction plant (presses, distillers, freeze dryers).
  - Process validation and first analytical tests.
- ✓ Main fixed costs:
  - Depreciation of equipment and facilities.
  - R+D, quality control and technical equipment salaries.
  - Machinery maintenance and software licenses.
  - Periodic certification costs (organic, clean-label).
- ✓ Main variable costs:
  - Purchase of imperfect citrus fruits according to volume.
  - Laboratory supplies and consumables (solvents, reagents).
  - Energy for thermal processes and freeze-drying.
  - Technical packaging and air-conditioned transport.
- ✓ Reason for costs:
  - Ensure traceability, purity, and regulatory compliance.
  - Maintain high quality and constant production capacity.
- ✓ Most expensive resources/people:
  - State-of-the-art extraction and analysis equipment.
  - Specialized chemists and process engineers.
  - External certification and advanced testing services.
- ✓ More expensive activities:
  - Extraction and concentration processes (distillation, freeze-drying).
  - Quality control and batch certification.
  - Cold logistics and technical packaging.

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3.2.2 BMC for suboptimal limes

1. Value propositions

- ✓ Customer offer:
  - high-quality, organic yellow limes for fresh produce section.
  - A fully ripe, flavourful lime, visually striking due to its yellowish color.
  - Sustainability contribution by using these yellow limes directly as a fresh produce, instead of being discarded.
- ✓ Combination of products and services:
  - Fresh organic yellow limes more reliable
  - Certified supply plus marketing support (e.g. POS materials on sustainability).
- ✓ Needs and problems we solve:
  - Retailers need innovative, sustainable products with strong customer appeal.
  - Offer visual differentiation and help to reduce food waste.
  - Need to expand the assortment with a unique, natural product and contribute to sustainability
- ✓ Coverage of the target's needs:
  - Meet the growing consumer demand for sustainability, transparency,and organic produce.
- ✓ Obstacles we eliminated:
  - Confusion about what yellow limes are
  - Perception that green=limes and yellow=lemon
  - Assumption that yellow limes are either overripe, old or spoiled
  - Overcome the prejudice that only green limes are fresh/ripe by informing and raising awareness of both retailers and customers
- ✓ How we help the customer:
  - Deliver a ready-to-market, sustainable product with a story, helping retailers differentiate and meet sustainability goals.
- ✓ Differentiators from the competition:
  - Focus on premium-quality yellow limes (previously underutilized product).
  - Combine the premium-quality yellow limes with a clear bio and anti-food waste positioning

2. Customer segments

- ✓ Key customers and their needs
  - German retailers (e.g. Globus, Edeka, Dennree) They need distinctive, organic products that sell well and are logistically reliable. Offer differentiate products and respond to consumer interest in zero-waste, organic and climate-friendly products.

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- Restaurants. Offer organic and climate-friendly products.
- Food service business. Offer organic and climate-friendly products.
- Health and sustainable focused consumers.

✓ Desired vs. unwanted customers
- Wanted: food retailers with a clear sustainability, fresh products and organic products.
- Unwanted: Juice producers or producers of any other product produces with limes.

✓ Acquisition channels and origin
- Sectoral fairs and congresses (Fruit Logistica),
- Farmer associations
- Organic-retail networks
- Technical publications and webinars in trade journals and LinkedIn
- Direct outreach to purchasing deparments

✓ Purchase Decision-Makers
- Purchasing managers for fresh produce
- HQs of supermarket chains at regional or national level

✓ Determinants of Buying Behavior
- Price
- Product quality and appealing
- Sustainability credentials
- Reliability of supply, taste
- Organic trademarks (certifications)
- Logistic accesibiliy and infrastructure

3. Customer relationships

✓ Establishment and maintenance
- Through personal contact
- Product samples
- Personalized offers
- Regular follow-ups
- Build a loyal and transparent commercial relations
- Customized marketing support

✓ Relationship Type by Segment
- Personal assistance and co-creation in early stages
- Digital contact and Automated service

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- Co-creation, transparent and educated relationship (educate the retailers that yellow limes are perfectly fine and tasty)
- Regular communication on what works and what not works

✓ Contact channels
- Automated email.
- Virtual/face-to-face meetings and sector fairs.
- Technical support hotline (phone/chat).

✓ Contact Moments
- Pre-sale: product trials
- Seasonal planning
- Follow-ups
- Promotions
- Logistics coordination

4. Channels

✓ Deliver green and yellow limes via the same marketing channel such as:
- Direct sales and trade shows, B2B marketing via LinkedIn, Industry platforms, Partnership with grocery stores, Subscription services and bionetworks

✓ Generating interest:
- Strong visuals sample tastings, sustainability storytelling and showing missed revenue potential from underused fruit.

✓ Prospecting, sales and delivery:
- Via email, phone calls, sales via direct outreach, online platforms, community delivery services and delivery via logistics partner warehouses.

✓ Accessibility conditions:
- Reliables delivery logistics, flexible volumens, food safety standards and clear documentation (eg. organic certification)

✓ Projected image:
- Fresh, premium, eco-conscious. Through branding, packaging, and transparent communication. Direct purchasing, good connection to farmers in Columbia.

✓ Brand style:
- Logo colors are in between yellow and green with the shape of a lime, some slogans below:
- Green and yellow limes are the same. Same fruit, different shade!
- Try it – same tangy lime taste, just sunshine yellow!
- Not lemons. Just yellow limes.
- Ripe, bright, and lime all right

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5. Revenue streams

- ✓ Make money:
  - By selling organic yellow limes to food retailers at an attractive, competitive entry price. (10% discount)
- ✓ Customers are willing to pay:
  - A marketable, flavorful product with a clear story and visual appeal. However, as this is a new product category, competitive pricing will be essential at the beginning.
  - The costumer pays for organic certification, consistent quality, sustainability story, and marketing support, reduce food waste,
- ✓ Customers are not willing to pay:
  - Inconsistent quality, additional logistics and handling, unnecessary packaging, or vague origin claims.
- ✓ Revenue model you will set
  - Unit-based B2B pricing per kg, possibly combined with volume-based discounts. Same price-quality ratio for green and yellow limes in the long run.
  - Starting with a classic per-unit pricing model with a ~10% introductory discount compared to green limes, to encourage trial and adoption. The price can be reassessed based on market response.
- ✓ Revenue reception
  - per delivery invoice
- ✓ Revenue model to fit customer segment
  - The competitive introductory price reduces the barrier for retailers to list the product, especially while product awareness is still being built

6. Activities

- ✓ Product sourcing, quality control, sales outreach, logistics coordination, marketing expertise, technology support, distribution network, packaging,
- ✓ Deliver your offer: Sourcing and packing (align with EU regulations on sustainability and packaging)
- ✓ Reach and convince your customer: Marketing & trade shows
- ✓ Build and expand your customer relationship: Follow-up and build on trust and effective communication
- ✓ Create value for yourself and your customer: Sustainability narrative + reliable supply

7. Key resources

- ✓ People and resources

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- Reliable growers
- Sales & account managers
- Quality control staff
- Logistics and distribution staff
- Marketing and promotion materials

✓ Key resources

- Organic-certified supply chain,
- funding for logistics/marketing,
- skilled staff,
- professional network in food retail,
- storytelling assets (photos, impact stats)

8. Strategic partners

✓ Strategic partners needed to successfully produce, realise and sell products

- Organic lime growers, transport companies (cold chain), B2B marketing partners.

✓ Additional partners

- Food waste organizations, farmers and growers, retailers and supermarkets, other potential limes' partners in the supply chain.

✓ Services provided by partners

- Production, logistics, co-marketing, promotional support.

✓ Partners that can strengthen the offer

- Retail networks, NGOs focused on food waste, sustainable farming initiatives.

