HUNGARIAN UNIVERSITY OF AGRICULTURE AND LIFE SCIENCES
Institute of Food Science and Technology

FoodWaStop Guidelines for valorisation of fruit, vegetable, cereal and animal product processing side-streams - an update

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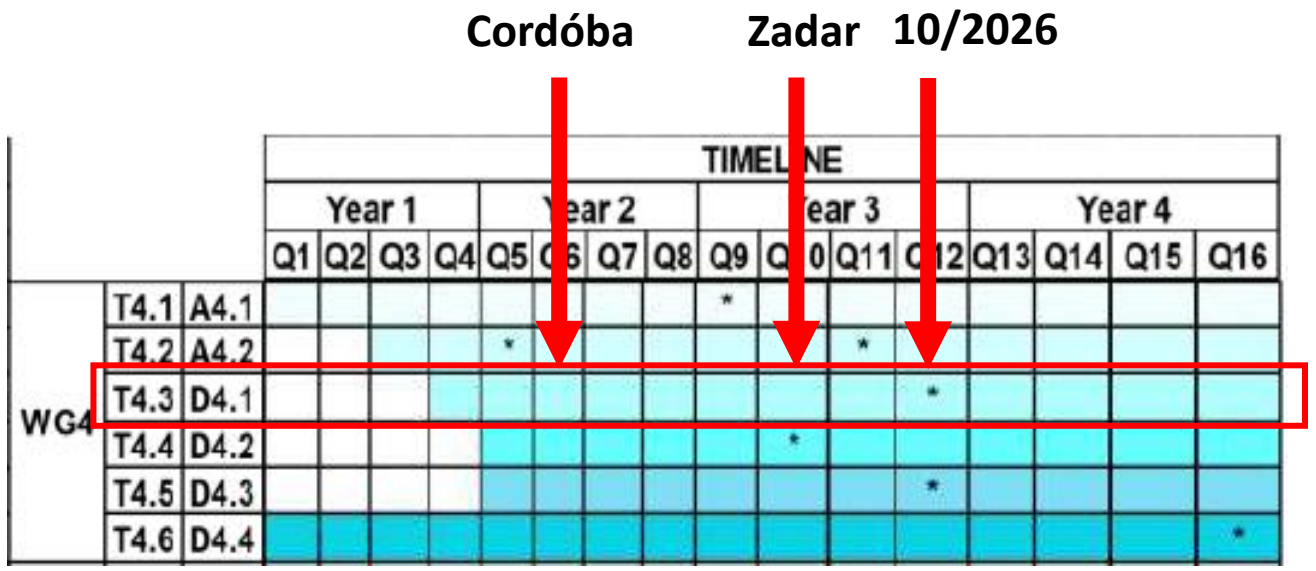
Context

WG4 - Valorisation of agrofood waste and a circular bio-economy

T4.3 Develop a more comprehensive understanding of valorisation strategies for their improvement, and to define new ones;

D4.1. Guidelines for the new valorisation strategy (M36)

Goal of the document: *Rather than providing an exhaustive review, this document is intended to highlight key issues that are worth further consideration when preparing future strategies for agrifood by-product valorisation.*



