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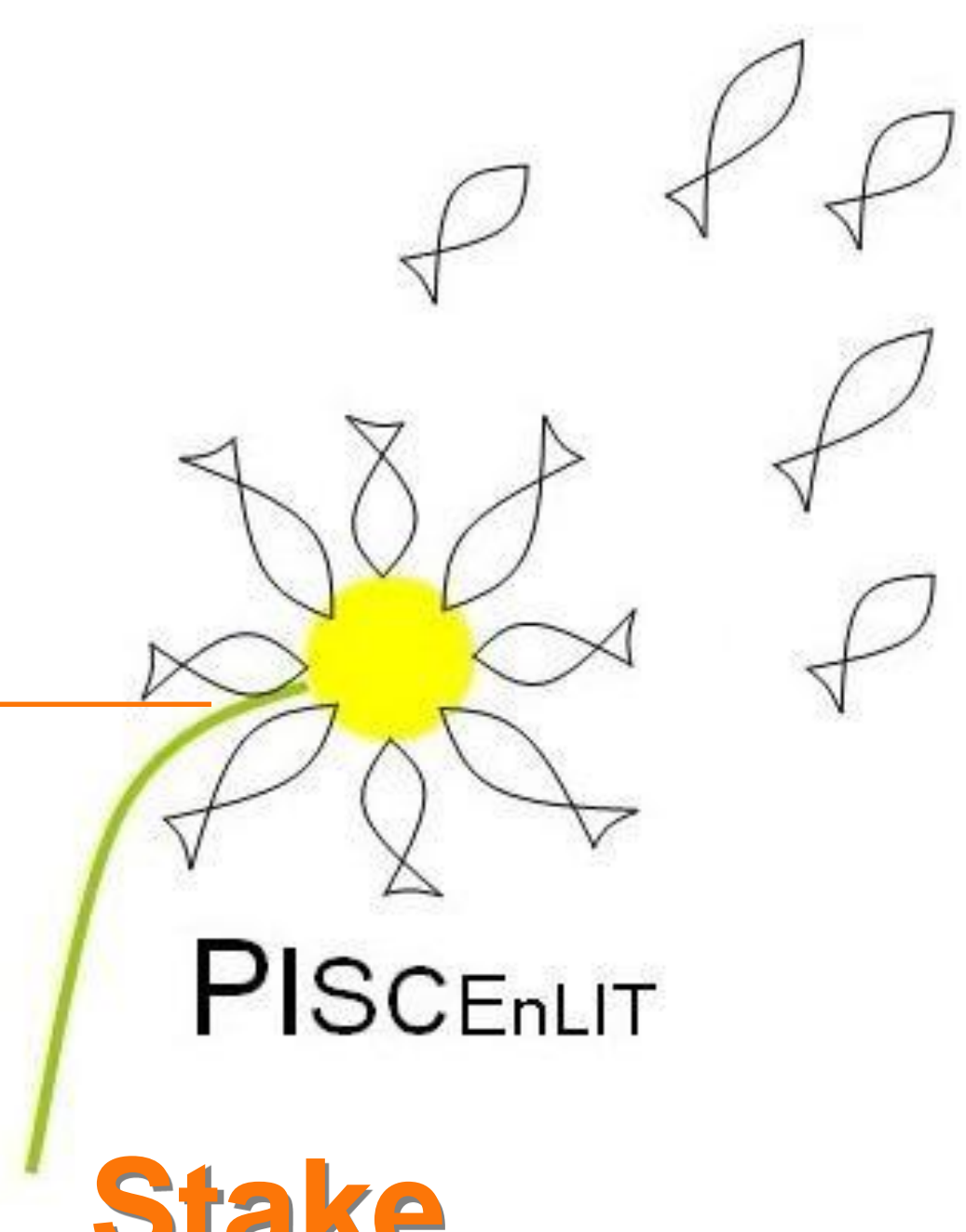
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# A combined method for assessing ecological intensification in aquaculture systems

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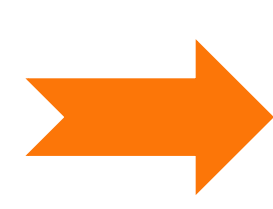
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## Stake

2050: 9 billiards of people on earth

- Increasing demand for food but decrease in wild fish stocks
- Increasing pressure on natural resources but demand for more sustainable production systems and a respected environment



These refers to a **new paradigm**: High level of output/ha, production in harmony with the environment by enhancing natural resources and ecosystemic services → **Ecological Intensification** of fish farming system