✓ What do partners possess (complementary to our services)

- Network and distribution channels. Know the local customer trends and interests. Depending on seasonal products and availability, it is helpful to work proactively with retail chains to improve visibility in stores (e.g., shelf space or special display areas for yellow limes).
- Provide and support thematic and seasonal recipes and ideas for cooking with yellow and green limes.

✓ Core partners' activities

- Production
- Transportation
- Marketing

9. Cost structure

✓ Development costs:

- Product sourcing, transport, marketing materials, staff fees, logistics and coordination, certification fees.

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- ✓ Main fixed costs:
    - Fixed: marketing, personnel
- ✓ Main variable costs:
    - Fruit purchase, transport,
- ✓ Reason for costs:
    - To ensure high quality, compliance, and visibility in retail.
- ✓ Most expensive resources/people:
    - Product sourcing (price per kg), personnel staff
- ✓ More expensive activities:
    - Supply chain logistics, sales outreach, product certification.

3.2.3 BMC for suboptimal apples

1. Value propositions

- ✓ Customer offer:
    - 100% natural fruit purees made from fresh fruits. Purees that do not contain added sugars, preservatives or artificial additives. A way to eat healthy and authentic fruits. Packaged in convenient, resealable formats like
    - Doypacks and trays. This format offers on-the-go consumption for all ages.
- ✓ Combination of products and services:
    - Different combination of products within its fruit puree line, mixing various fruits such as apples, peares, mangoes, peaches and mixed berries.
    - Different packaging formats: doypacks and trays
    - Offering conventional, organic and baby food certified products.
- ✓ Needs and problems we solve:
    - Fruits purees conver the demand for healthy, natural and convenient snack options.
    - An easy and fast way to consume fruit
    - Eliminates barriers to consume fresh fruit, such as perishability, messiness and preparation time
- ✓ Coverage of the target's needs:
    - Ensure user-friendly formats, such as resealable Doypacks and aluminium trays
    - Suitable for busy individuals, families and anyone seeking for nutritious options on the go.
    - Appropriate for public canteens (schools, hospitals, elderly care centers)
    - Long shelf-life and ready-to eat that contributes to reduce food waste.
- ✓ Obstacles we eliminated:
    - Steps for fruit preparation: washing, peeling, cutting making fresh fruit easy to consume.

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- ✓ How we help the customer:
    - Offering ready-to-eat fruit purees. Contributing to cover the intake recommended by WHO, the five portions of fruit and vegetables a day.
- ✓ Differentiators from the competition:
    - Experience in cold extraction technology which preserves fruit's natural quality

2. Customer segments

- ✓ Key customers and their needs
    - National and International distribution groups, retailers and public institutions
    - End user consumers of all ages, especially families, children, and health-conscious individuals, seeking convenient and natural fruit based snacks.
- ✓ Desired vs. unwanted customers
    - Wanted: quality-oriented customers such as retailers, distributors, and public institutions who want to offer healthy, natural food options to their own customers—whether they are families doing grocery shopping or people attending public canteens like schools or hospitals.
    - Does not focus on customers looking for ultra-processed or low-cost mass-market snacks where quality and natural ingredients are not a priority.
- ✓ Acquisition channels and origin
    - customers come from Italy, across Europe, and extra-EU countries.
    - Long-standing industry relationships, trade fairs, direct commercial outreach and referrals, supported by its sales office.
- ✓ Purchase Decision-Makers
    - buyers and category managers within retail chains and distribution groups
    - procurement officers in public institutions like schools, hospitals, and elderly centers.
- ✓ Determinants of Buying Behavior
    - product quality, certifications (e.g. organic, baby food) and brand reliability
    - Today certifications are the main driver.

3. Customer relationships

- ✓ Establishment and maintenance
    - establishes and maintains customer relationships through its sales office, which manages direct contacts and long-term partnerships.
    - visits to production facilities of the company
    - supports customer audits, strengthening transparency, trust, and collaboration.
- ✓ Relationship Type by Segment
    - personal assistance, self-service, digital contact, automated service, community, cocreation,
- ✓ Contact channels

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- through the sales office, via email, phone, video calls, and
- in-person meetings.
- Initial connections often happen at trade fairs or through referrals, followed by direct commercial interactions.

✓ Contact Moments

- during initial negotiations, order placements, and
- product customisation phases, as well as for
- follow-ups, logistics coordination, and quality checks.

4. Channels

✓ Generating interest: through trade fairs, commercial visits, direct sales contacts, and industry networks

✓ Brand style: website and brand reputation to attract interest from new partners.

Offering wide range of purees farming methods (conventional and organic), certifications, and packaging formats. Competitive pricing combined with product quality makes the offer particularly appealing.

✓ Prospecting trade fairs, commercial outreach, and direct contact by the sales office, supported by its marketing team. While sales and negotiations are managed internally, delivery is typically arranged by the customers themselves

✓ B2B company. A well-organized loading area for trucks arriving at the production plants, ensuring efficient and safe handling of goods during pickup

✓ .Image to project: a reliable, innovative, and quality-driven company,committed to environmental and social sustainability. This is achieved through certified production standards, modern facilities, collaboration with charity organizations and paticipation in trade fairs.

✓ Logo visual elements emphasize naturalness, health, and trust.

5. Revenue streams

✓ Make money: Producing and selling fruit purees to retailers, distributors, and public institutions, both under its own brands and as

private label.

✓ Customers are willing to pay for high-quality fruit products that are easy to consume and allow them to eat fruit conveniently and quickly

✓ Customers are not willing to pay for low-quality, uncertified or for preservative containing products.

✓ Revenue model

- a transactional revenue model, earning income through per-unit sales of its products to distributors, retailers, and institutions.

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- Pricing varies based on volume, product type, certifications, and packaging formats.

✓ Revenue is received through one-off payments per order

✓ The per-order revenue model fits well with B2B customers, who typically purchase in large, scheduled

6. Activities

✓ constantly developing new products, such as fermented fruit purees for sports nutrition, while conducting ongoing market analysis to identify emerging consumer needs.

✓ In terms of production, a key activity involves purchasing large volumes of apples during the harvest season and storing them for up to one year—a complex process, especially for second-category fruit, which is usually not stored long-term by other producers.

✓ On the sales side, active engagement in maintaining and expanding contracts with both national and international clients through strong commercial relationships and tailored service

7. Key resources

✓ Human team
- Chemists and Process Engineers (R+D and QC)
- Laboratory technicians and plant operators
- Account managers and B2B sales team
- Logistics and warehouse staff

✓ Infrastructure and assets
- Extraction laboratory
- Air-conditioned production plant and warehouse with batch traceability
- B2B digital platform

✓ Other Resources
- skilled personnel,
- modern production machinery, and
- certified facilities suitable for processing, storing, and packaging fruit purees.
- Technical know-how, and a reliable supply chain (upstream and downstream)

8. Strategic partners

✓ Fruit suppliers
- farmers and cooperatives
- Other suppliers: packaging manufacturers, machinery suppliers and maintenance providers and distributors.

✓ Additional partners
- external consultants, marketing agencies and designers.

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- ✓ Services provided by partners
    - help structure internal processes and facilitate collaboration among departments, improving overall efficiency.
    - Marketing agencies help to develop marketing TV campains and designers are called to draw the packaging.
- ✓ Partners' complentary services
    - knowledge in areas complementary to production, such as marketing,branding, logistics, certifications, and governance.
    - Integrating external expertise with the company's internal know-how

9. Cost structure

- ✓ Development costs:

R&D activities for creating and testing new recipes,

    - market research to identify consumer needs and trends, and regulatory and certification expenses for complying with standards (especially organic and baby food lines). Additional costs arise from promotional campaigns to launch new products and from the commercial effort required to establish new contracts with customers and distributors.
- ✓ Main fixed costs:
    - warehouse operations,
    - production machinery, and certification and
    - audit expenses, which are necessary regardless of production volume.
- ✓ Main variable costs:
    - Purchase of imperfect citrus fruits according to volume.
    - energy and methane, water,
    - packaging,
    - personnel, and
    - byproduct disposal.
    - Internal quality checks fall under semi-variable costs.
- ✓ Reason for costs:
    - To ensure the continuous and efficient production of fruit purees
- ✓ Most expensive resources/people:
    - Personnel and electricity
- ✓ More expensive activities:
    - Quality control analysis

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3.3 BMC vegetables

3.3.1 BMC for suboptimal onions

In the BMC for suboptimal onions, we will explore the idea selling sprouted onions during the peak period (February to April). The idea is to sell the sprouted onions using a "Do It Yourself (DIY) box". In this boxes, instructions will be included to plant them and to eat, as well as some storytelling of the product and/or producer.

