

# ➤ ENVIRONMENTAL PERFORMANCES OF SEABREAM- OYSTER-CLAM-SHRIMP IMTA: THE LIFE CYCLE ASSESSMENT POINT OF VIEW



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## ➤ Integrated Multi-Trophic Aquaculture

- Moving from linear systems (feed->fish->waste) to looped systems by recycling nutrients has many theoretical advantages:
  - Limit the loss of nutrients, sometimes produced far away (fish meal from Peru, soybean from Brazil...)
  - Co-produce, thus increasing the inputs' efficiency
  - Increase the robustness of farms by producing different species
  - Improve biodiversity
  - ...
- IMTAs seem to be attractive solutions to move towards this nutrient looping in aquaculture systems
- However, few studies have confirmed these hypotheses in real cases
- The global environmental balance is rarely established



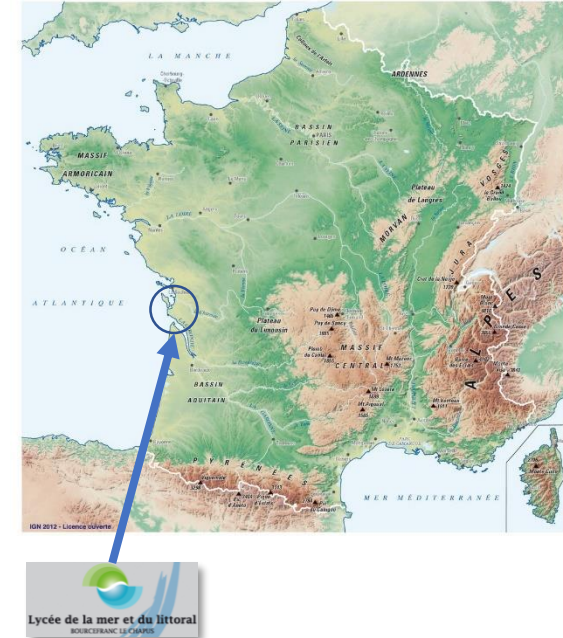
## ➤ Content of the study

### Objectives

- Draw up an environmental assessment of an IMTA system, using life cycle assessment (LCA),
- Identify areas for improvement on a study case
- Compare the effect of different practices on the environmental performances
- Improve the LCA methodology when applied on multi-product systems

### To do this

- In the framework of the EU Prima project SIMTAP
- Application of an IMTA system, at the Lycée de la Mer et du Littoral (Fr)
- Comparison with a private polyculture farm



