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# MEDITERRANEAN AGROFOOD ORGANIC WASTE STREAMS

## *OPPORTUNITIES FOR VALUE RECOVERING THROUGH A CASCADE APPROACH*

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Project cofinanced by the European Regional Development Fund (ERDF)

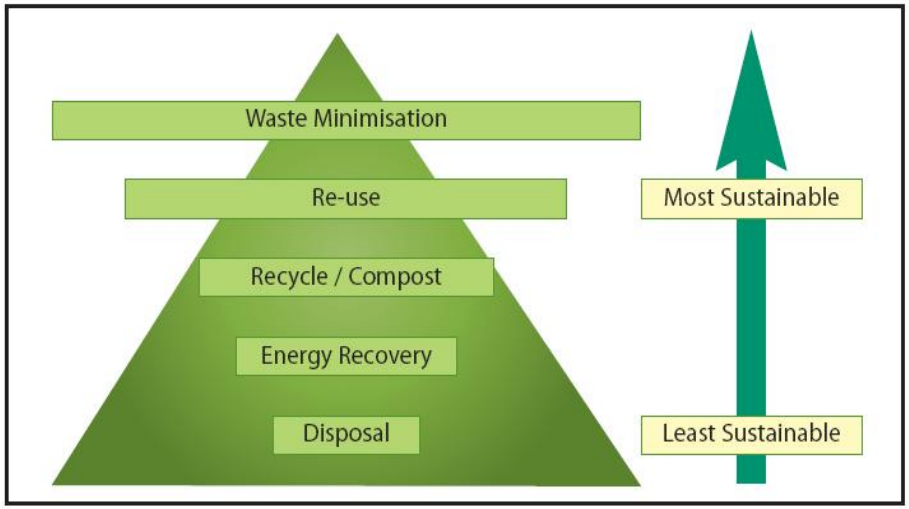
# Outline

- *Needs for changes*
- *Strong potential for new integrated production systems*
- *New ideas and concepts to disseminate*
- *Symbiosis, Circularity, Cascade*
- *Recovering value via mf nf uf filtering applied to food chain*
- *Energy as a driver or as a residual end production*

W.E.F. NEXUS

# Why?

- Mediterranean countries with their typycal food chains produce large amounts of residues
- Economic as well environmental cost to manage or dispose it are quite high for Med food enterprises
- New legislation and EU environmental and energy goals impose to change SMEs attitudes and behaviour
- Residues are not waste but raw materials for new products




A need to change!

# Open issues for agrofood sector

- ✓ How to properly manage «residues»
- ✓ Decrease environmental impacts and costs
- ✓ Making food products safe, cheap and green
- ✓ How enterprises could deal with EU obligations and target?

Changing and innovating!