Evolution of the Guideline

2025 March (Cordóba) – Table of Content is proposed

2025 March –April – TOC -> open for discussion

2025 May – Outline is ready. First circular to recruit contributors

2025 June – First group of potential contributors

2025 September – Contributions are consolidated

2025 October – First formatted draft (v1)

2025 October – Templates for Annex 1 & 2 of D4.1

2025 December – 2026 January – consolidation of contributions

2026 February – Draft V2 is ready

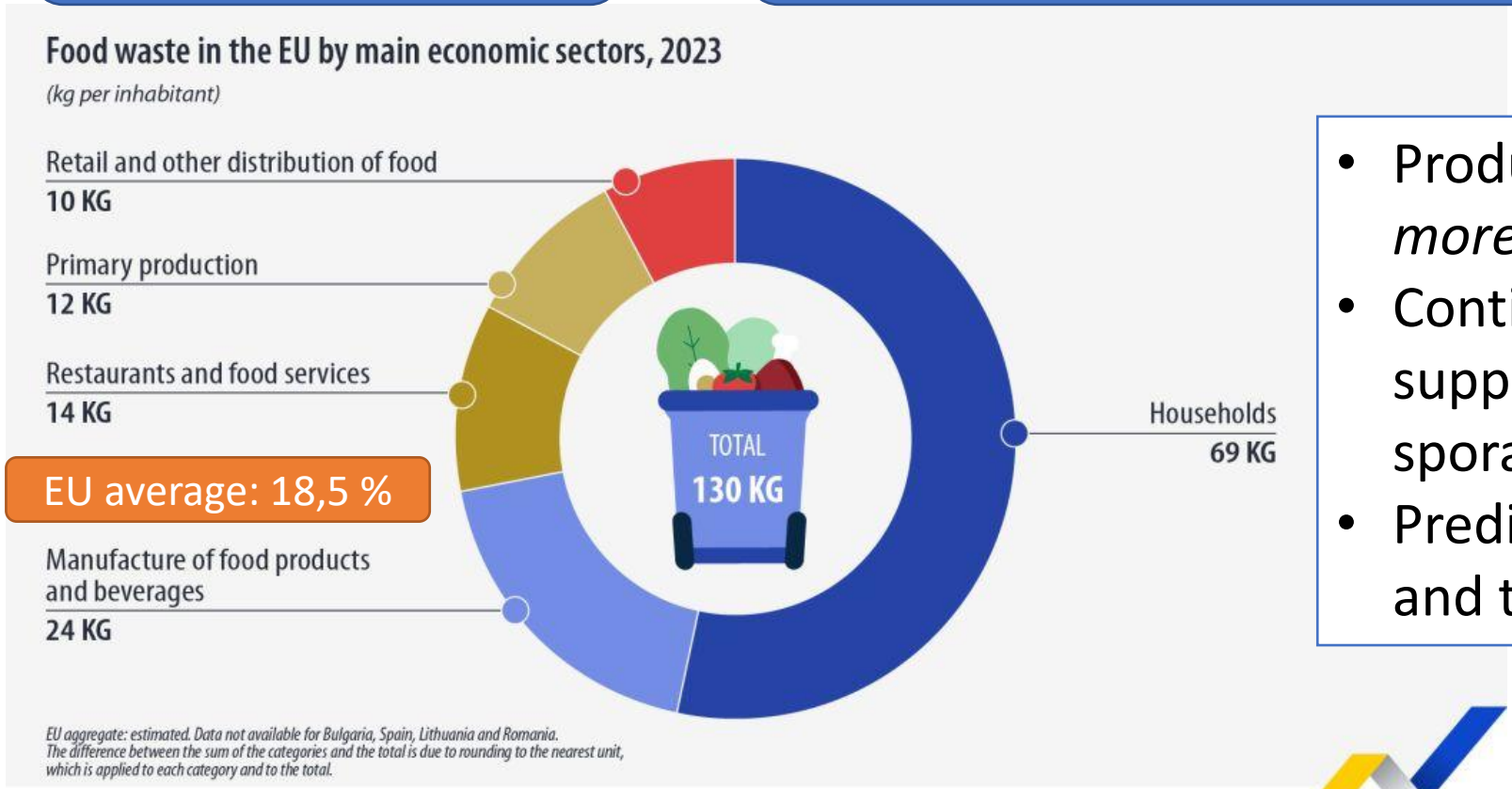
Actual title:

GUIDELINES FOR VALORISATION OF **FRUIT, VEGETABLE, CEREAL AND ANIMAL** PRODUCT **PROCESSING** SIDE-STREAMS

Wide focus on various types of input material

However, narrow focus on the location of by-product generation

→ **Manufacture of food and beverage production**



- Production in industrial settings → *more controlled environment.*
- Continuous and reliable, centralised supply, rather than an arbitrary or sporadic occurrence.
- Predictable and tracable composition and timing.