*Self-Sufficient  
Integrated Multi  
Trophic AquaPonics*



# ➤ Prototype design

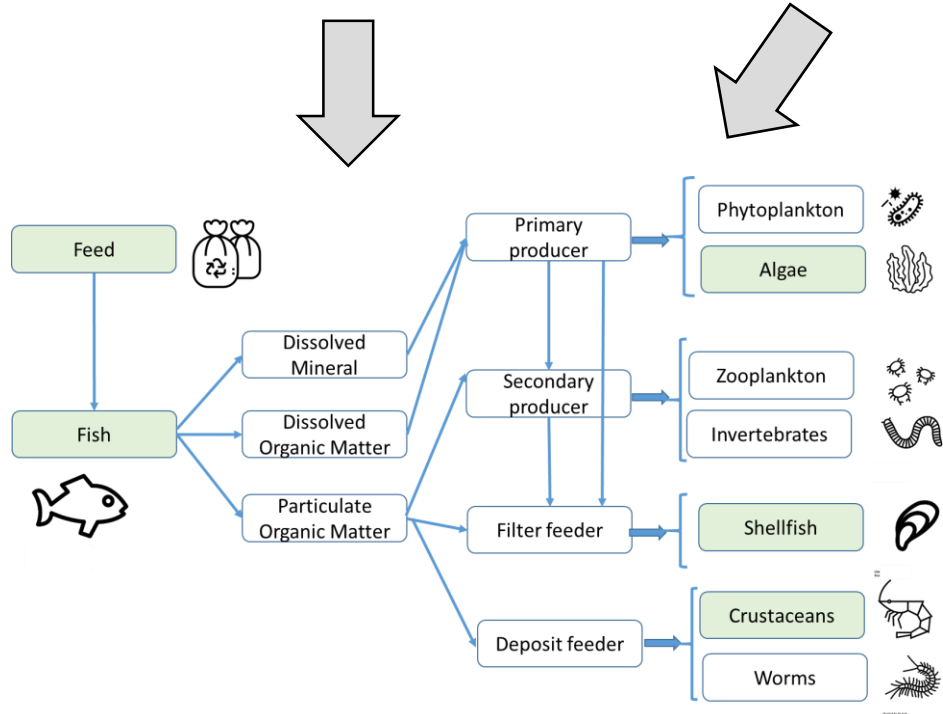


Local existing initiatives



Knowledge and know-how

Agroecological principles

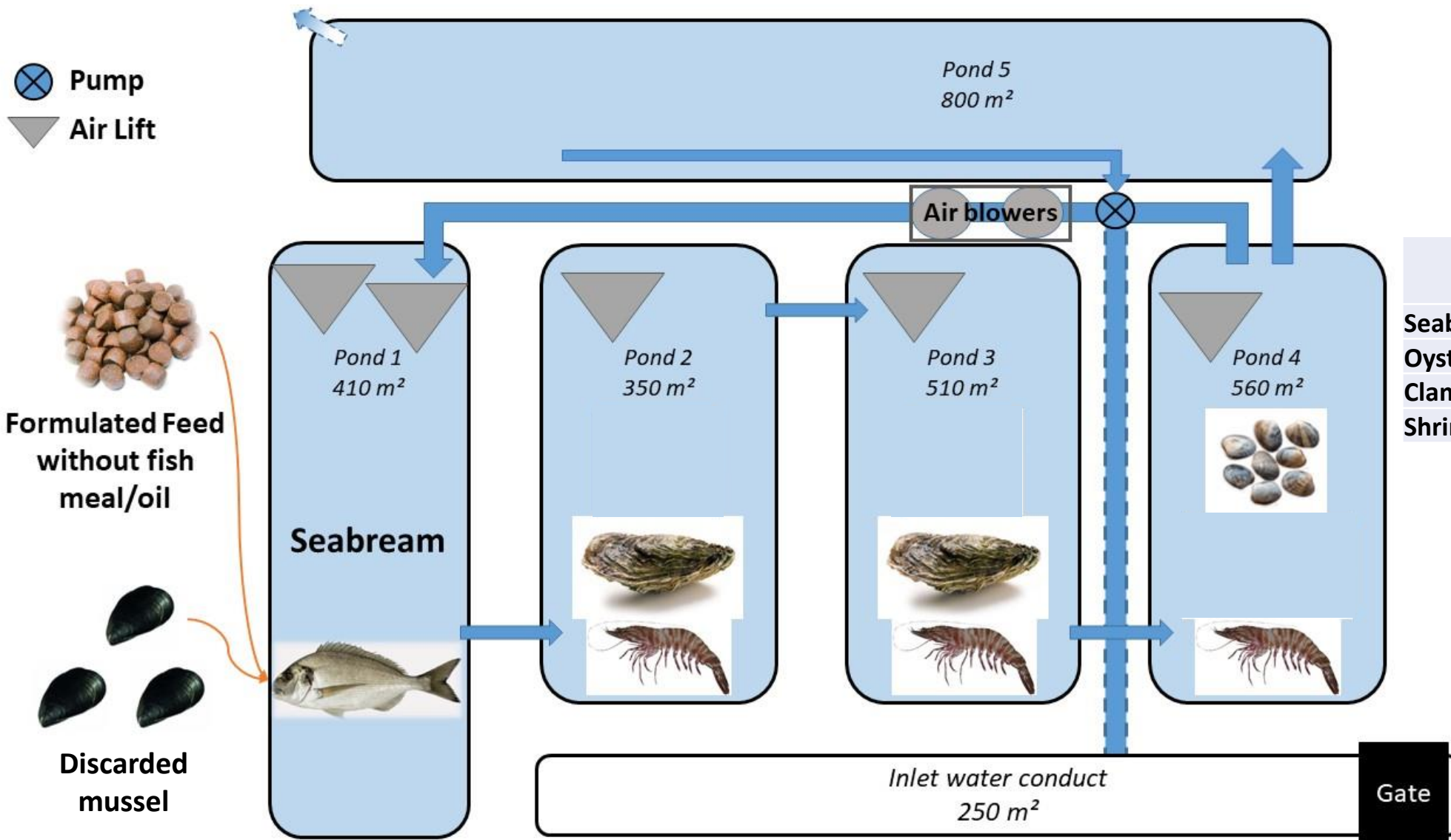


## Details

- In local existing structures: oyster pond
- Semi-intensive system (low densities)
- Feed: without fish meal/oil, vegetable local resources, whole fresh discarded mussel
- Fish: adapted to this regime, large gilthead seabream (*Sparus aurata*)
- Pacific oysters (*Crassostea gigas*) and clams (*ruditapes philippinarum*) as filter feeders
- Kuruma shrimp (*Marsupenaeus japonicus*) as deposit feeder
- Ulva (*U. lactuca*) as primary producer (didn't work)
- Involvement of other species from the environment : phyto and zoo plankton, invertebrates (wild shrimp, worms...)



