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Imca Sampers, Geneviève Gésan-Guiziou, Thierry Benezech, Samuel Le Féon, Caroline Pénicaud, Marine Penland, Stéphanie-Marie Deutsch, Elodie Lerolle-Rio, Virginie Herbreteau, Odile Parizel, et al.

### ► To cite this version:

Imca Sampers, Geneviève Gésan-Guiziou, Thierry Benezech, Samuel Le Féon, Caroline Pénicaud, et al.. Innovative upgrades to value and packaging of small quantities of liquid food products. 36th EFFoST International Conference 2022, EFFoST: federation of associations and societies focused on food science and technology in Europe., Nov 2022, Dublin, Ireland. hal-03877296

**HAL Id: hal-03877296**

**<https://hal.inrae.fr/hal-03877296v1>**

Submitted on 29 Nov 2022

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## Innovative upgrades to value and packaging of small quantities of liquid food products



EFFoST

7-9 November  
Dublin, Ireland

\*\*\* 2022 INTERNATIONAL  
CONFERENCE



# Innovative upgrades to value and packaging of small quantities of liquid food products

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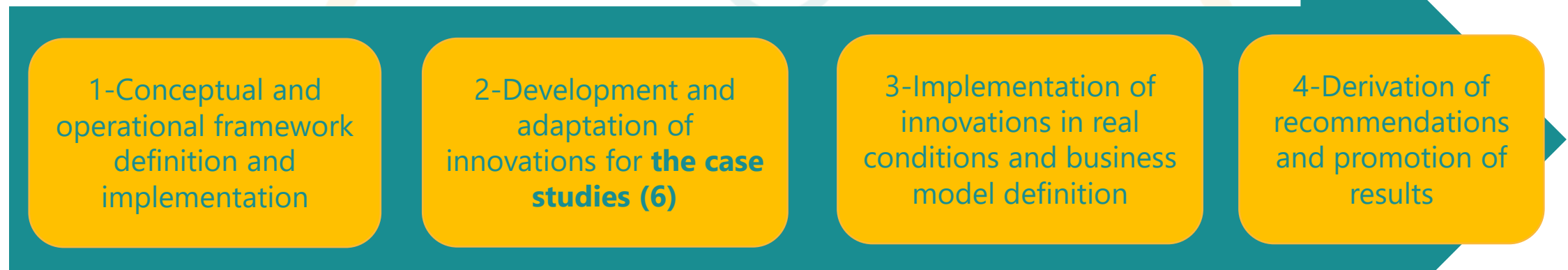


Nathalie Roland



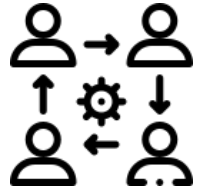
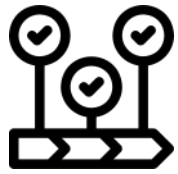
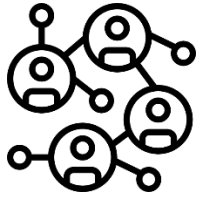
# FAIRCHAIN

- **Objective** : Test, pilot and demonstrate **technological innovations** that have the potential to support the scaling up and expansion of small and mid-sized farmers and food producers
- **Methodology**



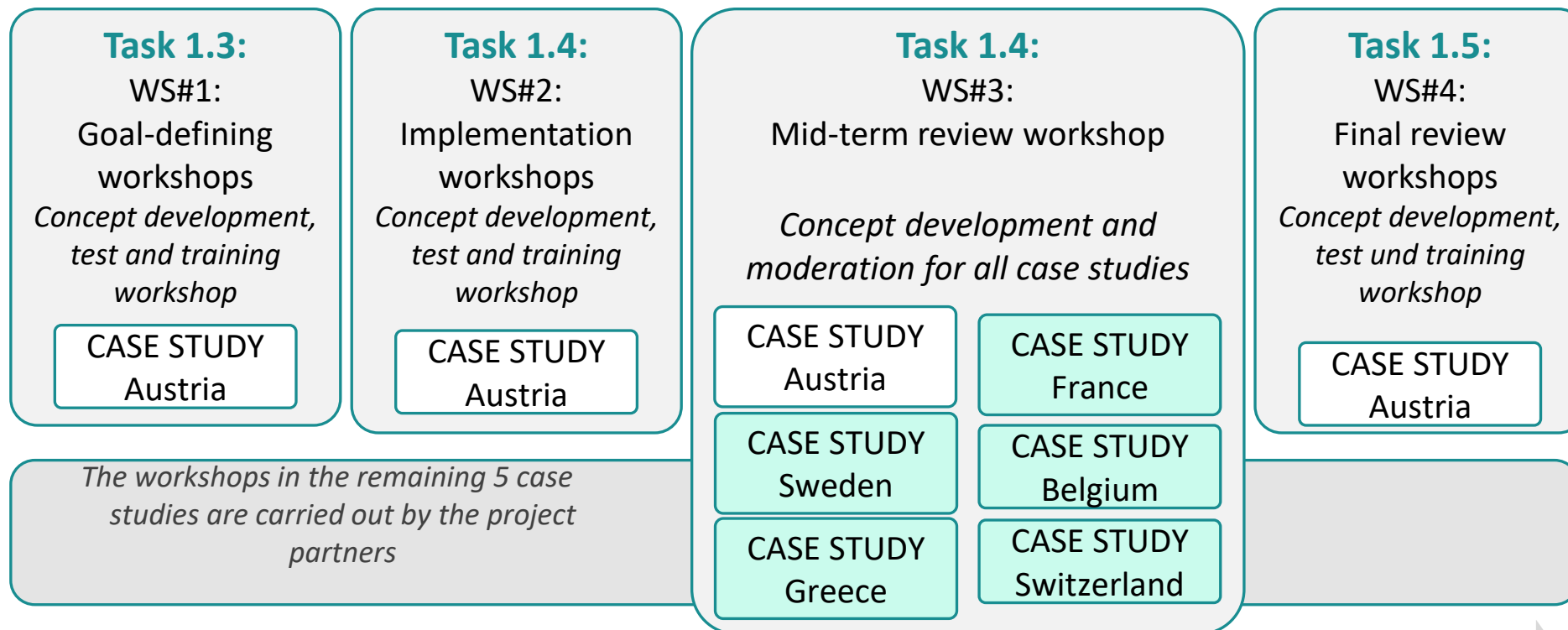
**Multi-actor co-creation process  
&  
Multi-perspective assessment framework**