# What ?

Large amount of organic residues liquid, semiliquid or solid

MED typical food chain: Grapes – Wine

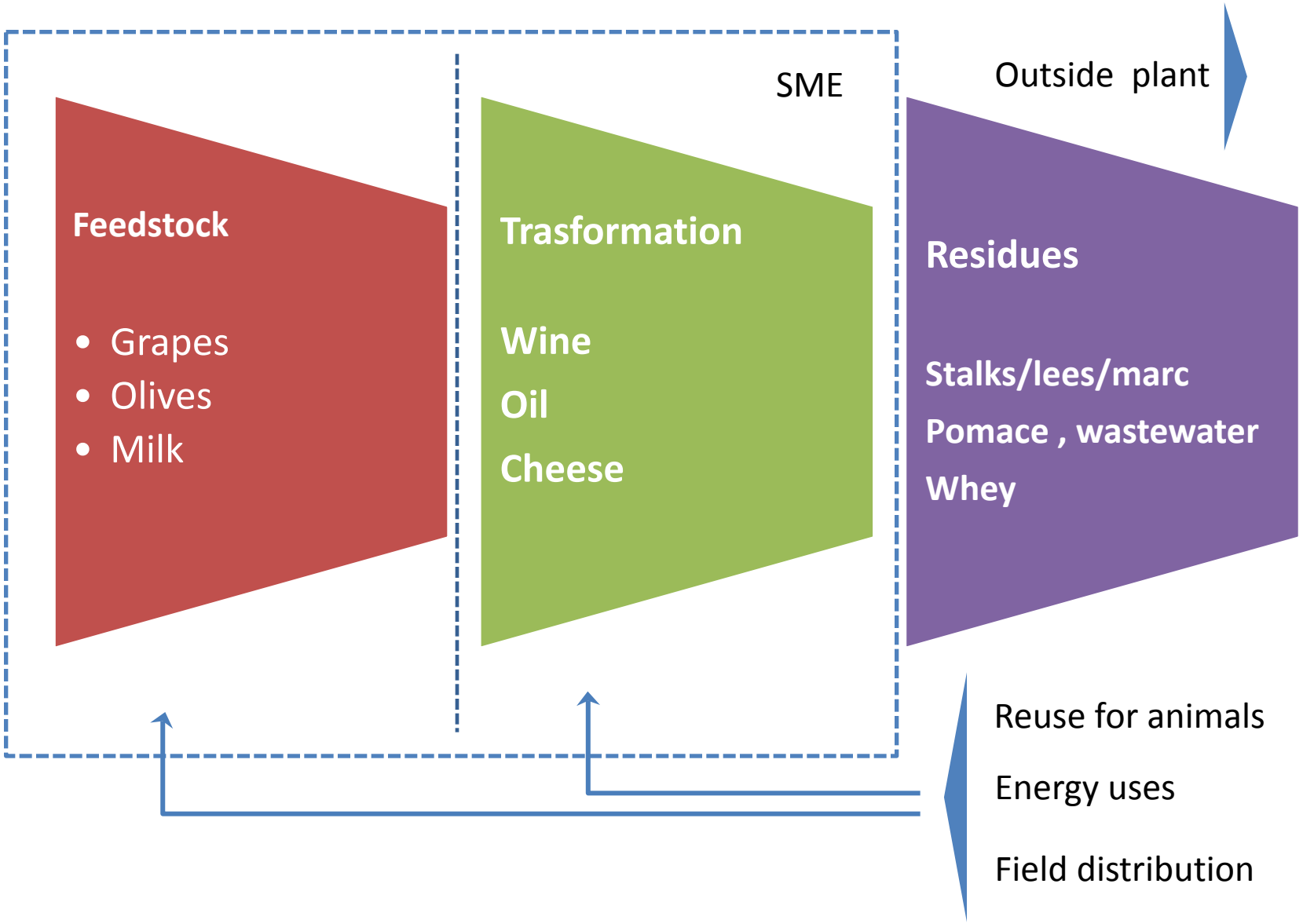
Olives – Oil

Cow-Sheep Milk - Cheese

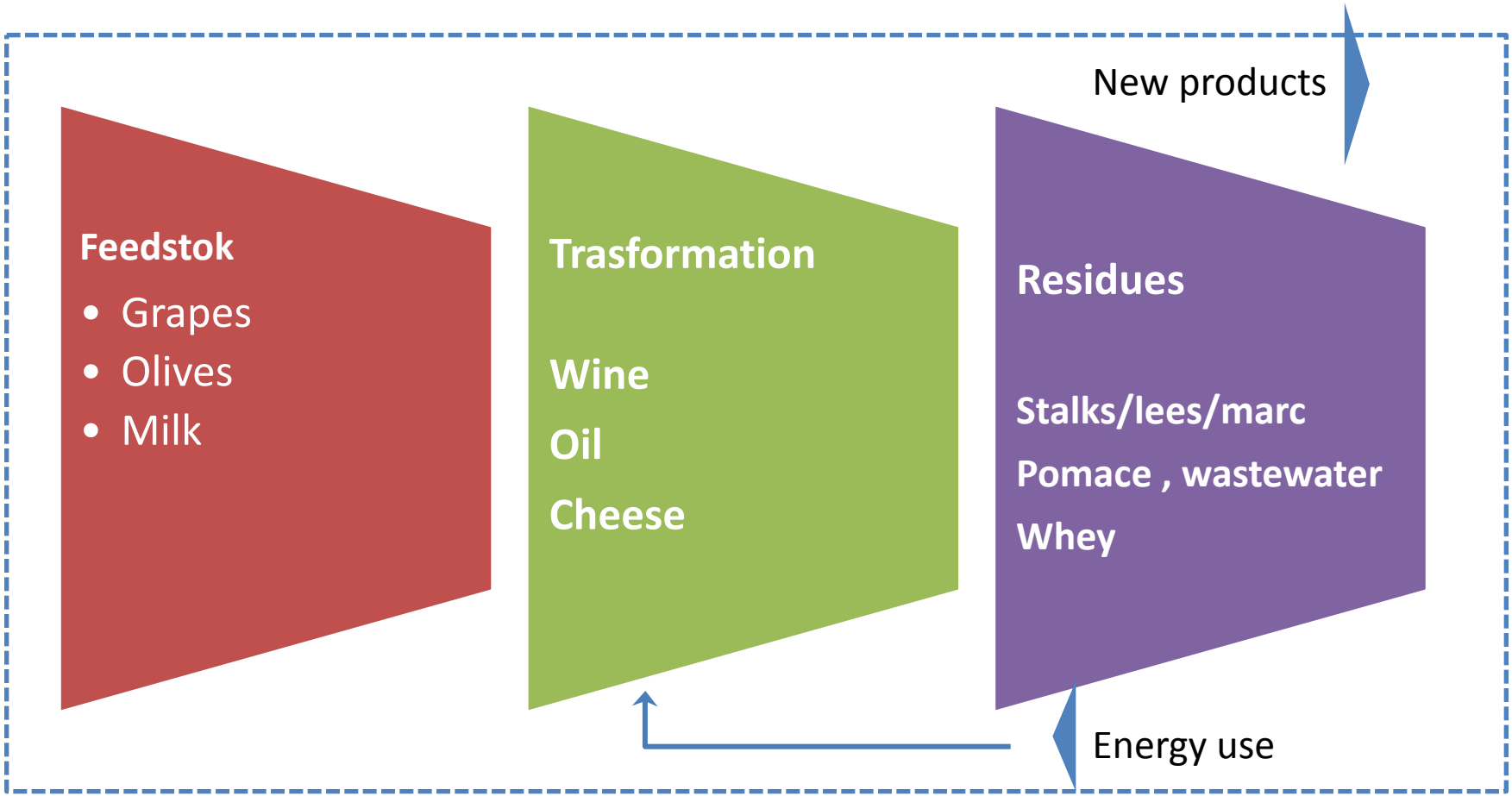
SMEs crucial issues: conservation and storage, fermentability, odours, transport, composting, disposal or delivery cost, legislation

Changing and innovating!

# Food company traditional pathway



# New approaches, new production




Integrating the food chain actors and streams

Who drives what !

# New approaches, new production

**Three main objective**

- ✓ Circularity
- ✓ Local Farm and  Food enterprises symbiosis
- ✓ Cascading value approach

**What does it means ?**

- ✓ Rethinking productive cycle
- ✓ Looking for cooperation,  connection
- ✓ Introducing new technologies
- ✓ New markets