# ➤ SIMTAP LML in 2020



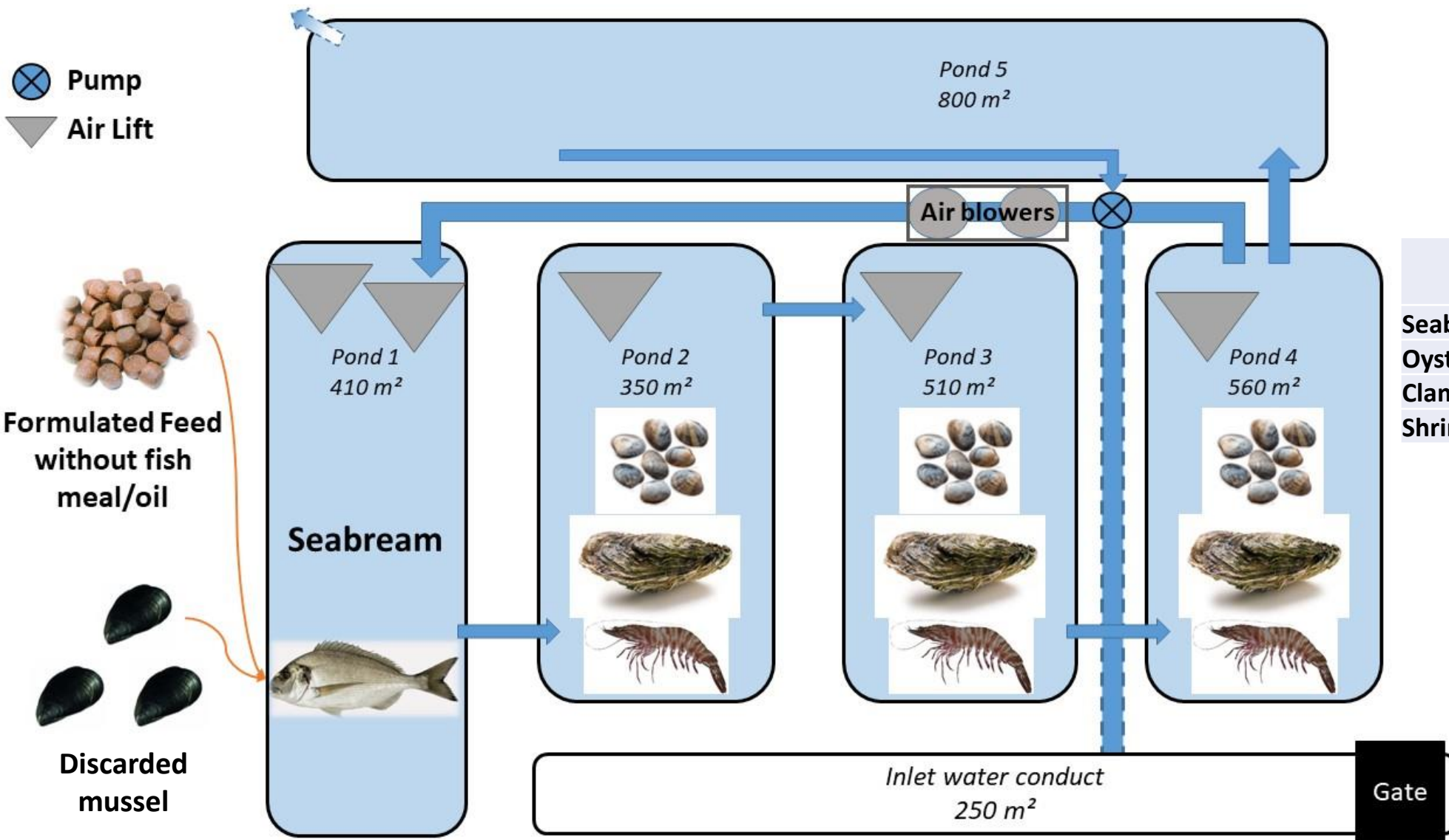
Stocking in May-June 2020

	Number	Mean weight
<b>Seabream</b>	3,2 ind /m <sup>2</sup>	210 g
<b>Oyster</b>	2 ind /m <sup>2</sup>	55 g
<b>Clam</b>	21 ind/m <sup>2</sup>	3,4 g
<b>Shrimp</b>	2,5 pL /m <sup>2</sup>	0,5 g

Harvesting in October 2020

	Production
<b>Seabream</b>	418 kg
<b>Oyster</b>	120 kg
<b>Clam</b>	92 kg
<b>Shrimp</b>	42 kg