# Multi-actor Co-Creation Approach: Goals



- Integrate **expertise** from different stakeholders
- Include and address stakeholders and actors across the **entire value chain**
- Generate **new perspectives** on each of the case studies
- Ensure **fair(er) distribution** of benefits and risks along the VC
- Design the new/reconfigured value chains in each case study
- Foster **exchange between** the different FAIRCHAIN **case studies** to provide new insights from other areas of expertise and can lead to spill-overs.
- Foster **collaboration** and partnerships among stakeholders that can thrive and grow **beyond the duration of the project.**

# The FAIRCHAIN Co-creation process



**Which steps, actions and competencies are required by which actor to achieve the goals and implement the innovation?**

**What do you want the case study to achieve?  
What are the most pressing concerns for the respective case study?**



# Key aspects/challenges for a successful co-creation

- **No default co-creation process**; must be tailored specifically to case study setting and stakeholder resources
- **Representativity**: Stakeholder identification and involvement according to PESTEL, affectedness and influence, covering all stages of the value chain
- **Early involvement**, influence: give stakeholders the opportunity to shape (parts of) the case study
- Openness for **different kinds of innovation** (technical, social, organisational)
- Task definition, influence, transparency: very **clear communication** of co-creation workshop goals, what is negotiable, what not
- **Fair and transparent** decision-making and conflict-solving processes

Specific effort  
to involve  
SMEs or small  
producers

**Important steps:** identify stakeholder, facilitate dialogue and knowledge sharing, incentivise stakeholders, build long-lasting cooperations



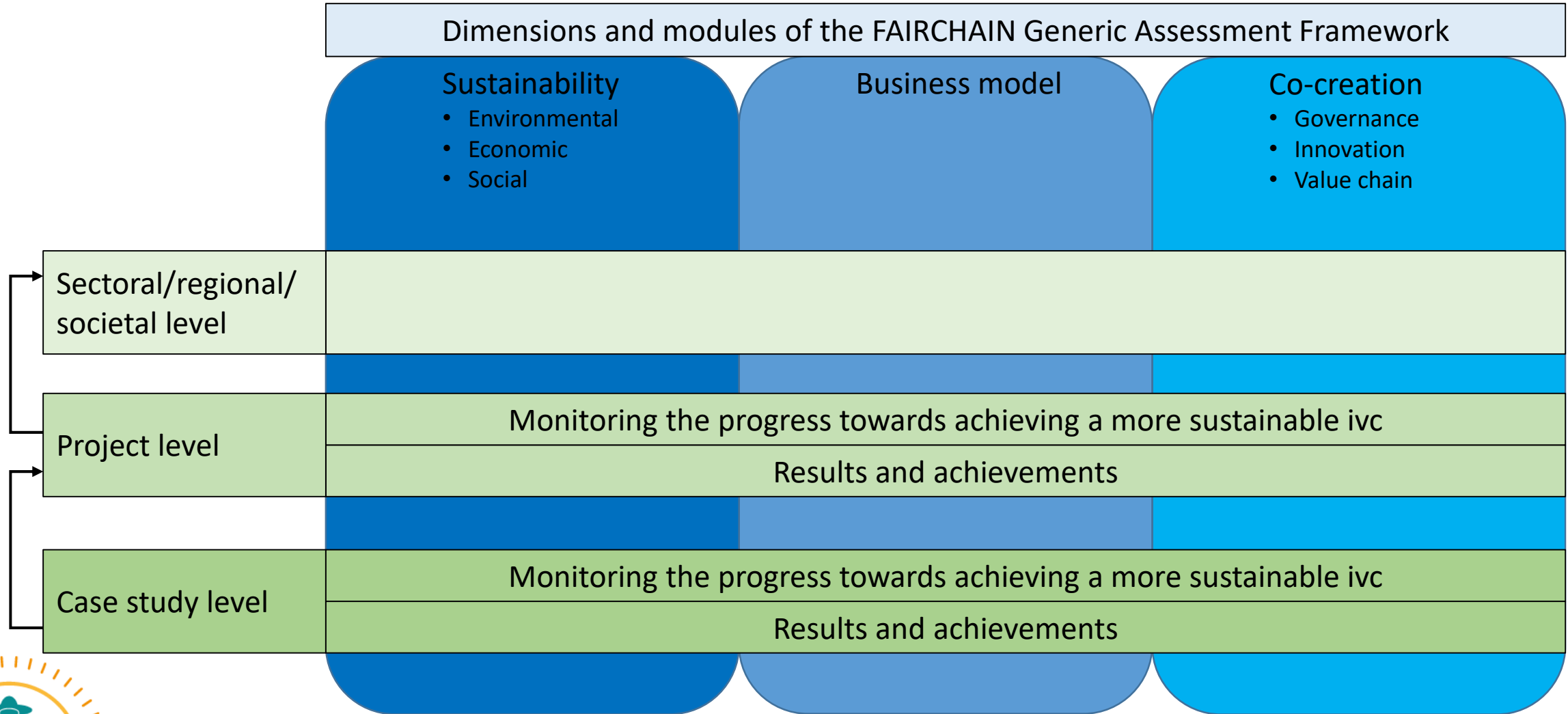
# FAIRCHAIN-specific assessment framework

- High-quality case study execution
  - integrate stakeholder perspectives, sustainability and business model development right from the start of the innovation process
  - ensure that sustainability hot spots are addressed
  - ensure that suitable business models are developed
  - provide guidance between different options
  - Compare before – after and monitor progress towards goals
- Project achievements must be more than the sum of the case study achievements
  - unifying function of the methodology
  - allows cross-case study analysis
- Team-building function in the consortium
  - close interactions between project partners when elaborating and applying the methodology
  - inducing mutual learning processes





# Structure of the FAIRCHAIN Assessment Framework





# Innovative fermented whey-based drinks



# Current situation versus aim



Whey

Curd  
(Cheese)