# Cascading principles

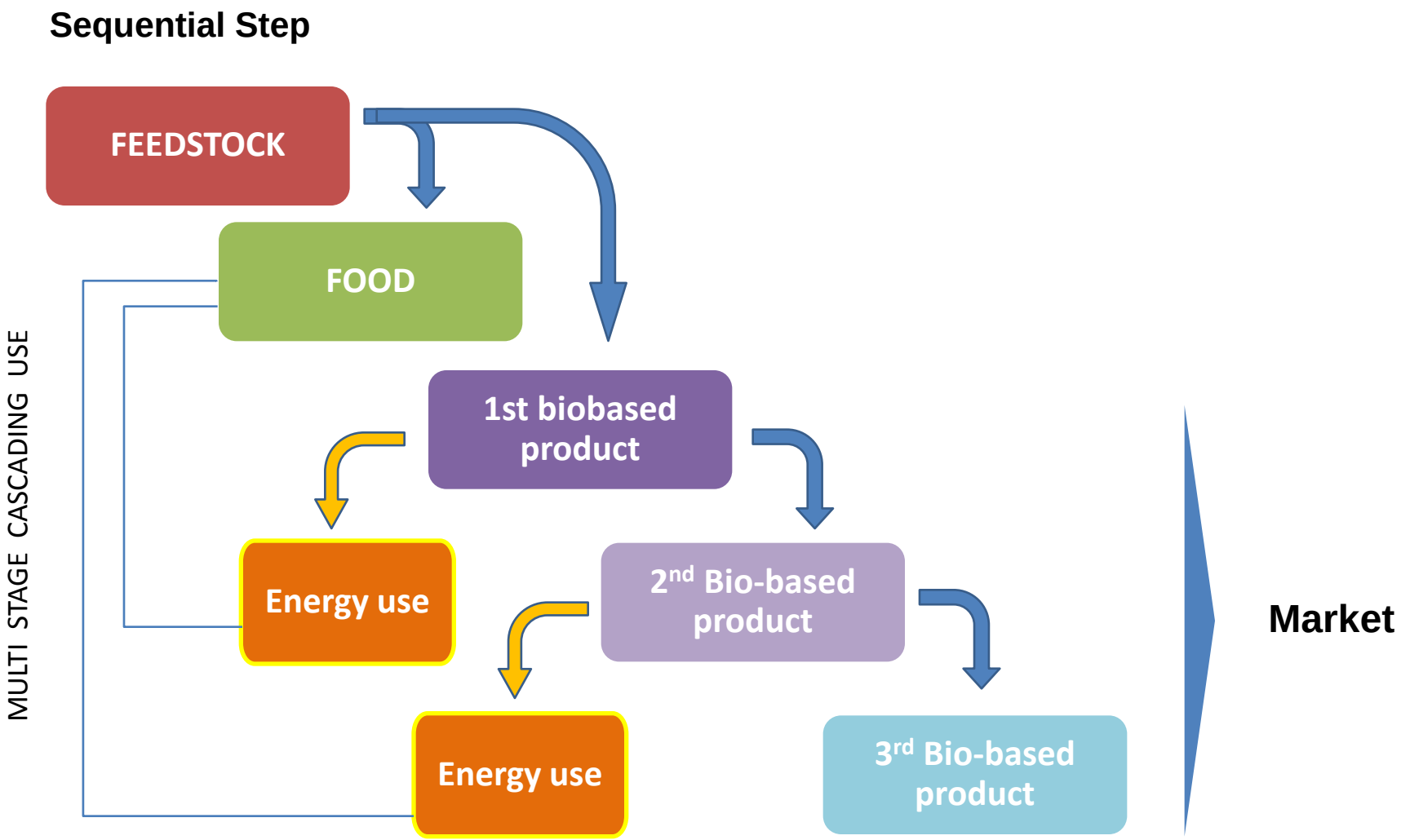
**Definition**

*Strategy for using raw materials or the products made from them in chronologically sequential steps as long, often and efficiently as possible for materials and only to recover energy from them at the end of the product life cycle.*

*It is based on the use of so-called 'cascades of use' that flow from higher levels of the value chain down to lower levels, increasing the productivity of the raw material.*

**"Extracting" added value**

# The Cascade


Sequential Step
FEEDSTOCK
FOOD
1st biobased product
Energy use
2nd Bio-based product
Energy use
3rd Bio-based product
Market
MULTI STAGE CASCADING USE

# From theory to ……..

**Scaling up**

**Demonstrate**

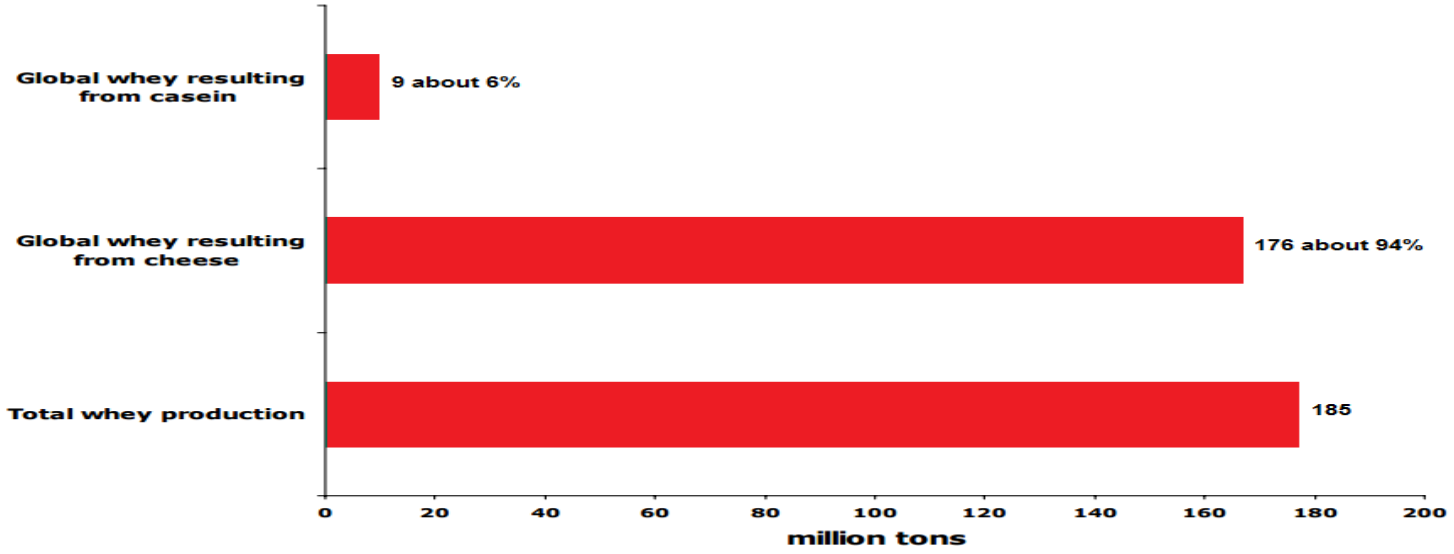
**Co-product Market growth**

**Energy and water driven**

…..practice

# Whey resources

Whey separates  from milk after curdling.
Mixture of different substances, some of which potentially valuable.
Global production of liquid whey from cheese amounted to 186  MT in 2008.
The EU and US produce ~70% of whey in the world.