# ➤ SIMTAP LML in 2021



Stocking in May-June 2021

	Number	Mean weight
<b>Seabream</b>	3,5 ind /m <sup>2</sup>	210 g
<b>Oyster</b>	2,5 ind /m <sup>2</sup>	37,5 g
<b>Clam</b>	15 ind/m <sup>2</sup>	3,4 g
<b>Shrimp</b>	2,5 pL /m <sup>2</sup>	0,5 g

Harvesting in October 2021

	Production	/2020
<b>Seabream</b>	443 kg	+6%
<b>Oyster</b>	325 kg	+171%
<b>Clam</b>	151 kg	+64%
<b>Shrimp</b>	54 kg	+29%

## ➤ Comments on rearing performances

### 2020

- **Seabream:**
  - 1 month of adaptation (large size, from RAS)
  - Overall good growth (370g) and FCR (1.9) : diet adapted!
- **Oysters:**
  - Good growth (72-88g)
  - High survival rate (>90%, no summer syndrome)
  - Very high flesh yield (18-21%)
- **Clams**
  - Good growth (11.4g)
  - High flesh yield (20%)
  - Medium survival (70%)
- **Kuruma shrimp**
  - Good growth but variable among ponds (27-36g)
  - Survival: loss of one pond due to climatic event



### 2021

- **Seabream:**
  - 1 month of adaptation (large size, from RAS)
  - Overall good growth (360g) and FCR (1.76) : diet adapted!
- **Oysters:**
  - Good growth but different among ponds (74-103 g)
  - High survival rate (>93% no summer syndrome)
  - Very high flesh yield (22-26%)
- **Clams**
  - Good and homogenous growth (12g)
  - High flesh yield (19%)
  - Survival medium to poor (39-78%)
- **Kuruma shrimp**
  - Good growth but variable among ponds (23-35g)
  - Survival variable among ponds (17-76%)