Key areas covered in the document

Current Landscape and Challenges

Conceptual and Terminological Ambiguities

In food processing sector

Food waste typically denotes **discarded post-production food** that was originally intended for consumption.

waste

food

by-products and side streams

Side streams: refer to all substances or residual materials generated during primary food production that are not the primary intended food product. This term includes ***waste, wastewater, by-products, and inedible fragments***.

By-products are a subset of side streams, generally unavoidable, residual products resulting from the material being processed. These by-products may be suitable for human consumption or other valorisation pathways (e.g., feed, bio-based materials, cosmetics).

Co-product implies that the secondary material is deliberately generated and retained under controlled conditions with the intention of being marketed or utilised as a product.

Regulatory compliance aspect: rather than referring to materials as “waste”, “by-products”, or “co-products”, the most desirable approach is to treat (co)-**products** simply as food, feed, or functional ingredients, depending on their intended use.

Key areas covered in the document

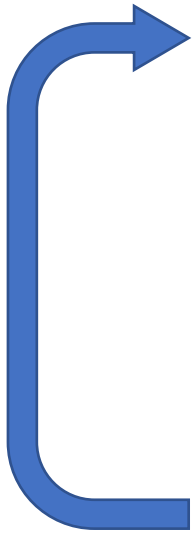
Valorisation as a Multi-step Value Chain

0th step: avoid loss and waste

Valorisation: add value and giving a new perspective to unavoidable by-products

Extraction of a valuable compound / fraction from a given biomass → key step, but only **part of the valorisation process**

Holistic valorisation approach:



- Apropriate collection
- Rapid stabilization
- (Optional) transformation, extraction and formulation
- Avoid premature energy recovery, when more efficient options are feasible
- Utilise (upcycle) in downstream products (food, cosmetics, feed, fertiliser etc.)

Tracebility, maintanance of hygienic and safety aspects

Market-ready secondary, tertiary product

Downstream integration

Instead of reactive waste handling → proactive design of valorisation routes

Key areas covered in the document

Concept of multipurpose (zero waste) valorisation

Extraction, isolation and fractionation processes inherently generate secondary by-products

Apply a similar the multistep, holistic approach to these by-products / residues.

Avoid loss and waste → Design downstream integration

Concept of hierarchical valorisation

When designing valorisation pathways for food industry by-products, it is essential to validate targeted end-uses based on the following key criteria:

- **sustainability impact**
  - energy use, footprint → LCA (baseline → landfill)
  - emphasis on societal aspects and impacts of sustainability (population size that benefit)
  - preservation of biological complexity of the biomaterial → resource efficiency
- **circularity** → retain the original purpose of the primary product (food system proximity)
- **economic value potential**

Concept of hierarchical valorisation

Prioritization principles for the intended use of the by-product, from a circularity / food system proximity perspective.

Food upcycling

- This includes the recovery and utilisation of functional ingredients.

Feed Applications

- Feeding applications supports livestock or aquaculture creating food for human consumption.
- If direct feed use is not viable, side streams may be routed to insect rearing, where insects serve as feed ingredient for food-producing animals.

Plant and Soil Applications

- Returning nutrients to the agricultural system via composts, biostimulants, or fertilisers. These applications support food production indirectly by enhancing soil health and crop yield.

Non-agricultural applications → Energy recovery

- Priority might be given to material uses that support the food system, such as packaging.

Key amendmends to this hierarchy:

Lower-tier options (e.g. composting) might be more sustainable or economically more practical.

Subsidised energy recovery pathways frequently diverts valuable by-products from more circular uses.

Nutraceutical and cosmetic ingredients may not represent the most sustainable pathways, yet they frequently provide the financial backbone that enables cascading biorefineries.