# Whey production and use

In Med countries a large part of the milk produced is transformed in cheese by an high number of small/medium creameries, spread on the whole territory.

In Europe, the amount of whey produced every year is huge ($40 \times 10^6$ tons/year).

Till some years ago given to pigs or introduced directly into the river systems, thus contributing to water organic pollution

it is a special waste!

Annual estimated surplus of whey is $13 \times 10^6$ tons, containing about 600,000 tons of lactose.

Whey disposal represents a serious problem both from an economical and an environmental point of view.

Recovery of whey components and/or use of whey as fermentation medium is not only advantageous for the environment but also for a sustainable economy.

# Whey values and valorization

Whey  is rich in noble substances
substances to be employed in pharmaceutical, cosmetics and food industry,
New technologies: membranes and filtration

**CHEESE WHEY**

**WATER** (935 g/l) — **TOTAL SOLIDS** (65 g/l)

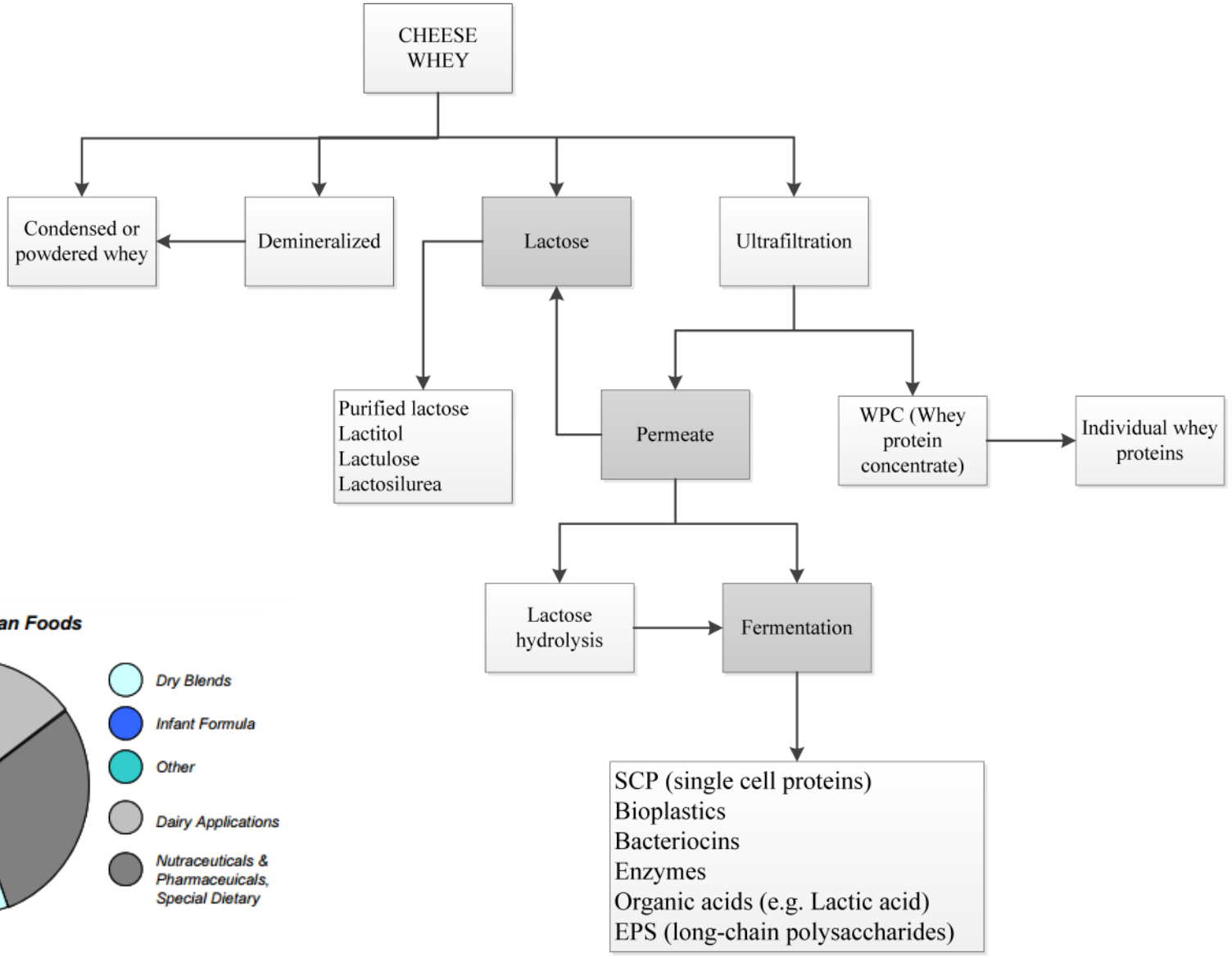
**Grams/litre**

| **CARBOHYDRATES** | | **MILK FAT** | (g/l) | **MINERALS** | (g/l) | **PROTEINS** | (g/l) |
|---|---|---|---|---|---|---|---|
| Lactose (47 g/l) | | Triglycerides | (0.25) | Calcium | (0.6) | β-lactoglobulin | (3.0) |
| | | Diglycerides | (0.05) | Magnesium | (0.1) | α-lactalbumin | (1.2) |
| | | Fatty acids | (0.05) | Phosphorous | (0.7) | Serum albumin | (0.4) |
| | | Phospholipids | (0.15) | Potassium | (1.5) | Immunoglobulin-G | (0.7) |
| | | | | Chloride | (1.1) | Proteose pepton | (0.6) |
| | | | | Sodium | (0.5) | Other proteins | (0.3) |