## ➤ Private polyculture farm



**Area: Charentes**

**30 ha of marshland of which 12 ha in water**

**Annual production:**

**7200 kg oysters**

**7200 kg clams**

**3600 kg Kuruma shrimps**

**Use of formulated feed**

**to stimulate the natural production of polychaete worms (for shrimp)**

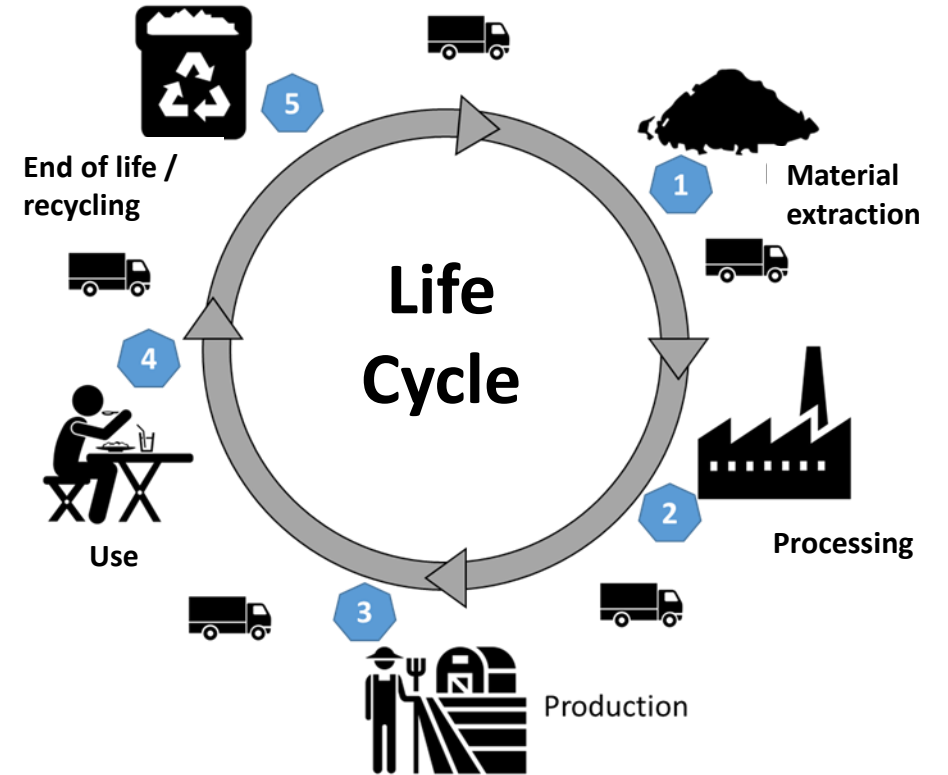
**No pumping (water filling by tide)**





## ➤ Life Cycle Assessment

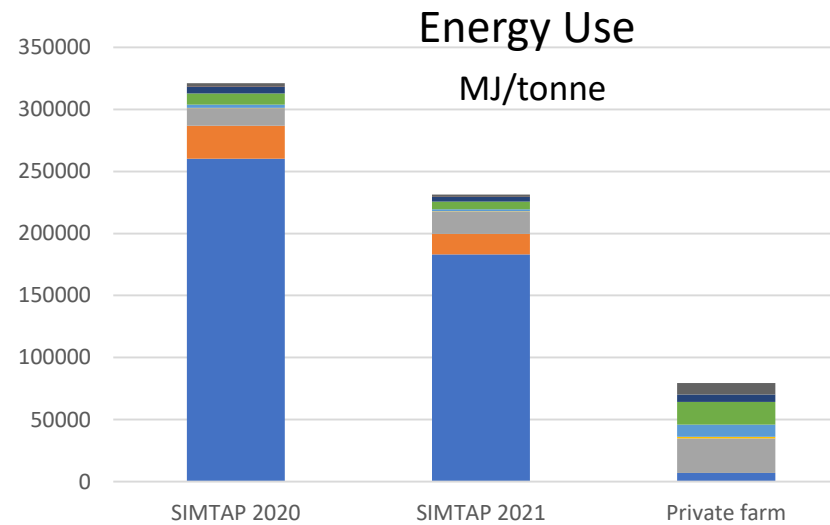
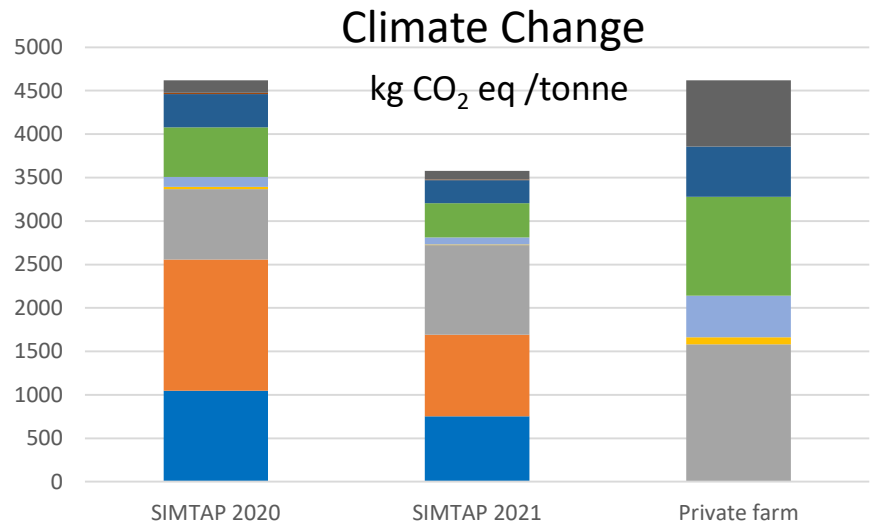
- LCA quantifies the environmental impacts of a product or a service throughout its life cycle
- An approach that integrates knowledge and interprets complex systems in order to help make decisions
- International recognition: ISO 14040 to 14043