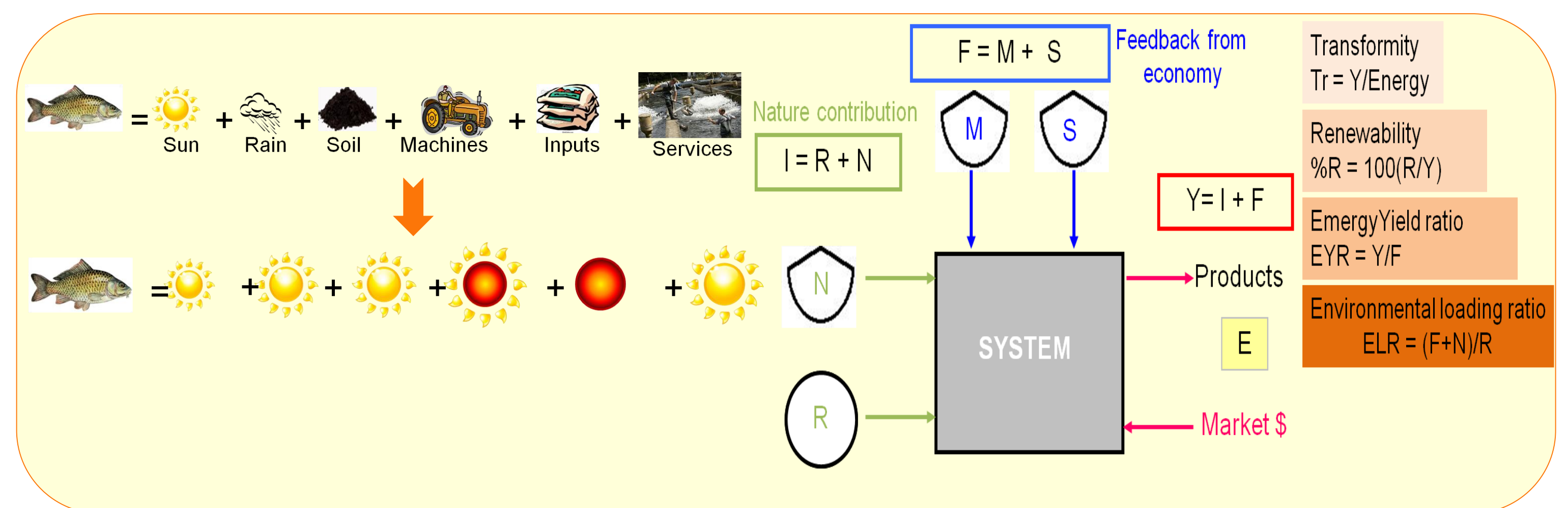
A multiscale assessment method is needed for assessing ecological intensification of fish farming system : Combination of LCA and Emery accounting is proposed.

## Methods

### LCA

- CML 2001 (v2.04) for Climate change (CC), eutrophication (EU), acidification (AC), land occupation (LO),
- Total cumulative energy demand (v1.05) (TCED)
- Net primary production use (Papatryphon et al, 2004) (NPPU)
- Water dependence (Aubin et al, 2009)(WD)

### Emery Accounting



### Fish farming systems

#### Recirculating System Farm (RSF)

- 55 tons of Atlantic salmon
- Water area : 1.7 ha
- Fish density : 32.35 t/ha
- Feed: Commercial (50% fish)
- Fingerlings: 100 % from Scotland
- Chemical inputs: Disinfectants