**Milligrams/litre**

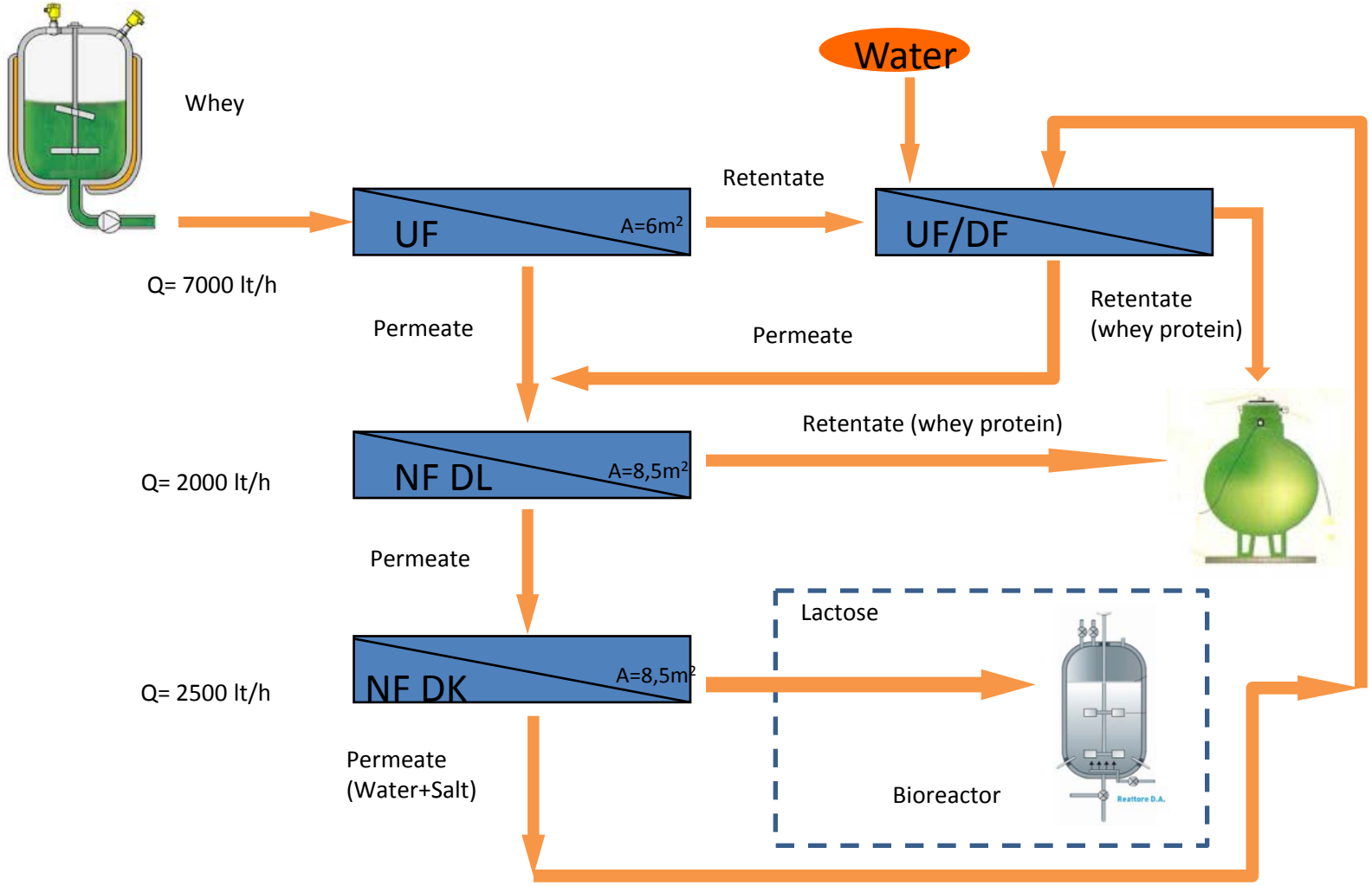
| **NPN** | (mg/l) | **VITAMINS** | (mg//l) | **TRACE ELEMENTS** | (mg/l) | **MINOR PROTEINS** | (mg/l) |
|---|---|---|---|---|---|---|---|
| Urea | (80) | Vitamin $B_5$ | (4.0 ) | Zinc | (1.5 ) | Immunoglobulin-A | (50) |
| Amino acids | (25) | Vitamin $B_2$ | (1.5 ) | Iron | (0.6 ) | Lactoferrin | (45) |
| Cholin | (15) | Vitamin C | (1.5 ) | Iodine | (0.5 ) | Lactoperoxidase | (25) |
| Orotic acid | (12) | Vitamin $B_6$ | (0.5 ) | Copper | (0.2 ) | Lysozyme | ( 2) |