The Vevy cheese dairy

Processing 1

Processing 2

Pressing

Sweet whey

Sweet whey

Molding & maturing

Slightly acidified whey

Preconcentrator plant

Slightly acidified whey

Drying plant

Wastewater treatment plant

Long dominant value chain

Comté



PDO (Protected Designation of Origin) cheeses



Tomme



Raclette

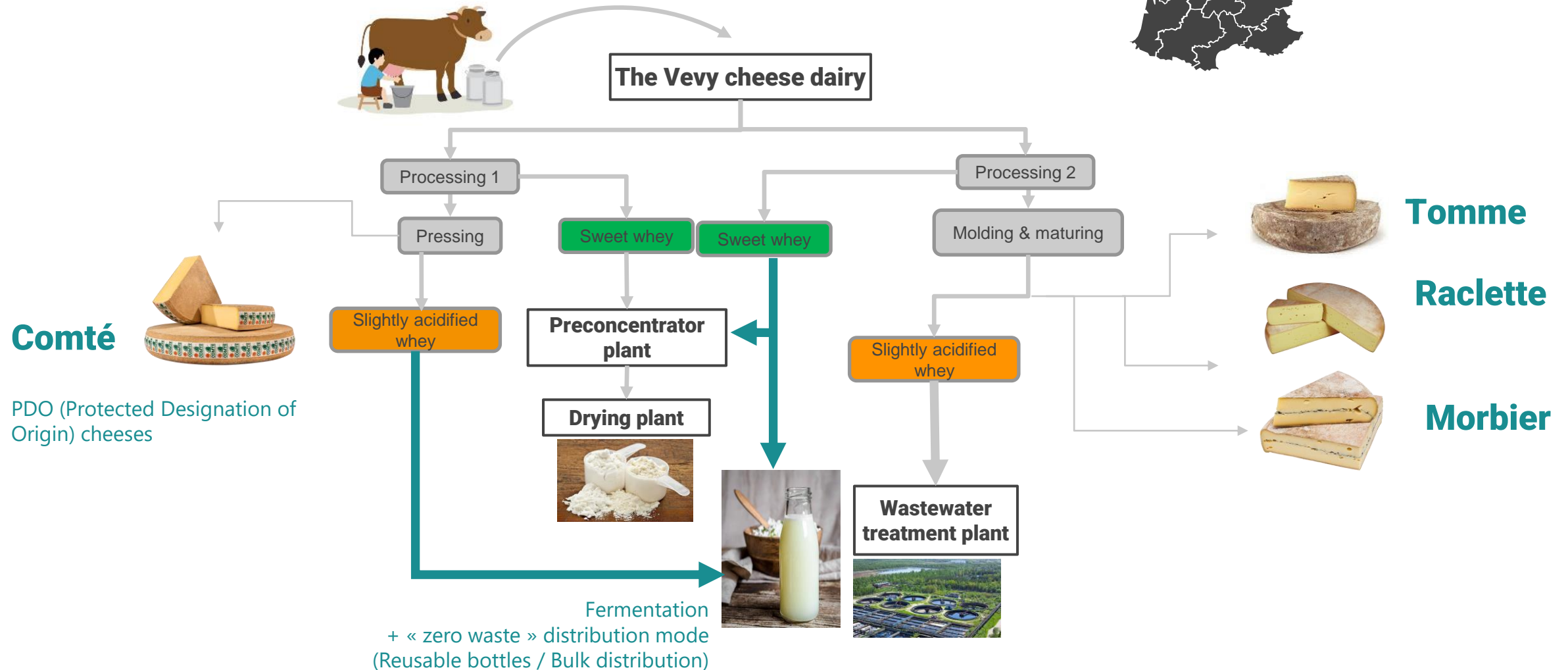


Morbier



# Current situation versus aim

→ Find a new route adapted to small and mid-sized actors at a regional level for upgrading value of whey by developing innovative fermented whey-based drink



# Development of the fermented whey-based drinks

- Determine heat-treatment conditions to stabilize wheys (lab-scale)  
Obj: Remove native cheese whey micro-organisms with minimal impairment of whey organoleptic properties
- Screen and select the micro-organisms on wheys alone
  - Screening of > 125 lactic acid bacteria (or consortia of yeasts + lactic acid bacteria) on ≠ wheys to identify the strains with the best acidification and sensorial properties
    - Selection of 20 promising strains on Comté acid whey and 32 strains on Morbier sweet whey
- Carry out fermentation assays on wheys mixed with fruits/vegetables/herbs
  - Over 15 flavours (fruit juice or herb) were tested,
  - Selection of **4 bacteria strains (/ whey type)** working well in association with (at least) one flavour
  - Some of the best prototypes were tasted and validated by CS-Fra team

Poster P4.1.32



→ Many options / degrees of freedom (flavours, texture, ... conditions of storage, type of packaging ...)

# Main learnings from the co-creation process

- **Lack of market studies and definition of consumer expectations / innovative drinks**
  - Need to identify the targeted consumers to define the drink features
  - Emphasis of the ‘story-telling’ of the innovative drinks
  - Need to co-develop the drink with the consumer at an early stage
- **Re-organisation of activities, planning, budget**
  - **Consumer studies** → 3 concepts that best suit consumers **were identified and validated by stakeholders** :  
“Whey-based Kefir”; “Fruit whey-based drink”; “Whey-based concentrate to dilute
  - **Priorization of technological development**
- **Emergence of new ideas and / or barriers that need to be investigated**
  - Constraints in the development of the new business models : low volume of whey to be collected, high cost of collection, storage, and production/distribution; constraints imposed by the protected designations of origin (PDO) regulation of cheeses, ...
  - Weak know-how of the cheese makers as regards fermentation; lack of equipment in the current cheese dairies;
  - Definition of a specific brand for the drink;
- **New stakeholders** are prone to actively participate  
(ex: The Franche-Comté region, J’aime Mes bouteilles)



# Main learnings from the assessment baseline

## **From an environmental perspective**

- The management of whey is not a hotspot (milk production and whey drying);
- Transport of whey from cheese dairies to valorization sites is not negligible → The innovative drinks should be produced as close as possible to the cheese dairy

## **From a social point of view**

- Generation of more jobs and reinforcement of the regional workforce.
- More stability and independence on the costs of current markets. → Reinforcement of the independence of the regional players facing international market (whey) prices, which fluctuate according to world market demand (infant milk with Asia) or political situations (like the war in Ukraine)

## **From an economical point of view**

- Producers and processors, being part of the SODIAAL cooperative, would benefit directly from the margin profit.
- The business models needs to consider the constraints imposed by PDO regulation and be defined by considering the volume, the cost of collected whey, storage conditions, and production/distribution modes and the different implementation schemes of the distribution reuse loop, including cleaning and packaging machine.