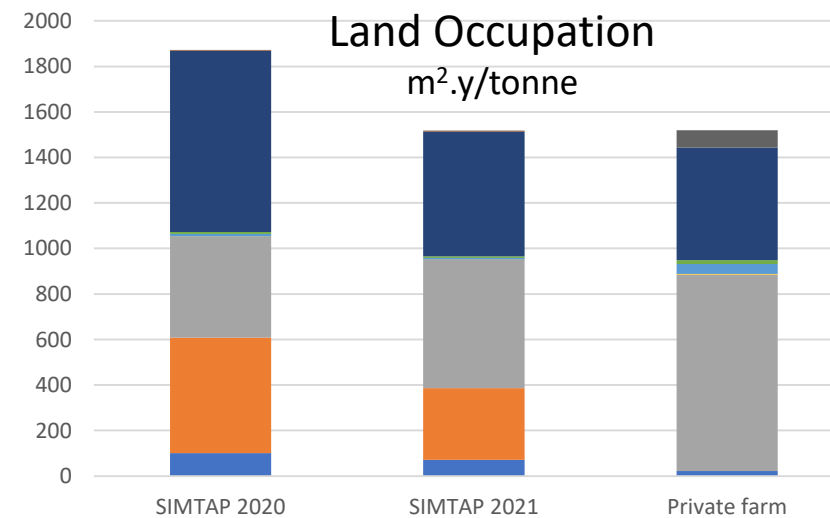
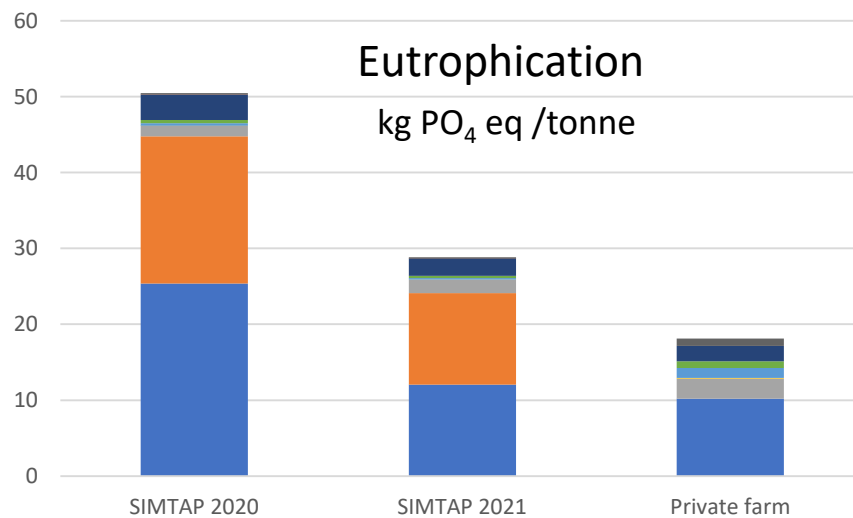
### Application:

- From cradle to farm gate
- Impact categories:
  - Climate change (GWP 100), kg CO<sub>2</sub>eq
  - Eutrophication (CML2), kg PO<sub>4</sub>eq
  - Energy use (CED), MJ
  - Land occupation (CML2), m<sup>2</sup>.y
- Functional unit: 1 tonne of aquatic products

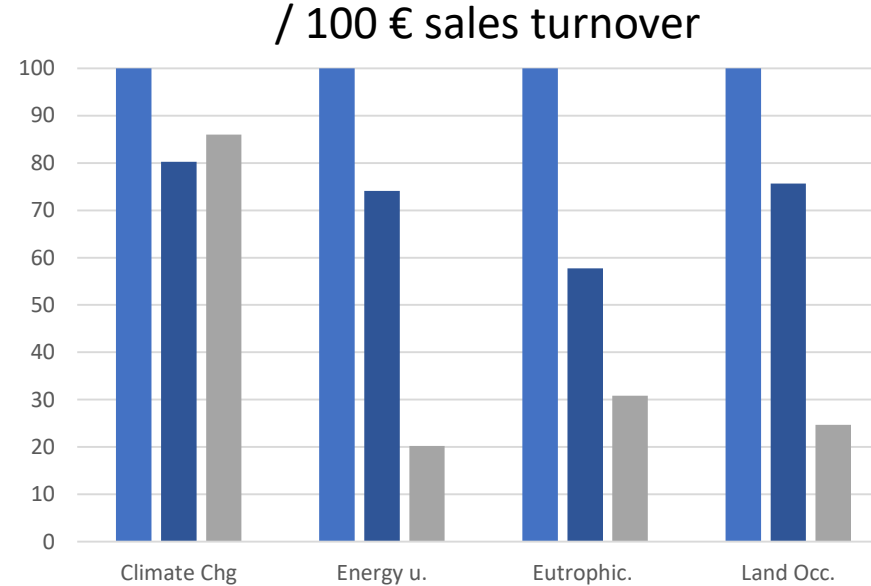
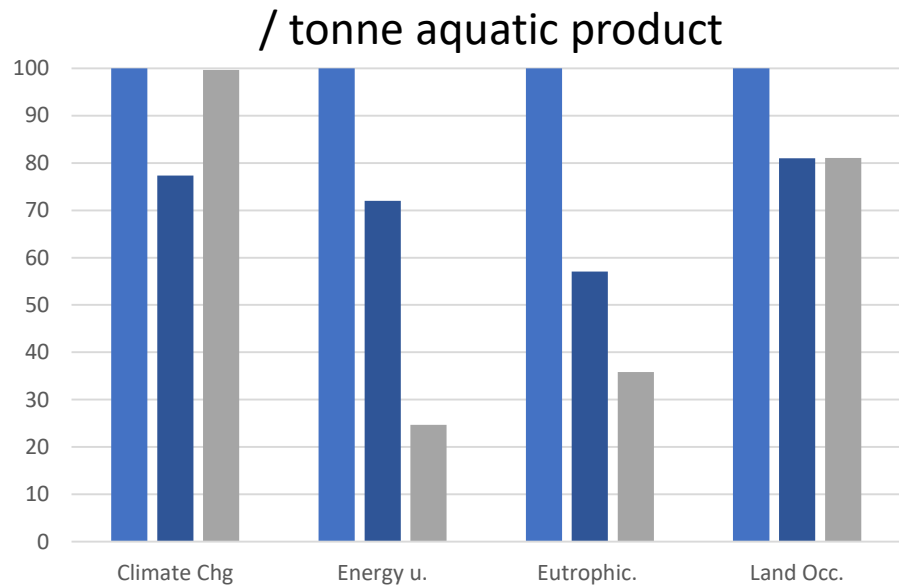
# ➤ Impact levels and contribution analysis