1. Value proposition

- ✓ Tasty, healthy recipes made from sprouted onion (affordable yet high-quality food). Helps fight food waste and supports local farmers.
- ✓ Provides a hands-on, educational gardening experience. It engages children and adults.
- ✓ The DIY box has a purpose: the customers support a cause by buying these products

2. Customer segment

- ✓ Focus on schools and kindergardens (urban and rural)
- ✓ City garden initiatives and community gardens
- ✓ Eco-conscious consumers: people in search of sustainable, healthy and local options
- ✓ Health-focused individuals/families (home cooks and foodies, parents (choosing healthy snacks)

Main challenge is: how do we target other customer segments?

3. Customer relationship

focus on B2C

- ✓ Educational support (guides, videos, workshops, and newsletters). We can use storytelling about the rescued sprouted onions and the local farmers. Customers can learn how onions grow, …
- ✓ Community engagement (sharing results, school competitions)
- ✓ Feedback channels for recipe and gardening success stories (and giving inspiration to the customers)

Focus on B2B

- ✓ In a later stage, it would be possible to talk to retailers: look at innovation department of retailers)

4. Channels

- ✓ Direct sales to schools and kindergartens.
- ✓ Online store for individual and community orders
- ✓ Partnerships with urban gardening programs and local authorities
- ✓ Social media campaigns and educational events

5. Revenue streams

- ✓ Sale of "DIY sprouted onion boxes" to schools, city gardens, and individuals

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- ✓ Subscription of the seasonal box model (maybe this can be combined with other seasonal offes)
- ✓ Workshops and educational program fees (this is linked to community building. Some cities give 'seed money/startup money' for these kind of initiatives)
- ✓ Sponsorship or grants from sustainability or food waste prevention programs

6. Activities

- ✓ Sourcing and sorting sprouted onions during peak season (February–April)
- ✓ Assembling "DIY boxes" with planting instructions, recipes, give composting methods through storytelling content.
- ✓ Developing and printing educational materials (recipe,s, prevention methods such as composting ideas)
- ✓ Marketing and outreach to schools, city gardens, and home gardeners
- ✓ Managing logistics and delivery to customers
- ✓ Customer support and educational follow-up (e.g., online tips, workshops)

7. Key resources

- ✓ Reliable supply of sprouted onions (during February to April). The entrepreneur should have a contact list of farmers
- ✓ Educational and recipe content
- ✓ Packaging and assembly facilities
- ✓ Partnerships with schools and gardening organizations
- ✓ Marketing and outreach materials

8. Strategic partners

- ✓ Local onion producers and wholesalers. They will be the source of sprouted onions from February to April.
- ✓ Packaging suppliers (eco-friendly boxes, educational materials)
- ✓ Educational institutions: schools, kindergartens, city garden programs as well as urban gardening organizations and community gardens
- ✓ Optional: recipe developers and nutritionists
- ✓ Optional Logistics and delivery companies (cargobikes?)

9. Cost structure

Fixed cost

- ✓ Content development (recipes, guides, storytelling)
- ✓ Website or online store set up (there will be a set up fee for an e-commerce platform

Variable cost

- ✓ Procurement of sprouted onions (often at low or no cost due to waste status)

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- ✓ Delivery and distribution expenses
- ✓ Packaging material and printing
- ✓ Optional, when this initiative grows Staff for assembly, marketing (work with influencers), and logistics

3.3.2 BMC for suboptimal carrots

The idea is to sell boxes with different size carrots, where the ease of use is the most important factor to get as many people as possible to eat suboptimal food. Same as for the onions, we would go for a box with instructions and storytelling about the carrots and the producers.

- ✓ *The small **snack-size carrots: naturally** small, sweet, perfect for raw snacking or lunchboxes*
- ✓ *The big-size **soup carrots:** large and sometimes quirky-shaped, perfect for broth, stew, or purée.*

1. Value proposition

Makes eating suboptimal carrots easy and appealing to everyone. Snack-size carrots: ready-to-eat, sweet, perfect for lunchboxes. Big/quirky carrots: ideal for soups, broths, purée-no fuss, no waste. Each box includes simple instructions, recipes, and producer stories to inspire use. Supports farmers and reduce food waste.

2. Customer segment

- ✓ Busy families and individuals seeking healthy, convenient options.
- ✓ Parents looking for easy snacks for kids
- ✓ Home cooks who value sustainability and simplicity
- ✓ Schools and educational programs
- ✓ Environmentally conscious consumers

3. Customer relationship

- ✓ Direct support (online, email, social media)
- ✓ Educational and inspirational content with every box
- ✓ Community engagement (sharing recipes, stories, tips)
- ✓ Subscription options for convenience and loyalty

4. Channels

- ✓ Online store (a webshop)
- ✓ Partnership with shools and community organisations: This could be linked to an educational part on food waste and ‘ugly fruit and vegetables’
- ✓ Social media and influencer marketing
- ✓ Local events and pop-up stands: Host/plan workshops and events on food waste (at specific events, food fairs, farmer’s market, pop-up stores, …): to attract customer, this can be done with popular foodies as well as with farmers.

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5. Revenue streams

Focus on B2C

- ✓ Direct product sales of 'Roots in a box'
  - Subscription boxes (e.g. Fruta Feia in Portugal (works with local farmers to sell 'ugly fruit and vegetables' to urban consumers and gives farmers a fair compensation.)
- ✓ Workshops or educational events such as cooking classes (this is linked to community building. Some cities give 'seed money/startup money' for these kind of initiatives)
- ✓ Potential for 'upsell': recipe cards, calendars, other boxes with vegetables 'themed boxes'…

B2B

- ✓ Sales to schools or educational programs

6. Activities

- ✓ Sourcing and sorting carrots by size (snack-size, soup-size, quirky shapes)
- ✓ Packing boxes with clear usage instructions and storytelling about the products as well as from the local producers
- ✓ Developing easy, appealing recipes and snack ideas
- ✓ Create content for social media (storytelling, tips on how to use it, recipes to share, …)
- ✓ Managing online orders, customer service, and feedback
- ✓ Marketing focused on convenience, health, and sustainability

7. Key resources

- ✓ Consistent supply of varied carrots (Main carrot waste happens just after the main harvest (August to November). And then once more due to storage reasons in February to April.)
- ✓ Packing and storage facilities
- ✓ Digital platform for orders, content, and storytelling. Content on recipes, instructions, producer stories.
- ✓ Brand assets and marketing materials

8. Strategic partners

- ✓ Local carrot farmers (source of all sizes/shapes). Main carrot waste happens just after the main harvest (August to November). And then once more due to storage reasons in February to April. Think of supply agreements with farmers or wholesalers (for suboptimal produce: carrots and onions) with how many farmers do we start? How can we make this fair?
- ✓ Optional: packaging suppliers (eco-friendly, user-friendly materials), logistics and delivery partners, Recipe developers and nutritionists
- ✓ Sustainability and food education organizations

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9. Cost structure

Fixed costs

- ✓ Sourcing various sizes of carrots (and further handling: cleaning, sorting and prepping)
- ✓ Production and labor costs (this depends on European regions, and should be a fair income for farmers)
- ✓ Platform or e-commerce maintenance/ Rent of facilities depending on entrepreneur

Variable cost

- ✓ Packaging and logistics
- ✓ Marketing and advertising expenses (printing the materials, ...): eco-friendly

3.4 BMC Meat

This Business Model Canvas presents a valorisation strategy for suboptimal cooked ham, particularly from slicing losses and non-compliant products, by developing a **natural aroma powder** intended for use in the food industry. This approach aims to reduce food waste while creating a high-value ingredient aligned with sustainability and clean label trends.