# Many potential pathways



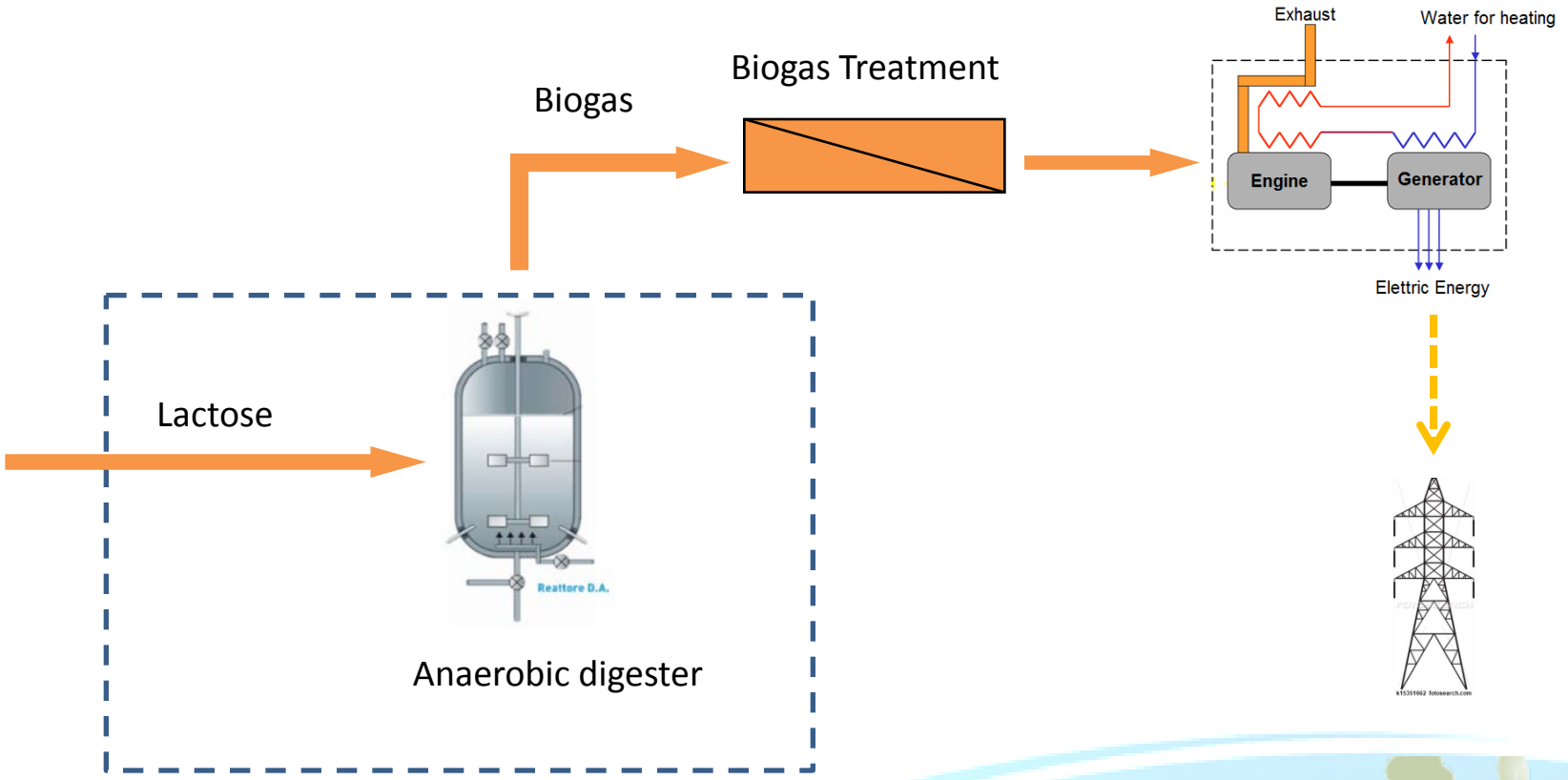
# Many potential pathways

In this case study, we have treated about 500 lt of whey (ENEA - Be & Save Project)



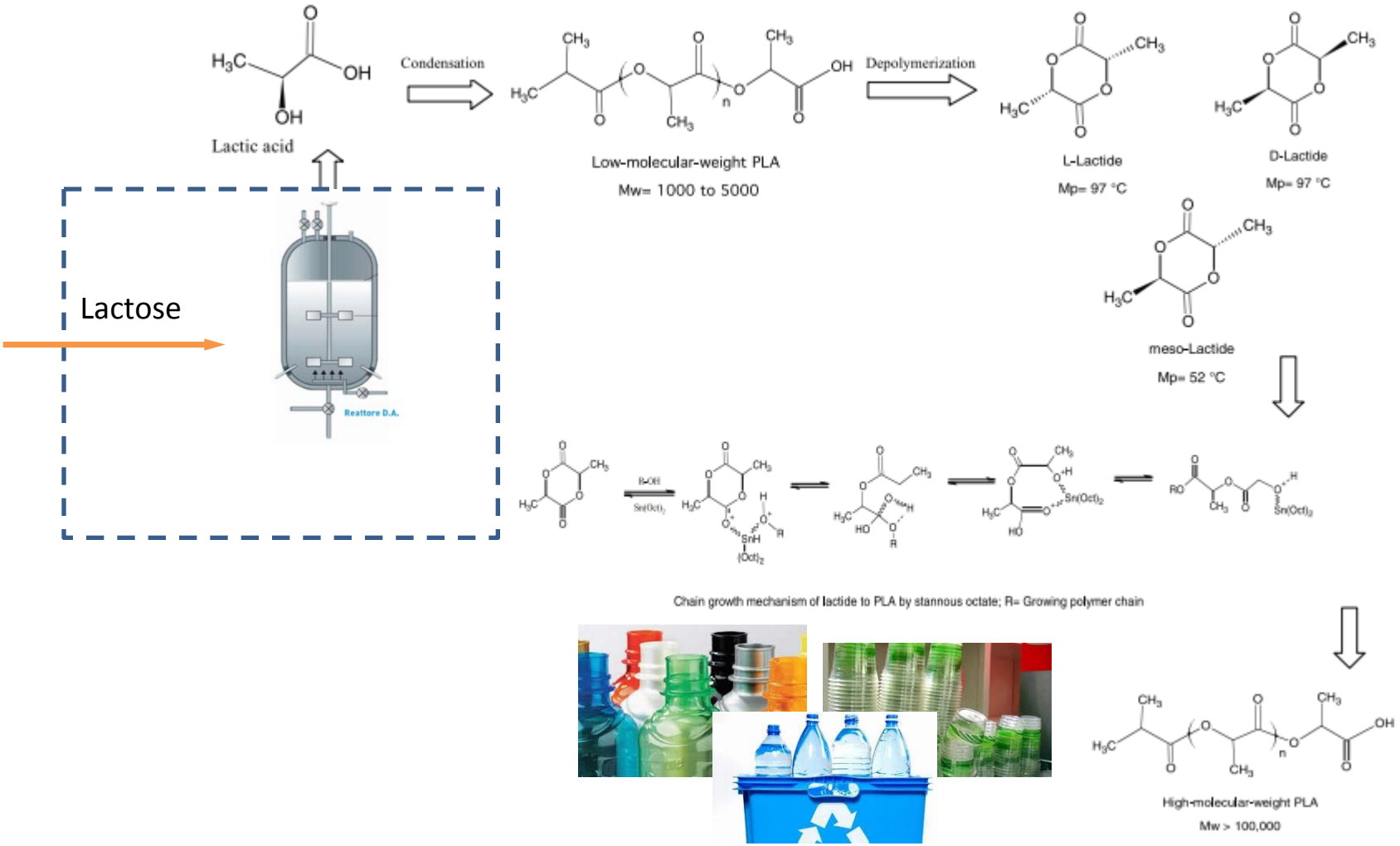
# Anaerobic digestion and Energy

Anaerobic digestion: The process of anaerobic microbial metabolism able to turn the organic matter of waste in a mixture composed of methane, hydrogen, carbon dioxide and water, called BIOGAS