The main challenges of this technological innovation are related to the economic sustainability of the innovative drink, including its acceptability by the consumers/citizens and the business models including the “zero waste”,



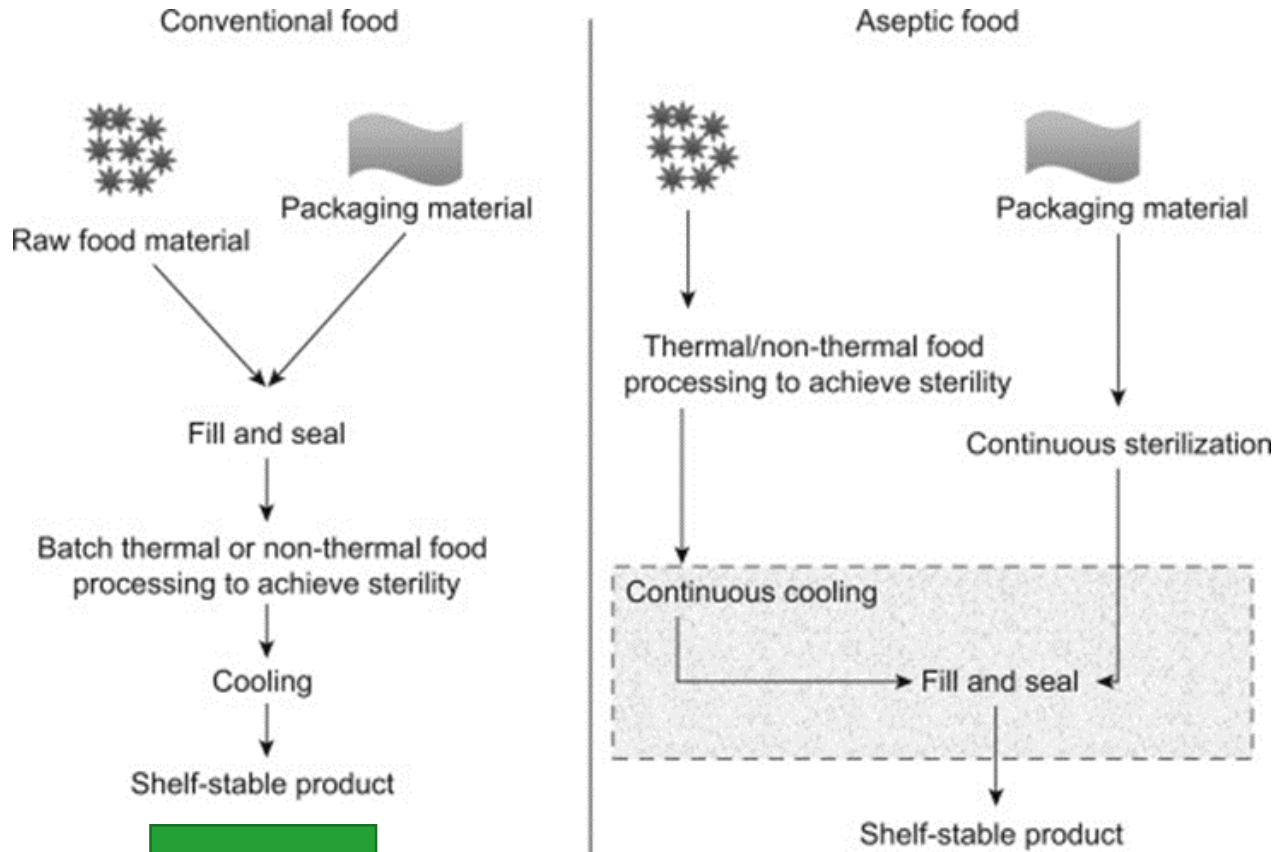


# Innovative aseptic filling machine





# Current situation versus aim



Fruit juice



Vegetable juice/soupe

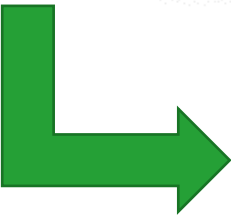


Whey based drink

• Up-scaling: Access; design and/or business models needed for small scale producers/farmers

• Down-scaling (process steps) big producers

More energy and water use



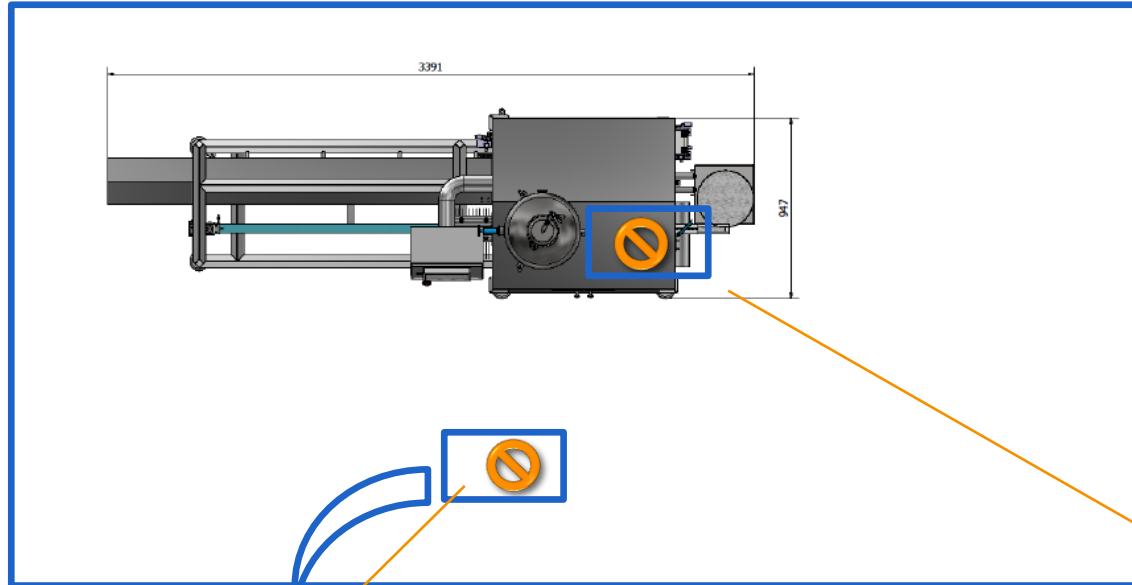
- Post-sterilization is not needed resulting in less dropout
- Less energy may be expected
- Packaging material could also be less resistant allowing the use of different (biobased) materials

• Effoast Dublin, the 9th November 2022



# Hygienic design: e.g. air quality toward new guidelines

Measure air where packaging enters the machine following the method of Pasquerella, 2000 (1 meter from the machine, 1 meter height, for 1 hour).