1. Value proposition

- ✓ Is built around transforming by-products from cooked ham processing into a functional flavouring powder, which can be used in soups, sauces, snacks, ready meals, and seasonings. The solution promotes the substitution of synthetic additives with natural alternatives, enhances flavour profiles in a sustainable way, and creates new revenue streams for meat processors.

2. Customer segments

- ✓ Include B2B food manufacturers focused on innovation and sustainability, companies developing clean-label products, and public/private stakeholders interested in food waste reduction and circular economy initiatives.

3. Customer relationships

- ✓ Are based on technical collaboration, long-term partnerships, and co-development of tailored flavour profiles. Communication focuses on product traceability, sustainability impact, and integration into reformulated product lines.

4. Channels

- ✓ Combine direct sales to manufacturers, participation in food industry events (e.g. SIAL, Anuga), and collaboration with ingredient distributors.

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5. **Revenue streams**

- ✓ Is based on the sale of the aroma powder, potential licensing of processing technologies, and participation in sustainability-focused funding or innovation projects.

6. **Activities**

- ✓ Involve the collection and triage of suboptimal ham, aroma extraction and stabilisation (via thermal treatment, drying, and encapsulation), sensory optimisation, regulatory documentation, and customer support.

7. **Key resources**

- ✓ Include high-quality suboptimal ham, processing infrastructure, technical and R&D teams, and food safety know-how.

8. **Strategic partners**

- ✓ Include ham producers, flavour houses, academic labs, certification bodies, and logistics providers.

9. **Cost structure**

- ✓ Includes raw material handling, processing, microbiological analysis (e.g. for Listeria), R&D, regulatory compliance, and marketing.

This valorisation pathway offers a practical and scalable solution for reducing industrial food waste while delivering an innovative and functional ingredient to the market.

3.5 BMC Eggs

The Breadcrumb project establishes a sustainable business model focused on the valorisation of eggshell waste as a natural source of calcium. In partnership with egg producers and food processing companies, discarded eggshells are collected, thoroughly cleaned, sterilised, and ground into a fine calcium-rich powder.

The final product targets various market segments: health-conscious consumers, food manufacturers (e.g., bakeries, plant-based product producers, and cereal companies), nutraceutical companies, retailers, and online platforms. The eggshell-derived calcium is used to fortify food products or as a natural dietary supplement.

2. Value propositions

- ✓ Affordable and Natural Calcium Supplement:
  - Cost-Effective: Eggshell-derived calcium supplements can be produced at a lower cost compared to synthetic alternatives, making them more affordable for consumers;
  - Natural Source: Eggshells provide a natural source of calcium, which is often preferred by health-conscious consumers over synthetic supplements.
- ✓ Sustainable Use of Waste:

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- Waste Reduction: By utilizing eggshell waste, the initiative helps reduce the amount of waste sent to landfills, contributing to environmental sustainability;
- Circular economy: This approach supports the principles of circular economy by transforming waste into valuable products, thereby reducing the environmental footprint.

✓ Enhanced Nutritional Value of Food Products:

- Fortification: Eggshell calcium can be used to fortify various food products, such as bread, cereals, and dairy alternatives, enhancing their nutritional profile;
- Health Benefits: Calcium is essential for bone health, and incorporating eggshell-derived calcium into food products can help consumers meet their daily calcium requirements.

✓ Environmentally Friendly Product:

- Eco-Friendly Packaging: The initiative can emphasize the use of sustainable packaging materials, further appealing to environmentally conscious consumers;
- Reduced Carbon Footprint; By repurposing eggshell waste, the production process can have a lower carbon footprint compared to traditional calcium supplement manufacturing.

✓ Innovative and Unique Offering:

- Market Differentiation: Eggshell-derived calcium supplements offer a unique selling point that differentiates them from other products in the market;
- Consumer Education; Educating consumers about the innovative product appeal.

✓ Support for Local Economies;

- Local Sourcing: Partnering with local egg producers for eggshell collection can support local economies and create job opportunities;
- Community Engagement; Engaging with local communities through educational programs and sustainability initiatives can foster goodwill and brand loyalty.

3. Customer segments

✓ Health-Conscious Consumers:

- Individuals Seeking Natural Supplements: consumers who prefer natural and organic products over synthetic alternatives;
- Fitness Enthusiasts: People who are actively engaged in fitness and wellness activities and are looking for supplements to support their health goals;
- Aging Population; Older adults who require higher calcium intake to maintain bone health and prevent osteoporosis.

✓ Food Manufacturers:

- Bakeries: Companies that produce bread and other baked goods can use eggshell calcium to fortify their products;
- Dairy Alternatives Producers: Manufactures of plant-based milk and dairy alternatives can enhance their products with natural calcium;

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- Cereal and Snack Producers: Companies that produce cereals, granola bars, and other snacks can incorporate eggshell calcium to boost nutritional value.

✓ Nutraceutical Companies:

- Supplement Manufacturers: Companies that produce dietary supplements can use eggshell calcium as key ingredient in their formulations;
- Functional Food Producers: Business that focus on creating foods with added health benefits can leverage eggshell calcium to enhance their offerings.

✓ Retailers:

- Health Food Stores; Specialty stores that cater to health-conscious consumers can stock eggshell-derived calcium supplements;
- Supermarkets: Large retail chains can offer these supplements as part of their health and wellness product lines;
- Online Retailers: E-commerce platforms can provide a convenient way for consumers to purchase eggshell calcium supplements.

✓ Educational Institutions and Research Organizations:

- Universities and Colleges: Institutions that conduct research on sustainable practices and food innovation can use eggshell calcium in their studies;
- Research Labs: Laboratories focused on food science and nutrition can explore the benefits and applications of egg-shell-derived calcium.

✓ Community and Environmental Organizations:

- Sustainability Advocates: Organizations that promote environmental sustainability can support and endorse the use of eggshell waste for calcium supplements;
- Local Community Groups: Groups focused on reducing waste and promoting local initiatives can collaborate on educational campaigns and community projects.

4. Customer relationships

✓ Customer Support:

- Responsive Assistance: Provide timely and helpful responses to customer inquiries to ensure customers feel heard and valued;
- Technical Support: Offer specialized support for food manufacturers and nutraceutical companies to help them integrate eggshell calcium into their products.

✓ Educational Content:

- Informative Materials: Create and distribute brochures, guides, and online content that educate consumers about the benefits of eggshell calcium and its sustainable production process;
- Workshops and Webinars: Host educational workshops and webinars to engage with consumers and industry professionals, providing in-depth knowledge about the product.

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- ✓ Personalized Communication:
    - Tailored Recommendations: Use customer data to provide personalized product recommendations and offers based on individual preferences and needs;
    - Feedback and Surveys: Regularly collect customer feedback through surveys and use the insights to improve products and services.