# Lactose valorization

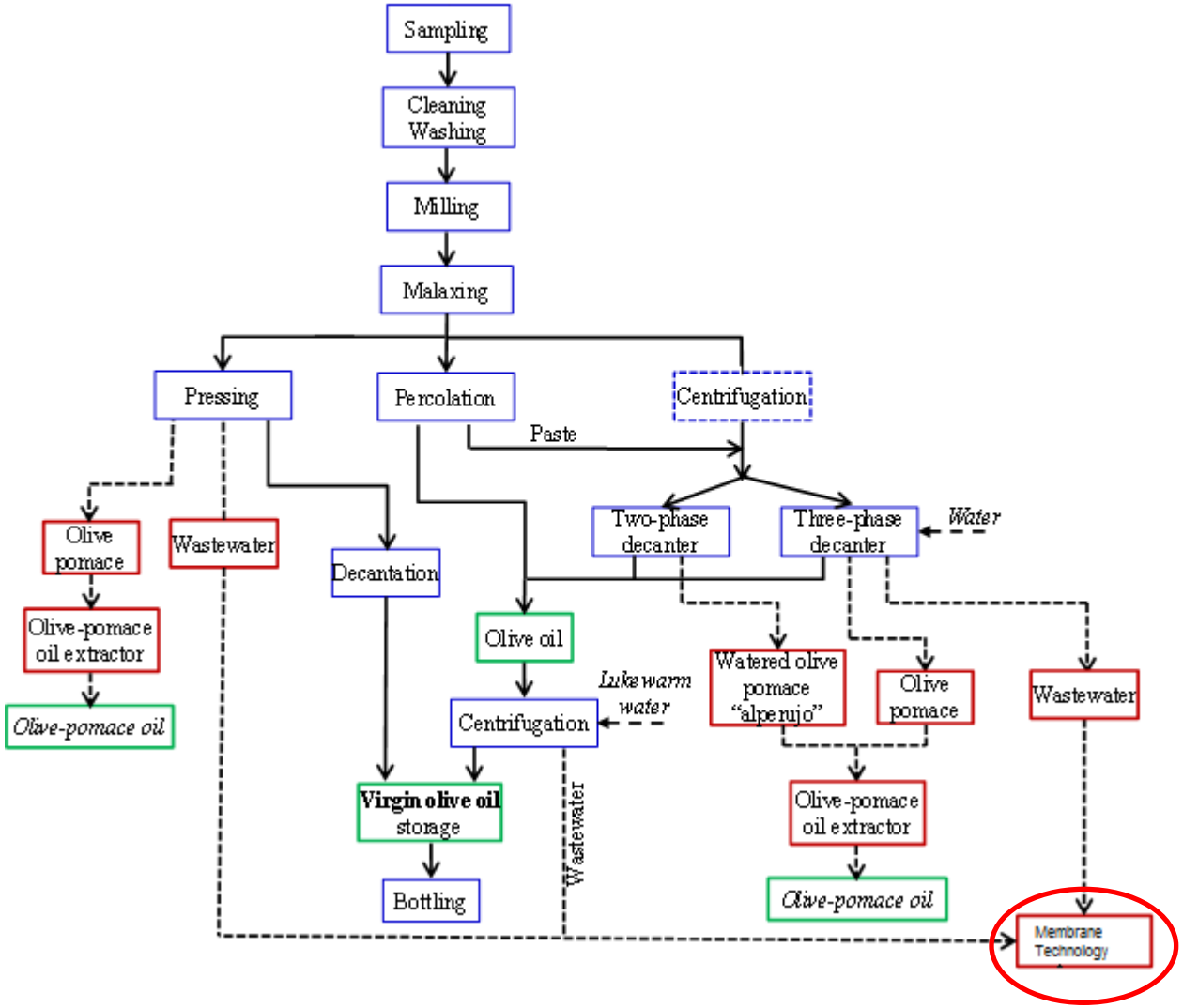
Using specific bacterial strains and enzymatic process, is possible to transform the lactose into lactic acid and then produce bioplastics



# Oil mill wastewater

The organic load is very high. The chemical oxygen demand (COD) is between 100 and 190 g /l of $O_2$ and biochemical oxygen demand (BOD) 5 is between 50 and 140 g /l of oxygen.

## Oil mill processing flow



# Oil mill wastewater an open issue

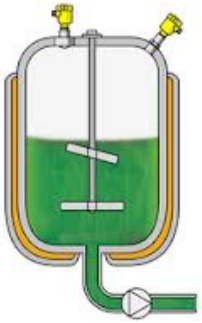
At the moment there is no European Union legislation regulating olive mill waste management, and standards are left to be set by individual countries, whereas in Italy, Portugal (Ouzounidou et al., 2010) and recently in Spain among olive-oil producing countries there is legislation for disposal/application in agricultural soil.


In Italy the law allowed the direct application of the olive mill wastewater without previous treatment (Kapellakis et al.,2008).

maximum tolerance limit for soils: 50 $m^3$ /ha/year for olive mill waste waters (olive oil wastewater) deriving from traditional mills (discontinuous extraction systems); 80 $m^3$ /ha/year for vegetable water deriving from centrifugal extraction (continuous extraction systems)

Source: Integrated Strategy of actions, measures and means suitable for Mediterranean Countries - Analysis of national and European legislative frameworks for Oil Olive Waste and Soil Protection