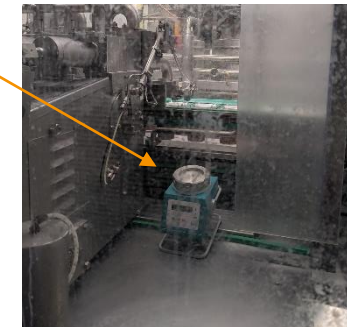
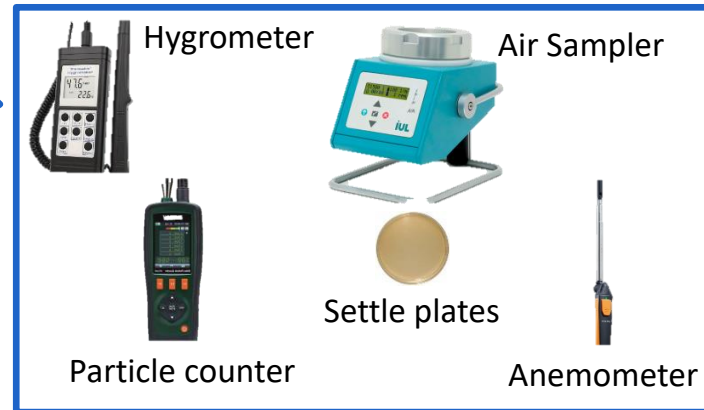


## Air Sample Point

- Passive (Settle plates)
- Active (Air Sampler)
- Temperature (Hygrometer)
- Relative humidity (Hygrometer)
- Air Velocity (Anemometer)
- Particles/diameter (Particle counter)



Outside Machine



Inside Machine

# Sampling campaign in Food Industry (Belgium)

Factory	Total Viable Count (Active)		
	n	$\bar{x}$ (CFU/m <sup>3</sup> )	std
Dairy 1	36	14	10
Dairy 2	6	1447	220
Dairy 3	15	356	518
Sauces 1	12	1050	1082
Sauces 2	6	406	46
Sauces 3	6	198	50
Margarines 1	18	44	42
RTE 1	12	208	118
RTE 2	27	112	82
RTE 3	12	204	126
Fruit puree	15	366	138

\*n – number of samples,  $\bar{x}$  - mean in CFU/m<sup>3</sup>, std - standard deviation

- Significant differences between factories for airborne contamination of TVC and Yeast/Mould (p<0.01) for active and passive measurements
- No correlation between relative humidity and active/passive counts
- No correlation between temperature and active/passive counts
- Weak positive correlation between high water pressure cleaning (r equals 0.305) and moulds/yeasts in the air (passive measurement)  
→ See next slide

E.g. Results winter/spring active air samples at food producer (Belgium)

Weak negative correlation when doors are closed (r equals -0.396) and TVC (active measurements)

→ Data collection summer/autumn still needs to be processed

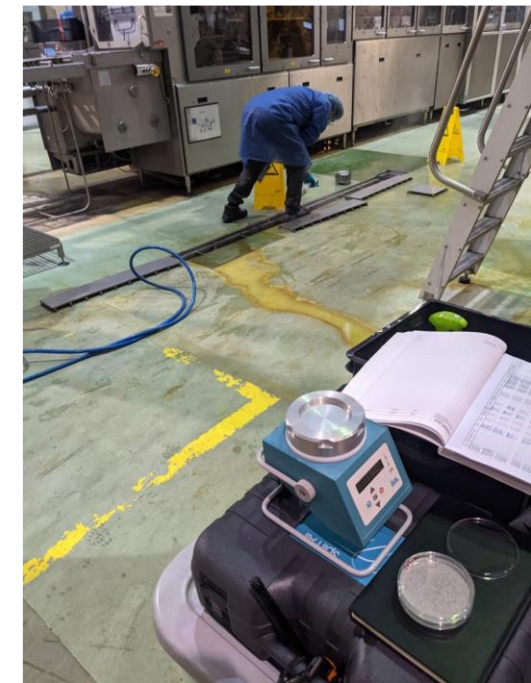
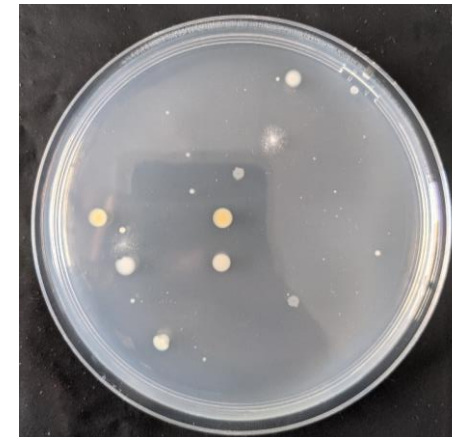


# Air Sampling @ Dairy Producer 1

E.g. results Moulds/Yeasts (mean) at dairy producer (Belgium)

	Morning (09:00 – 10:00)	Afternoon (13:00 – 14:00)	Evening (17:00 – 18:00)
Active	23 CFU/m <sup>3</sup>	293 CFU/m <sup>3</sup> *	15 CFU/m <sup>3</sup>
Passive	0 CFU/m <sup>2</sup> .h	0 CFU/m <sup>2</sup> .h	0 CFU/m <sup>2</sup> .h
Outdoor (Active)	105 CFU/m <sup>3</sup>	135 CFU/m <sup>3</sup>	160 CFU/m <sup>3</sup>
Outdoor (Passive)	1 CFU/m <sup>3</sup>	0 CFU/m <sup>3</sup>	0 CFU/m <sup>3</sup>
Temperature	21,1°C	20,8°C	20,8°C
Relative humidity	66,9%	64,6%	64,3%
Airflow	0,03 m/s	0,02 m/s	0,01 m/s

\* Higher CFU/m<sup>3</sup> counted when drains are cleaned with a high pressure hose during production near packaging line



# Integration of technological, organisational and social innovations into **business models**

## General perceptions of the solutions

### Machines and pouches



- Both machines are a great asset for users to reduce human labour and errors and save time for actors already engaged in a processing activity. But considered as a less priority investment for actors not already engaged in a processing activity.
- Packaging should not be considered in isolation but as one tool among others, in the whole process.
- High interest for the aseptic process of filling.
- Interest for a high versatility of the machine regarding the products to be packed and packaging (types and content). Few recommendations in terms of technical improvements.
- Capacity and purchase price of the light-version machine seems more appropriate to small and mid-sized actors, using or owning the machine.
- Plastic pouches not well accepted for some small and mid-sized actors, for convenience & environmental reasons. Seems more appropriate for B2B market & collective catering → Need for information & education on environmental impact of packaging solutions.