5. Channels

- ✓ Online Sales
- ✓ Retail Stores
- ✓ Health Food Stores
- ✓ Pharmacies
- ✓ Wholesale Distribution
- ✓ Food Manufacturers
- ✓ Nutraceutical companies

6. Revenue streams

- ✓ Sales of Calcium Supplements
    - Direct Sales: Revenue generated from direct sales to consumers through the e-commerce website, online marketplaces, and social media shops;
    - Retail Sales: Income from selling products through health food stores, supermarkets, and specialty stores.
- ✓ Wholesale Distribution
    - Food Manufactures: Revenue from supplying eggshell calcium to food manufactures for use in fortified products such as bread, cereals, and dairy alternatives;
    - Nutraceutical Companies: Income from partnering with nutraceutical companies to integrate eggshell calcium into their dietary supplement formulation.
- ✓ Licensing of Technology:
    - Patent Licensing: Revenue from licensing patented processing technology and formulations to other companies interested in producing eggshell calcium supplements;
    - Brand Licensing: Brand Licensing: Income from licensing the brand to other businesses for co-branded products.
- ✓ Educational Workshops and Seminars:
    - Event Fees: Income from hosting educational workshops and seminars where participants pay to attend and learn about the benefits of eggshell calcium and sustainable practices.
- ✓ Community and Sustainability Initiatives:
    - Grants and Funding: Revenue from grants and funding provided by environmental organizations and government agencies to support sustainability initiatives and waste reduction projects

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- ✓ Consulting Services:
    - Industry Consulting: Revenue from providing consulting services to other businesses and organizations on how to implement sustainable practices and valorize eggshell waste.

7. Activities

- ✓ Collection and Processing of Eggshells:
    - Establish partnerships with egg producers and food processing companies to collect eggshell waste. Implement thorough cleaning processes to remove any residual egg white or membrane. Use specialized equipment to crush and grind the cleaned eggshells into a fine powder;
- ✓ Quality control and testing:
    - Nutritional Analysis: Conduct regular nutritional analysis to ensure the calcium content meets industry standards;
    - Contaminant Testing: Test for contaminants such as heavy metals and pathogens to ensure product safety.
- ✓ Product Development:
    - Develop various formulations of the calcium supplement to cater to different consumer needs (e.g.: fortified bread, dietary supplements)
- ✓ Regulatory Compliance:
    - Ensure all product labels comply with regulatory requirements, including nutritional information and health claims.
- ✓ Research and Development:
    - Continuously explore new applications and improvements for the calcium supplement. Partner with research institutions and universities to stay at the forefront of scientific advancements.
- ✓ Customer Support and Education:
    - Provide customer service to address inquires and feedback and create educational materials to inform consumers about the benefits of calcium supplements and sustainable practices.

8. Key resources

- ✓ Eggshells:
    - Establish reliable sources of eggshell waste from egg producers, food processing companies, and restaurants.
- ✓ Processing Facilities:
    - Invest in equipment for cleaning and sterilizing eggshells to meet food safety standards. Utilize specialized machinery to crush and grind eggshells into a fine powder suitable for use as a calcium supplement. Set up efficient packaging lines to ensure the final product is securely and attractively packaged.
- ✓ Research and Development team

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- ✓ Product Development Specialists
- ✓ Quality Assurance Team
- ✓ Legal and Compliance Experts
- ✓ Marketing and Sales Team
- ✓ Logistic Partners
- ✓ Financial Resources
    - Funding and Investment: Secure funding from investors, grants, or loans to support the initial setup and ongoing operations;
    - Financial Management: Implement robust financial management practices to monitor expenses, revenues, and profitability.

9. Strategic partners

- ✓ Egg Producers and Food Processing Companies
    - Partnerships for Raw Material Supply to secure a consistent supply of eggshell waste.
    - Waste Management Solutions: Work together to develop efficient waste management practices that benefit both parties.
- ✓ Research Institutions and Universities
    - Collaborative Research: Partner with academic institutions to conduct research on the nutritional benefits and potential applications of eggshell calcium. Engage in joint projects to innovate new products and improve existing formulations.
- ✓ Regulatory Bodies and Certification Agencies
    - Compliance and Certification: Work closely with regulatory bodies to ensure all products meet food safety standards and obtain necessary certifications.
- ✓ Food Manufacturers and Nutraceutical Companies
    - Product Integration: Collaborate with food manufacturers to integrate eggshell calcium into their products, such as bread, cereals, and dairy alternatives.
    - Co-Branding Opportunities: Explore co-branding opportunities with nutraceutical companies to enhance market reach and credibility.
- ✓ Logistics and Distribution Partners
    - Efficient Distribution: Partner with logistics companies to ensure timely and efficient distribution of products to retailers and consumers.
- ✓ Marketing and Advertising Agencies
    - Brand Development: Work with marketing agencies to develop a strong brand identity and create effective marketing campaigns.
    - Consumer Outreach: Utilize advertising agencies to reach target demographics through various channels, including digital, print, and social media.
- ✓ Retailers and E-commerce Platforms

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- Sales Channels: Establish partnerships with retailers and e- commerce platforms to provide multiple sales channels for consumers.
- Promotional Activities: Collaborate on promotional activities and in-store events to increase product visibility and sales.

✓ Sustainability and Environmental Organizations

- Sustainability Initiatives: Partner with environmental organizations to promote sustainability and waste reduction initiatives.
- Community Engagement: Engage with local communities through educational programs and sustainability projects.

✓ Financial Institutions and Investors

- Funding and Investment: Secure funding from financial institutions and investors to support business operations and growth.
- Financial Advisory: Seek financial advisory services to manage investments and ensure financial stability.

10. Cost structure

✓ Collection and Processing Costs

- Raw Material Collection: Costs associated with collecting eggshell waste from egg producers and food processing companies, including transportation and logistics.
- Cleaning and Sterilization: Expenses for cleaning and sterilizing eggshells to ensure they meet food safety standards.
- Grinding and Milling: Costs for operating and maintaining machinery used to crush and grind eggshells into a fine powder.

✓ Research and Development (R&D) Expenses

- Product Development: Costs related to developing and refining calcium supplement formulations.
- Nutritional Analysis: Expenses for conducting nutritional analysis and testing to ensure product quality and safety.

✓ Quality Control and Testing

- Laboratory Testing: Costs for regular testing of products to ensure they meet regulatory standards and maintain consistent quality.
- Compliance and Certification: Expenses for obtaining necessary certifications and ensuring compliance with food safety regulations.

✓ Marketing and Distribution Costs

✓ Operational Costs

- Facility Maintenance: Expenses for maintaining processing facilities, including utilities, repairs, and upkeep.

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- Labor Costs: Salaries and wages for employees involved in production, quality control, R&D, marketing, and sales.
- Administrative Expenses: General administrative costs, including office supplies, insurance, and legal fees.

✓ Logistics and Warehousing costs

✓ Financial Costs

- Funding and Investment: Interest payments on loans or returns to investors.
- Financial Management: Costs for financial advisory services and accounting.

✓ Sustainability Initiatives

3.6 BMC Cereals

In cereal processing, a considerable amount of raw material is discarded or downgraded due to not meeting market standards, often because of physical or technological traits rather than safety. Wheat that has low protein content or gluten strength may not quality for premium bread flour types (e.g., T500, T850), while oats with low hectolitre weight are frequently rejected from industrial flake or flour production. However, these materials remain safe and nutritionally valuable and present clear opportunities for valorisation. Through basic milling or baking, they can be transformed into local, functional, and sustainable products, contributing to food waste reduction and supporting circular economy goals.