# Oil mill wastewater valorization



Olive oil Wastewater

Water

6042 mg/lt

MF

Retentate

13176 mg/lt

DF

9027 mg/lt

Permeate

1386 mg/lt

Permeate

2298 mg/lt

Water

UF

Retentate

5155 mg/lt

DF

3594 mg/lt

Retentate of Polyphenols

1397 mg/lt

270 mg/lt

Permeate

OI

7000 mg/lt

Water + salts

56 mg/lt

# Is it really a waste?

| Type | Biologic activity |
|---|---|
| Idrossitirosolo | antiossidante |
| | Cardioprotettiva, antiaterogenica |
| | chemopreventiva |
| | antimicrobica |
| | antiinfiammatoria |
| | sbiancamento della pelle |
| Oleuropeina | antiossidante |
| | Antiaterogenica,cardioprotettiva |
| | ipoglicemica |
| | antiipertensiva |
| | antivirale e antimicrobica |
| | antiinfiammatoria |
| | citostatica |
| | molluschicida |
| | attività endocrina |
| | regolazione enzimatica |
| Tirosolo | antiossidante |
| | antiinfiammatoria |
| | antiaterogenica |
| | cardioattiva |
| | antiossidante |
| acido caffeico | antiossidante |
| | chemioprotettiva |
| | antiaterogenica |
| | antimicrobica |
| | antiinfiammatoria |
| acido vanillico | antiossidante |
| | antimicrobica |

| | |
|---|---|
| Verbascoside | antiossidante |
| | chemiopreventiva |
| | cardioattiva |
| | antiipertensiva |
| | antiinfiammatoria |
| | antiaterogenica |
| | sedativa |
| acido elenolico | antimicrobica |
| | antivirale |
| | |
| acido p-cumarico | antimicrobica |
| | antivirale |
| Catecolo | fitotossica |
| | antimicrobica |
| | carcinogenica |
| | antiossidante e anticancerosa |
| Rutina | antiossidante |
| | antiaterogenica |
| | antiinfiammatori |
| | chemiopreventiva |

Many potential pharmaceutical use

H.K.,Obied , M.S.Llen, D.R. Bedgood and all; J. Agric. Food Chem. 47,and all, 2005 (53) 823-837.

# Demonstration and test plants

Ceramic and Polymeric Filtration Mobile plant for pilot scale at production plant directly on fresh residues production

# What's the Energy role?

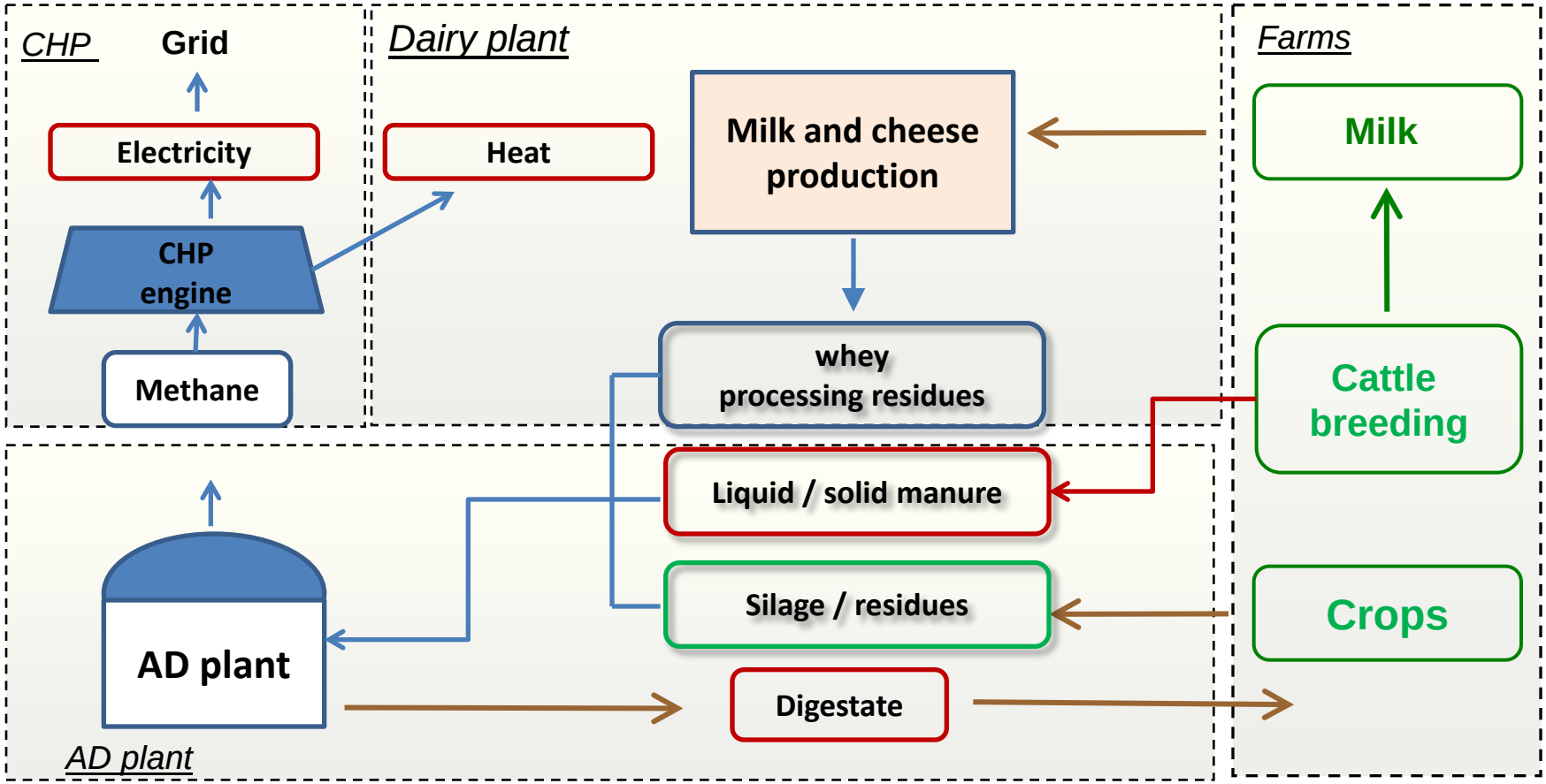
Is it only a product  end life destiny ?


Or is one  of the main driver?

Agrofood  enterprise needs  electric as well thermal energy

Recovering energy value via AD or combustion or what else is an opportunity,  reduce cost,  decrease emission, earning money and more….

# Farm dairy plant local symbiosis




Close relationship between local enterprises and farms to share energy, residues, inputs exploiting sinergies saving money and avoiding environmental costs

This work has been developed under two projects dealing with agroindustry, energy and residues recovery via innovative integrated systems

**EU**

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

**IT**

# Thank you for your attention !

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