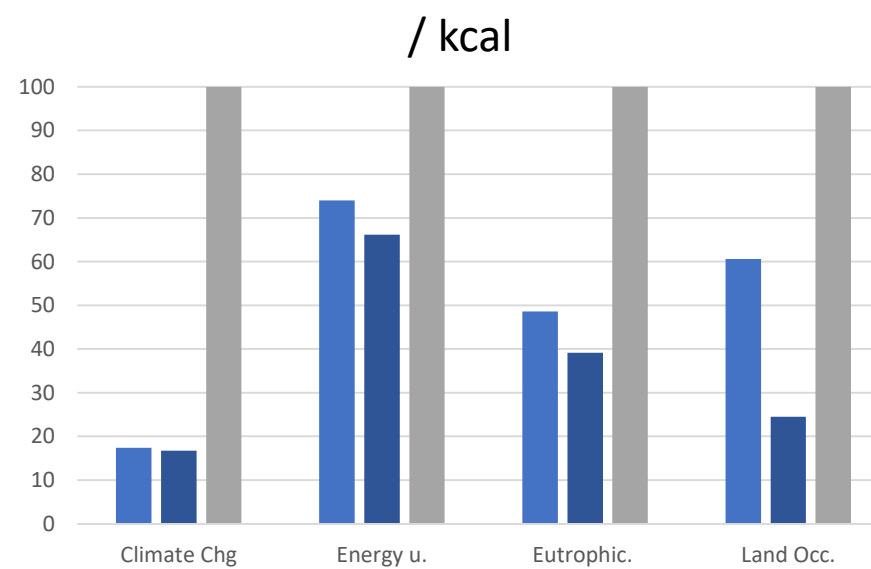
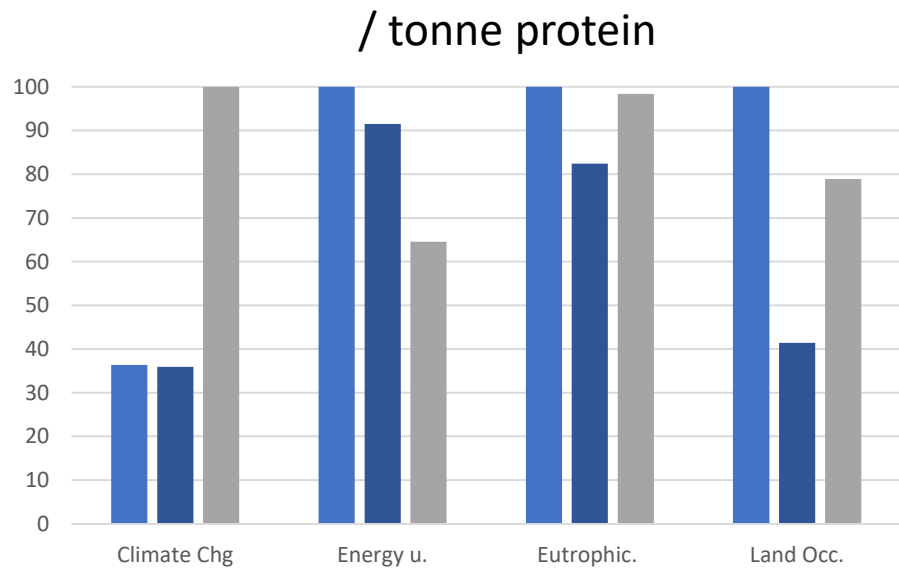
- Equipment
- Mussel
- Feed
- Pond
- Shrimp Pg
- Clam Pg
- Oyster Pg
- Seabream Pg
- Farm fct