3.6.1 BMC for Upcycled Wheat Flour from Lower-Grade Grains

1. Value Proposition

✓ Nutritious whole and semi-whole flour with higher fiber content

✓ Made from locally sourced, lower-grade wheat—minimizing food loss

✓ No chemical additives; clean-label product

✓ Ideal for rustic baking: bread, pancakes, and natural pastries

✓ Supports sustainable farming and circular economy principles

✓ Affordable alternative with strong sustainability narrative

2. Customer Segments

✓ Artisanal bakeries and patisseries seeking unique, natural ingredients

✓ Local consumers at farmers' markets prioritizing sustainability and health

✓ Specialty and zero-waste food shops

✓ Home bakers and nutrition-conscious customers

✓ Community-supported agriculture (CSA) programs

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3. Customer Relationships

- ✓ Community-building through transparency and storytelling
- ✓ Educational content on using "imperfect" flour (recipes, tips)
- ✓ Loyalty programs for frequent customers or subscribers Co-creation opportunities (e.g. baking workshops, recipe contests)

4. Channels

- ✓ Direct farmgate and cooperative sales
- ✓ Farmers' markets and local food fairs
- ✓ Direct-to-business (B2B) sales to small bakeries and food artisans
- ✓ Online shop with local delivery or pickup options
- ✓ CSA box add-ons and sustainable food baskets

5. Revenue Streams

- ✓ Retail sales of packaged flour (1 kg, 3 kg, 5 kg)
- ✓ Wholesale to bakeries and food producers
- ✓ Monthly flour subscription boxes with seasonal content
- ✓ Paid educational workshops on upcycled baking
- ✓ Collaboration with schools or NGOs for food education initiatives

6. Key Activities

- ✓ Cleaning, milling, and packaging operations
- ✓ Quality control and compliance with safety standards
- ✓ Consumer education and storytelling via digital and offline channels
- ✓ Building B2B and B2C sales networks
- ✓ Sustainable branding and community engagement

7. Key Resources

- ✓ Supply of lower-grade or rejected wheat from sorting facilities
- ✓ In-house or partner-operated small milling infrastructure
- ✓ Clean-label packaging and traceability system
- ✓ Food safety and quality certifications
- ✓ Digital platform for storytelling and e-commerce

8. Strategic Partnerships

- ✓ Local and regional wheat producers and sorting centers
- ✓ Artisan bakeries and local chefs (for product testing and promotion)
- ✓ Agricultural cooperatives and rural development programs
- ✓ Educational institutions and NGOs promoting food literacy
- ✓ Sustainable packaging suppliers

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9. Cost Structure

- ✓ Raw material acquisition and transport
- ✓ Milling, cleaning, and labour costs
- ✓ Packaging and labelling
- ✓ Marketing, branding, and customer support
- ✓ Logistics and distribution
- ✓ Regulatory compliance (food safety, organic labelling if applicable)

3.6.2 BMC for Upcycled Oat Flakes & Flour from Low-Hectolitre Oats

1. Value Proposition

- ✓ High-fibre oat flakes and flour made from underutilized, low-hectolitre oats
- ✓ Minimizes food loss by valorising non-standard grains
- ✓ Natural, additive-free, with excellent texture and nutritional value
- ✓ Ideal for use in granola, fermented drinks, porridges, cookies, and baked goods
- ✓ Transparent supply chain with environmental impact reduction
- ✓ Appealing to customers seeking traceable, low-waste products

2. Customer Segments

- ✓ Health and organic food retailers
- ✓ Manufacturers of granola, cereal bars, and plant-based snacks
- ✓ Artisan and specialty bakeries (oat cookies, muffins, etc.)
- ✓ Eco-conscious consumers seeking sustainable pantry staples
- ✓ Bulk food and zero-waste grocery stores

3. Customer Relationships

- ✓ Transparent communication through eco-labelling and storytelling (“rescued oats” narrative)
- ✓ Sustainable brand identity aligned with conscious consumer values
- ✓ Educational and interactive events (e.g. oat-based baking workshops, webinars)
- ✓ Community engagement through recipes, challenges, and partnerships with schools

4. Channels

- ✓ Online store with local/national delivery
- ✓ Food cooperatives and ethical purchasing groups
- ✓ Direct B2B sales to snack, granola, and cereal manufacturers
- ✓ Retail presence in zero-waste and organic shops
- ✓ Inclusion in CSA boxes or circular product bundles

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5. Revenue Streams

- ✓ Retail sales of packaged oat flakes and flour (500 g – 1 kg)
- ✓ Bulk sales to food producers (granola, porridge, snack bars)
- ✓ Sales of by-products (e.g. oat bran) for animal bedding, composting, or cosmetics
- ✓ Fees for educational workshops or brand collaborations
- ✓ Co-branded product lines with circular food start-ups

6. Activities

- ✓ Cleaning, moisture adjustment, and thermal stabilization
- ✓ Milling or flaking and packaging operations
- ✓ Product quality control (moisture, microbiological testing)
- ✓ Marketing, storytelling, and brand development
- ✓ Logistics, B2B relations, and community outreach

7. Key Resources

- ✓ Supply of low-hectolitre oats from local or regional farms
- ✓ Flaking and milling equipment (e.g. stone mill, steam flaker)
- ✓ Cleaning and heat stabilization units (to ensure food safety and shelf life)
- ✓ Sustainable packaging and traceability tools
- ✓ Skilled personnel for processing, QA, and outreach

8. Strategic Partnerships

- ✓ Local oat farmers and grain sorting facilities
- ✓ Regional mills or processing cooperatives
- ✓ Circular food innovators and sustainability-focused brands
- ✓ Educational partners (schools, food labs, NGOs)
- ✓ Packaging suppliers with a focus on compostable or reusable solutions

9. Cost Structure

- ✓ Energy and labour for thermal treatment and processing
- ✓ Equipment maintenance and raw material transport
- ✓ Packaging and eco-labelling materials
- ✓ Marketing, digital presence, and outreach activities
- ✓ Compliance and food safety certification

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3.7 BMC Fish

The completed **Business Model Canvas** for fish regards the valorisation of daily fresh local bogue (or other fish surplus/suboptimal fish) through ultra freezing and a social marketing campaign.

1. Value Propositions

- ✓ Provide high-quality, safe-to-eat ultra frozen local fish (including bogue) available year-round.
- ✓ Reduce food waste by valorising suboptimal or unsold fish from the daily auction.
- ✓ Promote underappreciated local species like bogue as healthy, sustainable, and affordable.
- ✓ Guarantee product availability during closed seasons at lower price for a targeted customer. who wants to buy local fish all year long.
- ✓ Support local fisheries and circular economy.

2. Customer Segments

- ✓ Environmentally and health-conscious consumers who prefer local fish food.
- ✓ Price-sensitive consumers seeking affordable seafood.
- ✓ Families or individuals looking for convenience (pre-cleaned, frozen).
- ✓ Local restaurants interested in local, sustainable seafood.
- ✓ Retailers or specialty fish shops.
- ✓ Possibly public sector buyers (e.g., schools, hospitals) interested in sustainable sourcing.

3. Customer Relationships

- ✓ Direct notifications to local fish shops for sales of local ultra-frozen fish available year-round.
- ✓ Informational: awareness and education campaigns on local species, such as bogue
- ✓ Personalized: newsletters or recipes to educate and retain customers to promote consumption of local fish food.
- ✓ Community: build a community around local sustainable seafood (events, tastings).

4. Channels

- ✓ Websites of OPPPB, local council, and ultra-frozen company.
- ✓ Local retail outlets or fish shops.
- ✓ Farmers' markets and food fairs.
- ✓ Social media campaigns (Instagram, Facebook).
- ✓ Pop-up tasting events or educational booths.
- ✓ QR codes on packaging for traceability and recipes.

5. Revenue Streams

- ✓ Direct sales of ultra frozen local fish to consumers.
- ✓ Wholesale to restaurants or retailers.
- ✓ Seasonal subscription boxes (e.g., "Local Catch of the Season").
- ✓ Public procurement contracts.

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- ✓ Branded content or sponsored campaigns via partnerships (e.g., with sustainability orgs).

  - **Key Activities**

- ✓ Collect, sort, and ultra freeze unsold/suboptimal fish daily.
- ✓ Store and manage frozen inventory.
- ✓ Manage relationships and procurement from local fisheries.
- ✓ Design and execute social marketing campaigns for consuming local fish, especially bogue.
- ✓ Traceability and labelling are already done in the first sale for fresh fish, so a similar system could be followed for freeze fish if there is no additional packaging.

6. Key Resources

- ✓ Ultracold storage facilities.
- ✓ Cold chain logistics (freezers, delivery vans).
- ✓ Staff for processing, logistics, customer support, marketing.
- ✓ Digital infrastructure (website, CRM, traceability systems).
- ✓ Branding and marketing content creators.