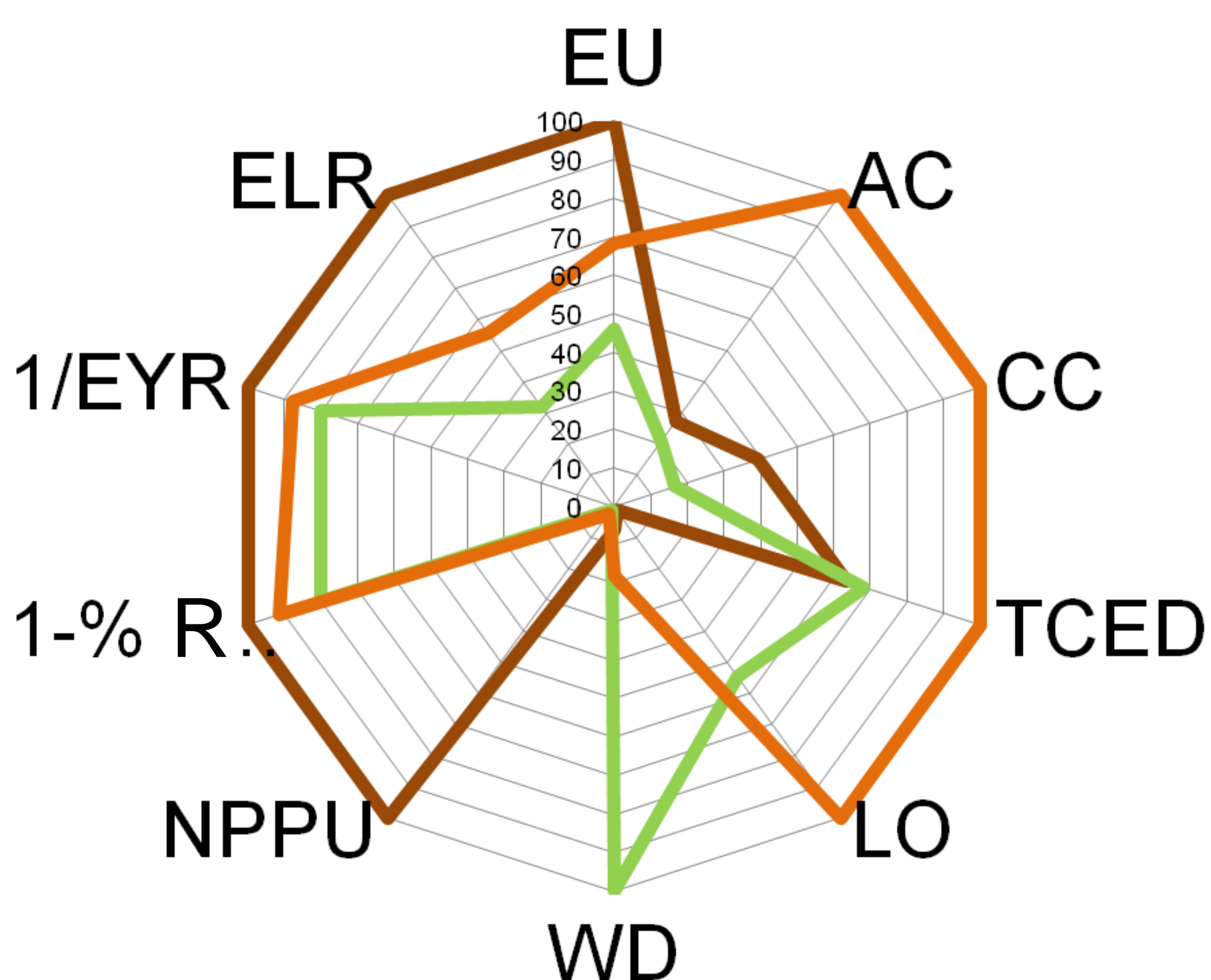
#### Extensive pond farm (PF1)

- 35 tons of carp, tench, roach...
- Water area : 96.0 ha
- Fish density : 0.36 t/ha
- Feed: 100 % unprocessed (wheat)
- Fingerlings: 99 % Natural
- Chemical inputs: 100 kg/ha Lime

#### Semi-extensive pond farm (PF2)

- 3.3 tons of carp, tench, roach...
- Water area : 12.0 ha
- Fish density : 0.28 t/ha
- Feed: Commercial (wheat, rape meal, extruded soybean)
- Fingerlings: 50 % natural
- Chemical inputs: 1000 kg/ha Lime

## Results



Relative environmental profile of RSF, PF1 and PF2 according to LCA and Emery indicators

- Environmental profile allows comparing systems
- RSF has better potential impacts but is
  - more dependant to economical inputs
  - use less renewable resources
  - rely less on local resources
  - is more sensitive to economical stress

EU: Eutrophication  
 AC: Acidification  
 CC: Climate Change  
 TCED: Total Cumulative Energy Demand  
 LO: Land Occupation  
 WD: Water Dependence  
 NPPU: Net Prim. Production Use  
 1-%R: 1- % Renewability  
 1/EYR: 1/Emery Yield Ratio  
 ELR: Environmental Loading Ratio

## Conclusions

- Extensive system is not necessarily more sustainable than an intensive system
- For 1 tonne of fish produced, RSF has a more favourable environmental balance than the ponds
- Recirculated systems are clearly disconnected from the surrounding environment and are highly dependent on external resources
- Ponds better value renewable natural resources but have high environmental impacts due to a low valorisation of external inputs

### What should be ecological intensification for aqua system ?

- a decrease of potential impacts per kilograms of final products
- a decrease of economical and external resource dependency
- an increase of renewable natural resources
- an increase of input efficiency.

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