# General perceptions of the solutions for users

## Business models

Two common aspects to the 3 Business Models (BM):

- The question of the cross-contamination (allergen, plant-based vs. animal products, organic vs. conventional)
- The need for associating the packaging machine to other processing machines to consider the whole process

**BM1**  
Mobile packaging machine

- + Save time in transportation
- + No need to consider maintenance
- Cost of the service for users and place needed

**Users with seasonal/punctual productions**

**BM2**  
Individual ownership with open access

- + Areas already complying hygienic norms
- + No need for considering maintenance
- Cost of the service, potential variability

**Users starting a new processing activity or with non-regular production**

**BM3**  
Sharing in cooperative

- + Shared investment AND skills, workforce, and other resources
- + Being part of the governance
- Higher administrative charge

**Users with similar needs and more regular productions**

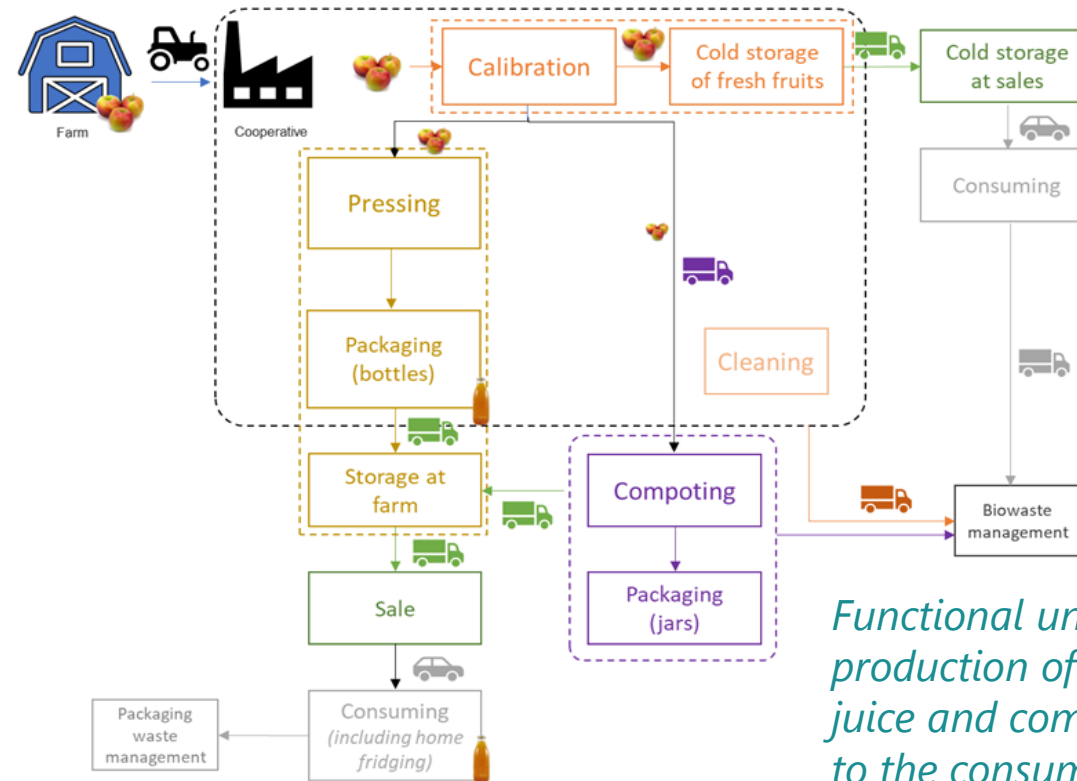
**Business models in the form of “shared workshops” or “food hubs” seems appropriate to small and mid-sized actors (compatible with BM2 and BM3).**



# Life Cycle Assessment of current situation: example of the upscaling scenario

## Apple production in French Flandres

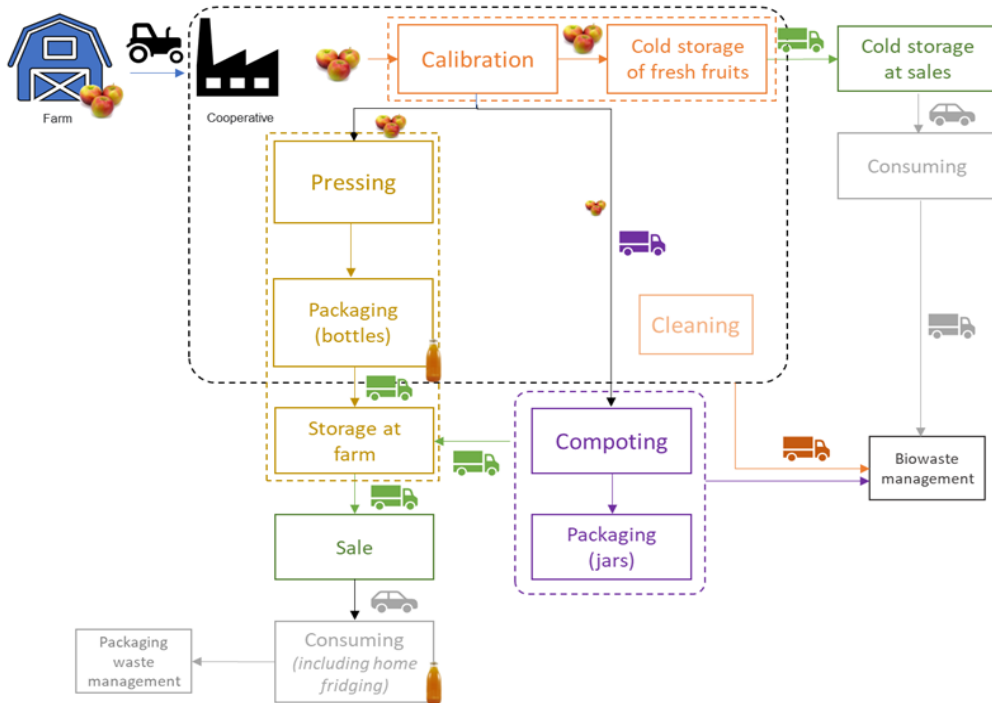
- Small producer: 3 ha
- Transformations: juice and compote (made off-farm)
- Packaging: glass bottles and jars
- Limited finance and workforce