# ➤ The best functional unit?



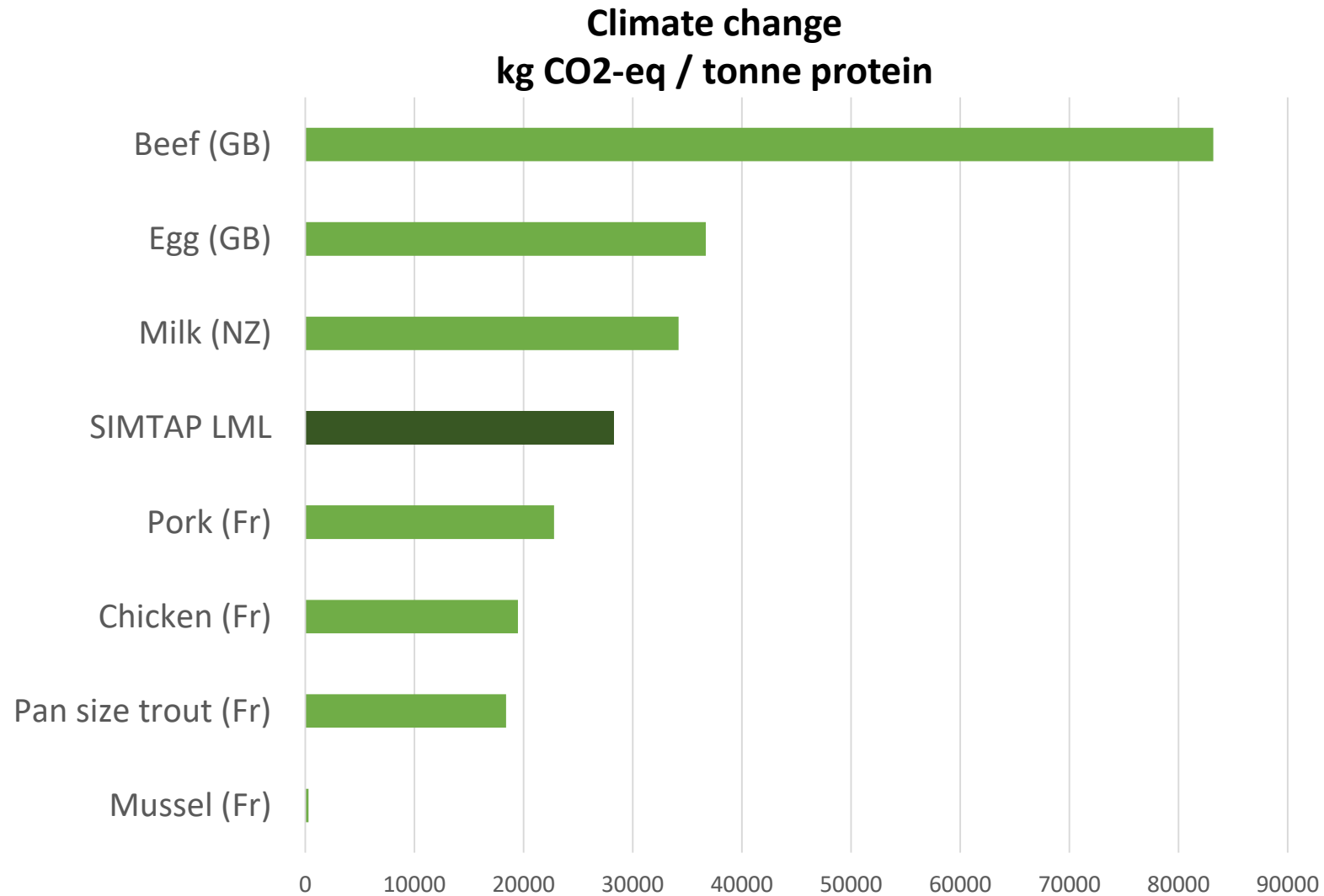
- SIMTAP 2020
- SIMTAP 2021
- Private farm



## Function?

- Producing aquatic product?
- Earning money?
- Providing food (protein)?
- Providing food (energy)?

## ➤ Comparison with other protein sources



## > Learnings

The SIMTAP pilot conducted in Lycée de la Mer provided very encouraging results, but it is not optimized (oysters are still too fat! variability in performances of shrimps and clams):

- one does not create a new production system in 2 years...
- Hotspots: energy use for recirculation and aeration
  - Search for other sources of energy (wind, solar) and review the water circulation
- Are seabreams at stocking too big?
  - Connection with other production systems to produce seabreams
  - Review the adequacy of the distribution of whole mussels and the size of the seabreams

IMTA (here : using fish production to fuel shrimp and bivalves) seems to be a solution for the future, but environmental performance is very dependent on practices, system productivity and inter-annual variations.

LCA is an interesting tool to rise questions on environmental performances but, always make sure of the basis of the comparison and the underlying hypotheses.

Thank you for your attention