7. Strategic Partners

- ✓ Local fishers and fish auctions.
- ✓ Local council, municipalities, local fish market and local fish cooperative.
- ✓ Logistics providers for cold chain transport.
- ✓ Local food influencers and chefs.
- ✓ Environmental or food waste NGOs.
- ✓ Local origin can be promoted without certifying it
- ✓ E. Facilities and access to consumers

8. Cost Structure

- ✓ Fixed: ultra freezing infrastructure, storage energy, facility costs.
- ✓ Variable: fish procurement, packaging, logistics, marketing.
- ✓ Personnel: processing workers, marketers, customer service.
- ✓ Marketing and outreach expenses (campaigns, materials).

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4 PRACTICAL LIMITATIONS OF SOCIALLY RESPONSIBLE CHANNELS

Food waste valorisation goes beyond environmental and economic impacts by addressing critical social challenges such as food insecurity and social inequities. In a world where over 800 million people face hunger daily, redistributing edible food waste represents a powerful way to combat food insecurity. While socially responsible channels such as food distribution and donation play a crucial role in mitigating food waste, there are practical limitations to these approaches. This section explores these limitations and argues that there is room for commercial exploitation of suboptimal foods, which can coexist with and support the social role of food redistribution.

For instance, surplus food from restaurants, supermarkets, and food production facilities can be repurposed into new food products or distributed to communities in need through food banks and social enterprises. Upcycled food initiatives, such as turning imperfect fruits into juices or jams, not only reduce waste but also make nutritious food accessible to underserved populations. Moreover, food waste valorisation nurtures social inclusion by promoting sustainable practices at the community level. Educational campaigns about food waste reduction and recycling empower individuals to contribute to a more sustainable and equitable food system. Socially responsible businesses that adopt valorisation practices also gain a competitive edge, attracting eco-conscious consumers and building stronger community relationships. When integrating food waste recycling into their operations, companies demonstrate their commitment to sustainability and corporate social responsibility, creating a ripple effect of positive change.

However, socially responsible channels face several challenges. Perishable food items require specific conditions for transportation and storage, which can be costly and logistically complex. Establishing and maintaining efficient distribution networks to reach those in need can be challenging, especially in remote or underserved areas.

Regulatory and safety concerns also pose significant barriers. Strict food safety regulations can limit the types of foods that can be donated, leading to potential waste of suboptimal but safe-to-consume foods. Organizations may be hesitant to donate food due to concerns about liability in case of foodborne illnesses.

Resource constraints are another major issue. Non-profit organizations often operate with limited funding and resources, which can restrict their capacity to handle large volumes of food waste. Reliance on volunteers can lead to inconsistencies in operations and challenges in scaling up efforts.

Awareness and accessibility are critical factors. Lack of awareness about food donation programs can result in underutilization of available resources. Ensuring that food donations reach the intended recipients in a timely manner can be difficult, particularly in areas with limited infrastructure.

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Despite the challenges, there is a strong economic viability for the commercial exploitation of suboptimal foods while safeguarding the social role of food redistribution. Developing markets for suboptimal foods can create economic opportunities for producers, retailers, and entrepreneurs. Selling suboptimal foods at a reduced price can help recover costs and reduce financial losses for businesses. Innovation and product development can play a significant role. Suboptimal foods can be transformed into value-added products such as sauces, soups, and snacks, which can appeal to consumers and reduce waste. Technological advancements in food processing and preservation can enhance the usability and shelf-life of suboptimal foods. Environmental benefits are substantial. Commercial exploitation of suboptimal foods can significantly reduce the volume of food waste sent to landfills, thereby lowering greenhouse gas emissions. Utilizing suboptimal foods maximizes the use of resources invested in food production, such as water, energy, and labour.

The social impact of commercial exploitation is noteworthy. Offering suboptimal foods at lower prices can make nutritious food more accessible to low-income populations. Commercial exploitation can complement food donation efforts by providing an additional channel for food waste reduction, ensuring that more food is diverted from waste streams.

To safeguarding the social role of food redistribution, collaboration and partnerships are key. Public-private partnerships between businesses, non-profits, and government agencies can enhance the effectiveness of both commercial and donation-based food waste reduction efforts. Pooling resources and expertise can help address logistical and regulatory challenges, benefiting both commercial and social initiatives.

Supportive policies and incentives are crucial. Implementing policies that encourage both food donation and commercial exploitation of suboptimal foods can create a balanced approach to food waste reduction. Providing incentives such as tax breaks or grants for businesses that engage in food waste reduction can promote the commercial use of suboptimal foods.

Education and awareness are key to success. Raising awareness about the benefits of consuming suboptimal foods can drive demand and acceptance among consumers. Engaging stakeholders across the food supply chain can foster a culture of sustainability and responsibility.

While socially responsible channels for food distribution and donation are essential, they face practical limitations that can hinder their effectiveness. By exploring the commercial exploitation of suboptimal foods, we can create a complementary approach that not only reduces food waste but also generates economic, environmental, and social benefits. It is crucial to ensure that commercial initiatives do not undermine the social role of food redistribution but rather enhance it through collaboration, supportive policies, and increased awareness.

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5 CONCLUSIONS AND REMARKS

5.1 Conclusion

Deliverable 4.1 offers a foundational analysis of the business potential of suboptimal foods through a structured typology of valorisation options. The work highlights that while food marketing standards are crucial for product consistency and consumer confidence, they also contribute to avoidable food waste. By identifying feasible valorisation pathways and applying the Business Model Canvas to real product cases, this task demonstrates how suboptimal foods can be re-integrated into the food system in a commercially viable and sustainable way.

To conclude, it can be said that different marketing channels are feasible, but in most cases, additional infrastructure is needed. There are potential alternative channels of interest for companies, but they require research and technological investment, which are not always accessible or realistic for all businesses.

The most important issue is to understand consumers' willingness to buy suboptimal foods or products derived from them, as this will be key to ensuring successful market acceptance and truly contributing to food waste reduction.

The insights and models developed in this report provide a solid base for the next project phases, including validation activities, consumer testing, and the design of tools to support decision-making and business strategy. Continued collaboration among partners will be essential to further develop, test, and scale these solutions in real-world contexts.

5.2 Limitations of the Study

Although Task 4.1 was successfully completed between March and June 2025, several limitations should be acknowledged.

Firstly, the time available for the task was relatively short considering the scope and complexity of the work involved, which included a comprehensive mapping of valorisation pathways, typology definition, and the initial development of business models.

Additionally, there was a need to broaden the review of existing reports and literature related to suboptimal food valorisation and marketing practices, which could not be fully addressed within the timeframe.

Another limitation was the limited involvement of Case Study partners in this phase, particularly in the identification of current or good practices and the exploration of potential business models relevant to their respective contexts. Their insights and local expertise would have contributed to a more robust and representative analysis.

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These limitations will be addressed in the following tasks, where further validation, partner input, and refinement of the results are expected.

5.3 Next Steps and Future Research

Following the completion of Task 4.1, the next steps will involve the necessary revision and consolidation of this deliverable with the active involvement of the Case Study partners. Their feedback will be essential to validate and, where needed, refine the identified valorisation pathways and associated business models, ensuring the outcomes reflect real-case contexts and sector-specific challenges.

In parallel, Task 4.2 will be launched with a clear distribution of responsibilities among partners to ensure timely and efficient progress.

AINIA with the support of ILVO will coordinate Task 4.2 overall, while each Case Study partner will be responsible for supporting the design and implementation of consumer acceptance activities related to their product categories.

AINIA will lead the definition of methodologies and the preparation of survey tools, while AEI Clusport will support the coordination of fieldwork logistics. Additional contributions from UNIBO and MC will ensure consistency with communication strategies and technical feasibility assessments. This collaborative and structured approach will ensure that the upcoming research effectively builds upon the foundation established in Task 4.1.