*Functional unit: « one year production of fresh apples, juice and compote delivered to the consumer »*

LCA is applied to the whole value chain to evaluate the potentialities to reduce environmental impacts with the innovation

# Life Cycle Assessment of current situation: example of the upscaling scenario



	At farm	Calibration and storage	Juice - processing and packaging	Compote - processing and packaging	Retail	Consuming
Climate change (CC)	Low	Low	Medium	Medium	Low	Medium
Ozone depletion (OD)	Low	Low	Medium	Medium	Low	Medium
Ionising radiation (IR)	Low	Low	Medium	Medium	Low	Medium
Photochemical ozone formation (POF)	Low	Low	Medium	Medium	Low	Medium
Particulate matter (PM)	Low	Low	Medium	Medium	Low	Medium
Acidification (Acid)	Low	Low	Medium	Medium	Low	Medium
Eutrophication, freshwater (Eutro-F)	Low	Low	Medium	Medium	Low	Medium
Eutrophication, marine (Eutro-M)	Low	Low	Medium	Medium	Low	Medium
Land use (LU)	High	Low	Low	Low	Low	Low
Water use (WU)	Low	Low	Medium	Medium	Low	Medium
Resource use, fossils (Res-F)	Low	Low	Medium	Medium	Low	Medium
Resource use, minerals and metals (Res-M)	Low	Low	Medium	Medium	Low	Medium

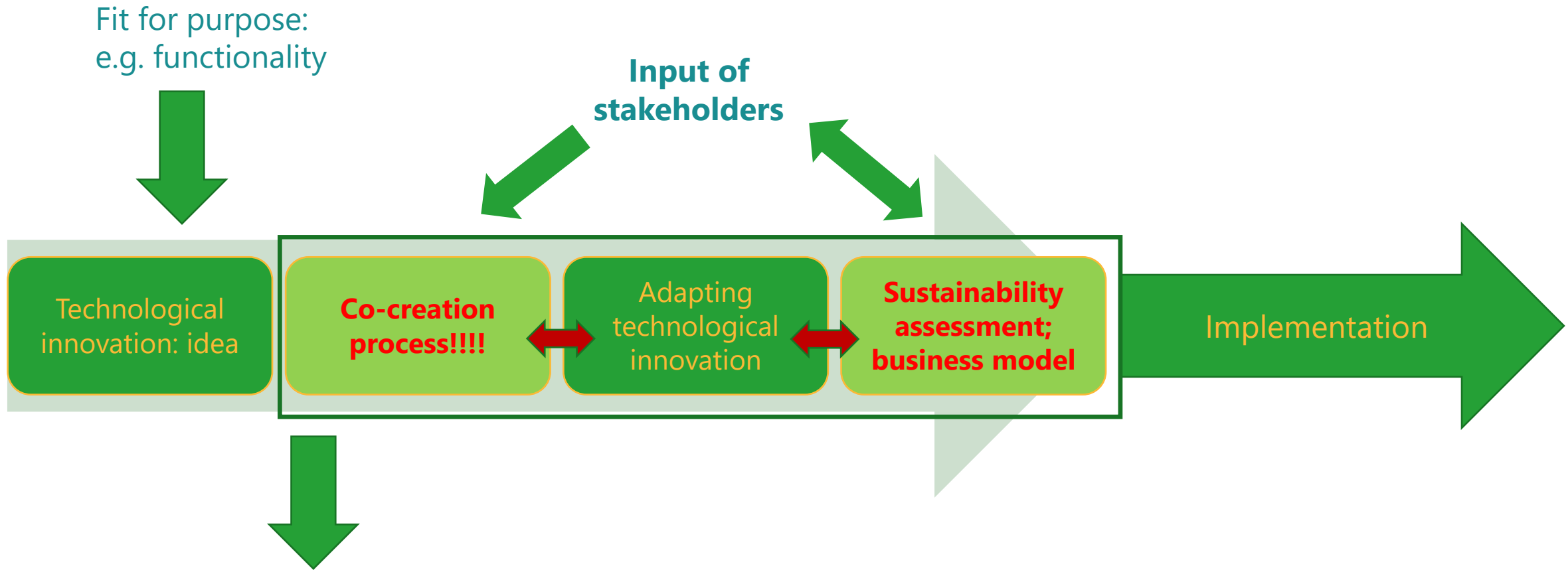
From 3% to 73% of the total impacts related to the processing and packaging of juice and compote

=> The innovation can potentially significantly improve the environmental performance of the farmer





# Take home messages



Output: e.g. improvement technological innovation; barriers; defining new business models; need of more info on environmental impact