Multi-criteria value assessment tools are recommended

Example: high economical interest cosmetic ingredient vs. composting

Further topics covered in the document

Regulatory aspects: novel food, food safety, ultra processed food

Annexes to the main document

1) Case studies

A short 3-5 page document that provides an overview of the utilization opportunities and current practices of a given by-product type.

A structured template (prepared by Sarah Milliken) has been created.

10 ”Case studies” have been created so far.

1. Introduction
2. Context and Baseline
3. Cascading Valorisation Pathways According to Food Use and Waste Hierarchy
   - Stage 1: Direct Food Use
   - Stage 2: Feed and Biochemical Valorisation
   - Stage 3: Non-food Valorisation
   - Stage 4: Energy Recovery and Disposal
4. Valorisation Challenges
   4.1 Infrastructure and Logistics
   4.2 Scale and Economic Viability
   4.3 Technical and Processing Challenges
   4.4 Environmental and Regulatory Issues
   4.5 Supply Chain and Collaboration Gaps
   4.6 Product Development and Marketing Challenges
5. Sustainability Assessment
6. Conclusions and Outlook

Completed case studies (January 2026)

No	Title	Author	Affiliation
1	Apple pomace	László Abrankó	Hungarian Universitiy of Agriculture and Life Sciences (MATE)
2	Rosehip (Rosa canina) Seed as Animal Feed Ingredient	Nurinisa Esenbuga	University of Ataturk
3	Lemon peel medium	Mario Riolo	University of Catania, Department of Agriculture, Food and Environment (Di3A)
4	Chitosan film with lemon peel medium	Mario Riolo	University of Catania, Department of Agriculture, Food and Environment (Di3A)
5	Citrus residues for esssential oils	Anna Maria Vettraino	University of Tuscia, Viterbo
6	Valorisation of Bee Bread by-product	Davut Karahan	Bingol University, Türkiye
7	Lycopene Extraction from Tomato Pomace Using Green Ultrasonic Technology	Omer Cevdet Bilgin	University of Ataturk, Turkiye
8	Fresh Grape Pomace for feed ingredient for cattle	Nurinisa Esenbuga	University of Ataturk
9	Grape Pomace for feeding ruminants	Nurinisa Esenbuga	University of Ataturk
10	Grape pomace for feed ingredient for fattening lamb	Nurinisa Esenbuga	University of Ataturk

- Typically:4 pages-long
- Follows the structure of the tamplate
- Contains literature references!!
- Ideally not an extract of a single research paper, but neither a comprehensive review

Case Study: Valorisation of Grape Pomace as a Functional Feed Ingredient for Ruminants

1. Introduction

Grape pomace (GP) is the major solid by-product generated during wine and grape juice production. It consists of grape skins, seeds, and small stems remaining after pressing. GP represents up to 20–25% of the original grape weight, making it one of the largest fruit-processing waste streams globally. Rich in polyphenols, tannins, fibres, oils, vitamins, and natural antioxidants, GP shows high potential as a functional feed ingredient for ruminants. Recent studies (MDPI, 2024) demonstrate that GP inclusion enhances antioxidant status, reduces lipid oxidation in meat and milk, and may partially replace conventional feed ingredients, contributing to circular bioeconomy and waste reduction.

2. Context and Baseline

Wine and grape juice industries produce millions of tonnes of GP annually. Traditionally, disposal methods have included:

- Land spreading

Annexes to the main document

1) Case studies

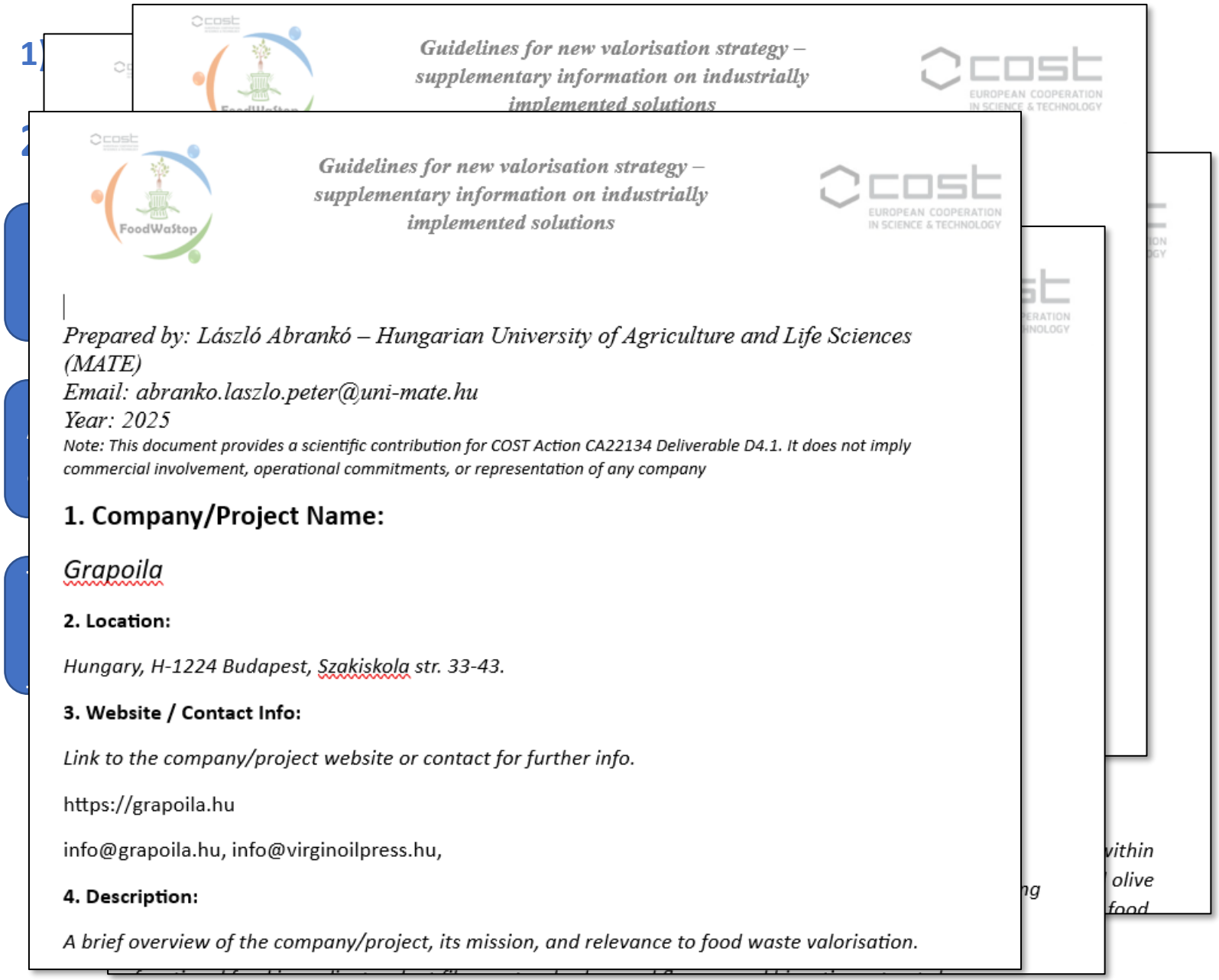
2) Industrially implemented solutions

A very short, 1-2 page document that introduces a **company or project** that deals with the processing and utilization of agri-food by-products.

A very important criterion is that we only want to include solutions that are already operational on an **industrial scale.**

These documents are created for informational purposes and do not imply commercial involvement, operational commitments, or representation of any company.

Annexes to the main document



26 documents are completed so far

There are still more companies (not only EU) waiting to be introduced using the template .

More interesting ”Case studies” are welcome.

Contibutions are still welcome

Acknowledgment

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Thank you for your attention!

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