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7 APPENDICE

7.1 BMC example – Cooked Ham Valorisation BMC

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Cooked ham valorization Business Model Canvas

8. Strategic partners

- **Local Farmers and Pork Producers:** Collaborate with farmers and producers to source suboptimal cooked ham that would otherwise go to waste.
- **Food Processing Companies:** Partner with companies that have the expertise and facilities to process and transform suboptimal cooked ham into valuable products.
- **Waste Management and Recycling Firms:** Work with firms specializing in waste management to ensure efficient collection and sorting of suboptimal cooked ham.
- **Research Institutions and Universities:** Engage with academic institutions for research and development of new product formulations and sustainable practices.
- **Government Agencies and NGOs:** Collaborate with government bodies and non-governmental organizations to support sustainability initiatives and secure funding.
- **Technology providers**: for specialized machinery, automation systems, or proprietary processing technologies.
- **Certifying bodies and consultants**: to ensure regulatory compliance, acquire relevant certifications, and support dossier preparation.
- **Marketing and communication agencies**: to shape messaging around sustainability, upcycling, and innovation.
- **Distributors or ingredient brokers**: to reach a broader B2B customer base within the food industry.
- **Sustainability and Environmental Organizations**: engage with local communities through educational programs and sustainability projects.
- **Financial Institutions and Investors**: Secure funding from financial institutions and investors to support business operations and growth; Financial advisory services to manage investments and ensure financial stability.
- **Universities and innovation hubs**: validating scientific claims and co-authoring research.
- **Retail and foodservice partners**: offering routes to market and consumer-facing positioning.

6. Activities

- **Collection and Sorting of Suboptimal Cooked Ham:** Implement systems for collecting and sorting suboptimal cooked ham from various sources.
- **Processing and Transformation natural flavouring powder:** Develop processes to convert suboptimal cooked ham into natural flavouring powder ingredients for the food industry.
- **Research and Development for New Product Formulations:** Invest in R&D to create innovative products and improve existing formulations.
- **Marketing and Promotion of Valorized Products:** Design marketing campaigns to promote the benefits of valorized products to consumers and businesses.
- **Distribution and Logistics Management:** Establish efficient distribution channels to ensure timely delivery of products to customers.
- **Deliver offer**: develop standardized production protocols, to ensure product consistency; Set up or outsource quality assurance systems; Create technical documentation for clients.
- **Create value for the companie and customer**: maximize yield from raw materials to reduce costs and environmental footprint; Continuously innovate to expand the portfolio of functional ingredients; Document and communicate the environmental and economic impact of the solutions.

7. Key resources

- **Raw Materials (Suboptimal Cooked Ham):** Secure a steady supply of suboptimal cooked ham from partners.
- **Processing Facilities and Equipment:** Invest in facilities and equipment necessary for processing and transforming suboptimal cooked ham.
- **Skilled Workforce:** Employ skilled workers with expertise in food processing, marketing, and logistics.
- **Research and Development Capabilities:** Maintain strong R&D capabilities to innovate and improve product offerings.
- **Marketing and Sales Teams:** Build a team to handle marketing, sales, and customer relationships.

1. Value propositions

- **Reduction of Food Waste:** Transform suboptimal cooked ham into high-value natural flavouring powder, reducing food waste and promoting sustainability.
- **Creation of Functional Ingredients:** Produce a **natural aroma ingredient** that enhances flavour in various food applications (soups, sauces, snacks), contributing to clean label products.
- **Sustainable and Eco-friendly Practices:** Implement eco-friendly practices throughout the production process to minimize environmental impact.
- **Cost-effective Solutions:** Provide cost-effective solutions for food producers by utilizing suboptimal cooked ham.
- **Disposal costs and inefficiencies related to suboptimal cooked ham and meat trimmings**: Offering a solution that allows producers to monetize these by-products, converting them into usable, regulatory-compliant ingredients. This also helps them meet sustainability targets and reduce waste management burdens.
- **Turn cost centers into revenue streams**: Giving economic value to what was previously considered waste and strengthen their environmental positioning and brand image throught circular economy practices.
- **Direct integration with cooked ham producers**: ensuring a consitent supply of raw material and full traceability;
- **Technological flexibility**: Adapt aroma profiles for different applications (soups, ready meals, seasoning mixes).
- **Economic efficiency and environmental responsibility**: Attract industrial players seeking natural, sustainable and cost-efficient flavouring solutions.

3. Customer relationships

- **B2B Partnerships with Food Manufacturers and Processors:** Establish strong relationships with food manufacturers and processors to ensure consistent demand for valorized products.
- **Customer Support and Technical Assistance:** Offer support and technical assistance to customers to help them integrate valorized products into their operations.
- **Educational Campaigns on Sustainability and Food Waste Reduction:** Conduct campaigns to educate consumers and businesses about the benefits of reducing food waste and using valorized products.
- **Food manufacturers and processors (B2B)**: Personal assistance and co-development of products; Long-term strategic partnerships; Tailored technical support and joint innovation projetcts.
- **Sustainability-focused organizations / Public entities**: Collaborative relationships (co-creation of sustainability projects, circular economy pilots); Regular reporting and alignement on impact KPIs.
- **End consumers (via brand communication)**: Community engagement throught sustainability messaging, social media, and storytelling; Digital contact and content marketing; Self-service information access via websites.

4.Channels

- **Direct Sales to Food Manufacturers:** Sell valorized products directly to food manufacturers and processors.
- **Trade Shows and Industry Events**: Participate in trade shows and industry events to showcase valorized products and network with potential customers.
- **Partnerships with Sustainability-focused Organizations:** Collaborate with organizations focused on sustainability to promote valorized products.
- **Added value**: sustainability, innovation, and cost-effectiveness; Technical workshops and sensory demonstrations..
- **Innovative, sustainable, science-backed:** strong visual identity; Consistent communication on sustainabilty; Thought leadership in circular economy.

2. Customer segments

- **Food Manufacturers and Processors:** Food and nutrition companies focused on flavour innovation and sustainability; Manufacturers of soups, sauces, ready meals and seasonings.
- **Health-conscious Consumers:** Appeal to consumers who are interested in sustainable and eco-friendly food products.
- **Sustainability-focused Organizations**: Engage with organizations that prioritize sustainability and reducing food waste.
- **Government and Regulatory Bodies:** Work with government agencies and regulatory bodies to support sustainability initiatives and secure funding.
- **We want**: Food and nutrition companies that value sustainability and innovation; Organizations integrating functional ingredients into healthy products; Public and private entities focused on circularity and environmental responsability
- **Direct access to manufactures**: already involved in meat processing or functional food development or partnerships with ingredient distributors.
- **Food industry trade fairs**: SIAL, Anuga, Vitafoods, ect..
- **Environmentally aware consumers**: who prioritize brands and products aligned with sustainability and food waste reduction.
- **Technical and functional needs**: ingredients with proven functionality (e.g.: texture and nutritional value).
- **Regulatory requirements**: compliance with EU food legislation.
- **Purchasing power**: varies by segment; the offer needs to provide clear cost-benefit.
- **Market trends**: growing demand for sustainability, clean label, and circularity.

9. Cost structure

- **Costs of Raw Material Collection and Sorting:** Expenses related to collecting and sorting suboptimal cooked ham.
- **Processing and Transformation Costs:** Costs associated with processing and transforming suboptimal cooked ham into natural flavouring powder.
- **Research and Development Expenses:** Investment in R&D to innovate and improve product offerings.
- **Marketing and Distribution Costs:** Expenses for marketing campaigns and distribution logistics.

5. Revenue streams

- **Sales of natural aroma powder to food manufacturers:** Generate revenue by selling natural ingredients to food manufacturers and processors
- **Licensing of Processing Technology:** Earn income by licensing processing technology to other companies.
- **Grants and Funding from Sustainability Initiatives:** Secure grants and funding from government agencies and NGOs supporting sustainability.
- **Partnerships and Collaborations with Research Institutions:** Collaborate with research institutions for joint projects and funding opportunities.