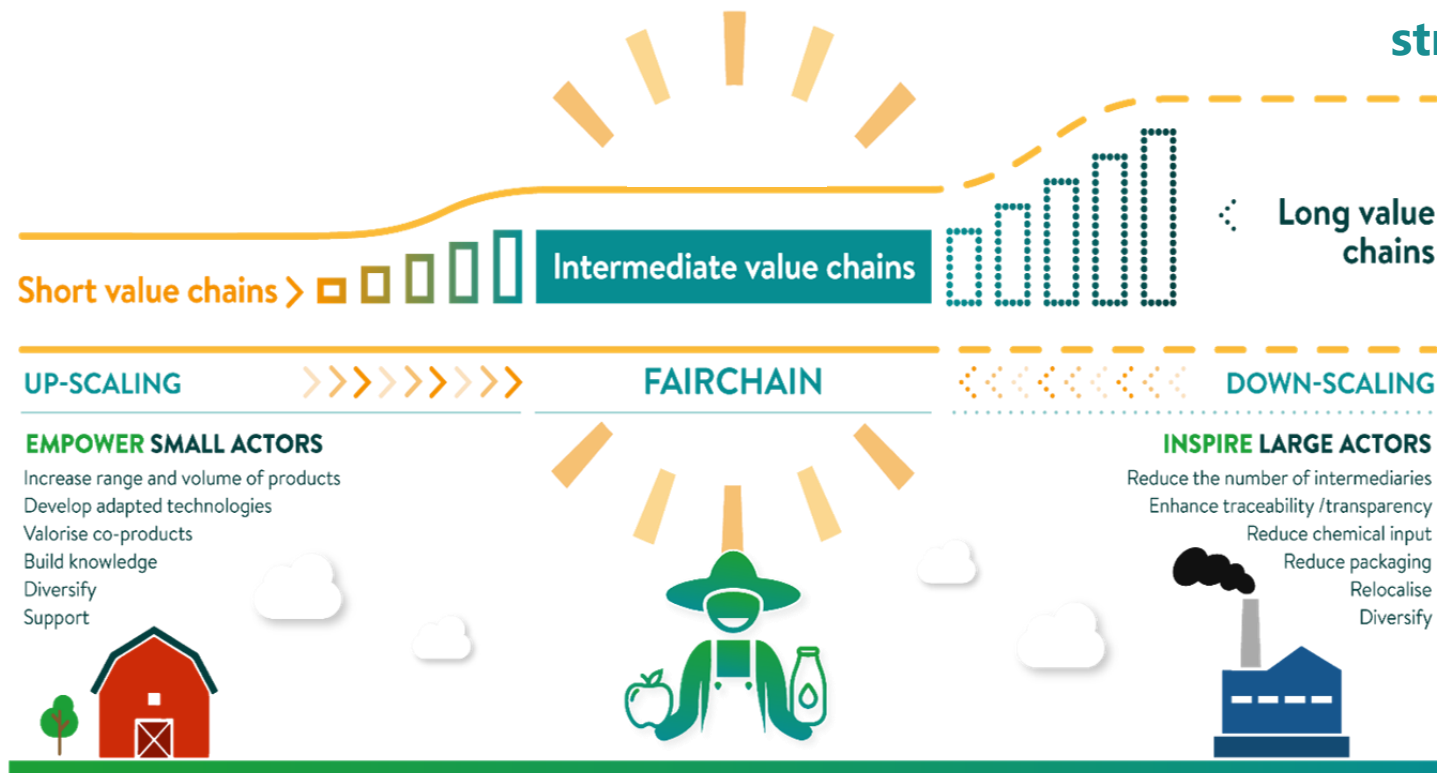


# FAIRCHAIN

Innovative technological, organisational and social solutions  
for FAIRer dairy and fruit and vegetable value CHAINS



**Goal** : Enable small and mid-sized farmers and food producers to scale up and expand production of nutritious food through **competitive intermediate value chains** at the regional level



**Intermediate value chains combine the strengths of both short and long chains while avoiding their weaknesses**

They are characterized by

- **cooperation of mainly small and mid-sized actors on a network or strategic alliance;**
- **trusted and transparent relationships** and a **fair distribution** of value created among the involved actors (win-win situations)
- implementation of **common values** through **collective organisation**.

They supply **sustainable and high-quality food products** to consumers beyond the local market **in greater quantities** - often on a regional level- with facilitated access for consumers.

Focus on postharvest steps in dairy and fruits & vegetables sectors

# Objectives

## Main Objective



Test, pilot and demonstrate **technological, organisational, social innovations** that have the potential to support intermediate value chains and address some of their issues

## Specific Objectives



Deliver a **set of innovations** at technology readiness level (TRL) 7, fostering the emergence of competitive intermediate value chains

Develop **business models** associated to these innovations and carry out environmental, social and economic impact assessment


Formulate **recommendations, create tools and guidance documents**, promote the results to ensure uptake and replicability of value chains developed within FAIRCHAIN

# Case studies and innovations at the start of FAIRCHAIN



**CS-Aut**  
Food Innovation Incubator

**Food Innovation Incubator**




**CS-Bel**  
Innovative packaging machine for small and mid-sized actors

**Flexible filling machine**

**Sharing of processing equipment and/or infrastructure**


**Funding system based on philanthropic income streams**



**CS-Fra**  
Production and distribution of innovative dairy drinks based on co-products of cheese

**Fermented whey-based drink**

**Distribution with reduction of packaging consumption**



**CS-Gre**  
Traceability and reliable information sharing in local dairy production

**Blockchain**



**CS-Swi**  
Fruit co-product valorisation for SMEs and regional stakeholders

**Alternative cleaning agent**

**Sharing of processing equipment and/or infrastructure**



**CS-Swe**  
Developing wild berry business to boost local economy and social cohesion

**ICT tool for berry picking**



# Consortium

## A multidisciplinary partnership including 22 organisations in 8 countries

(process engineering, environmental science, supply chain management, logistics, economy, marketing, social science, sensory and consumer science, information and communication technology, technology transfer...)

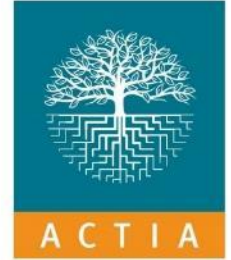
- Research (5+2)**
  - INRAE, RISE, FH JOANNEUM, Fraunhofer-Gesellschaft-ISI, Universiteit Gent, GRANGENEUVE, SLU
- SMEs (8)**
  - Scaldopack, Petrel, Laboratoires Standa, DSS (ex Sofies), Biofruits, Cogiterre, Synexilis, Stymfalia (end-users, processors and associated farmers, equipment providers, distributor, etc)
- Industry**
  - Pack4Food, Greenyard, Sodiaal
- NGOs**
  - ACTIA, Confagricoltura, ISEKI-Food, Make.org foundation

### PARTNERS

- INRAE, PETREL, STANDA, SODIAAL, ACTIA, MAKE.ORG
- FRAUNHOFER GESELLSCHAFT
- CONFAGRICOLTURA
- U GENT, SCALDOPACK, PACK4FOOD, GREENYARD
- RISE, SLU
- SOFIES, BIOFRUITS, COGITERRE, GRANGENEUVE
- JOANNEUM
- SYNEXILIS, STYMFALIA



# CONSORTIUM



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Linked third parties



itab  
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29/09/2022

2nd GENERAL ASSEMBLY MEETING

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