Gembloux Agro-Bio Tech
Université de Liège

# Plant and Fishing Farming BOX :
## review and perspective after 3 years of operation

B. Delaide, P.E. Lambrechts, S. Goddek,
N. Hanocq, G. Delhaye, J. Gott and M.H. Jijakli

Laboratory of Integrated and Urban Plant Pathology

mh.jijakli@ulg.ac.be

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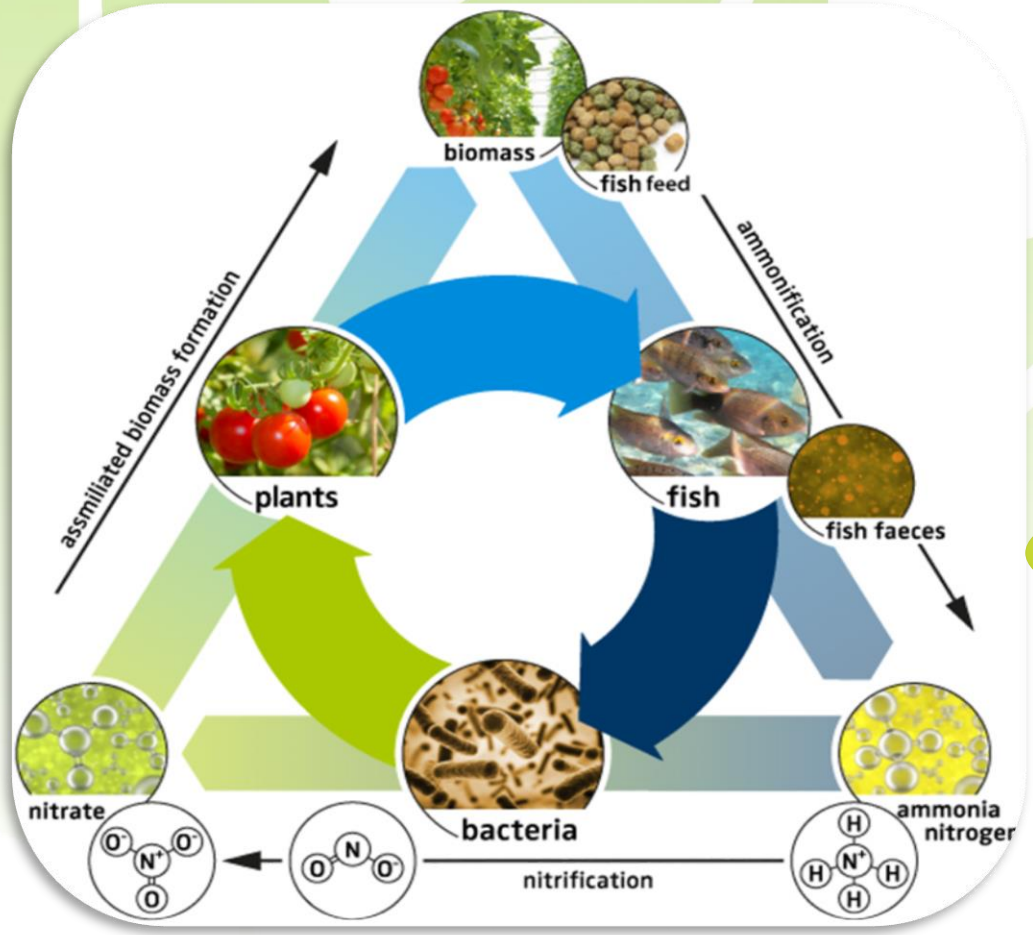
# AQUAPONIC SYSTEM : RAS + HYDROPONIC




**Symbiosis: Fish's microorganisms plants**

**Production with lower environmental impact ???**

Fig : S. Goddek, Delaide B., et al., 2014 Aquaculture Engineering

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- General objectives :
  - Building of a compact aquaponic system
  - Annual improvement of the system
  - Evaluation of water quality
  - Evaluation of plant and fish production
  - Evaluation of water and electricity consumption

  - Comparison of hydroponic, aquaponic and complemented aquaponic performance

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- Objectives PAFF BOX 2013:
  - Building of a compact aquaponic system
  - Production and first harvest of fish's and vegetable

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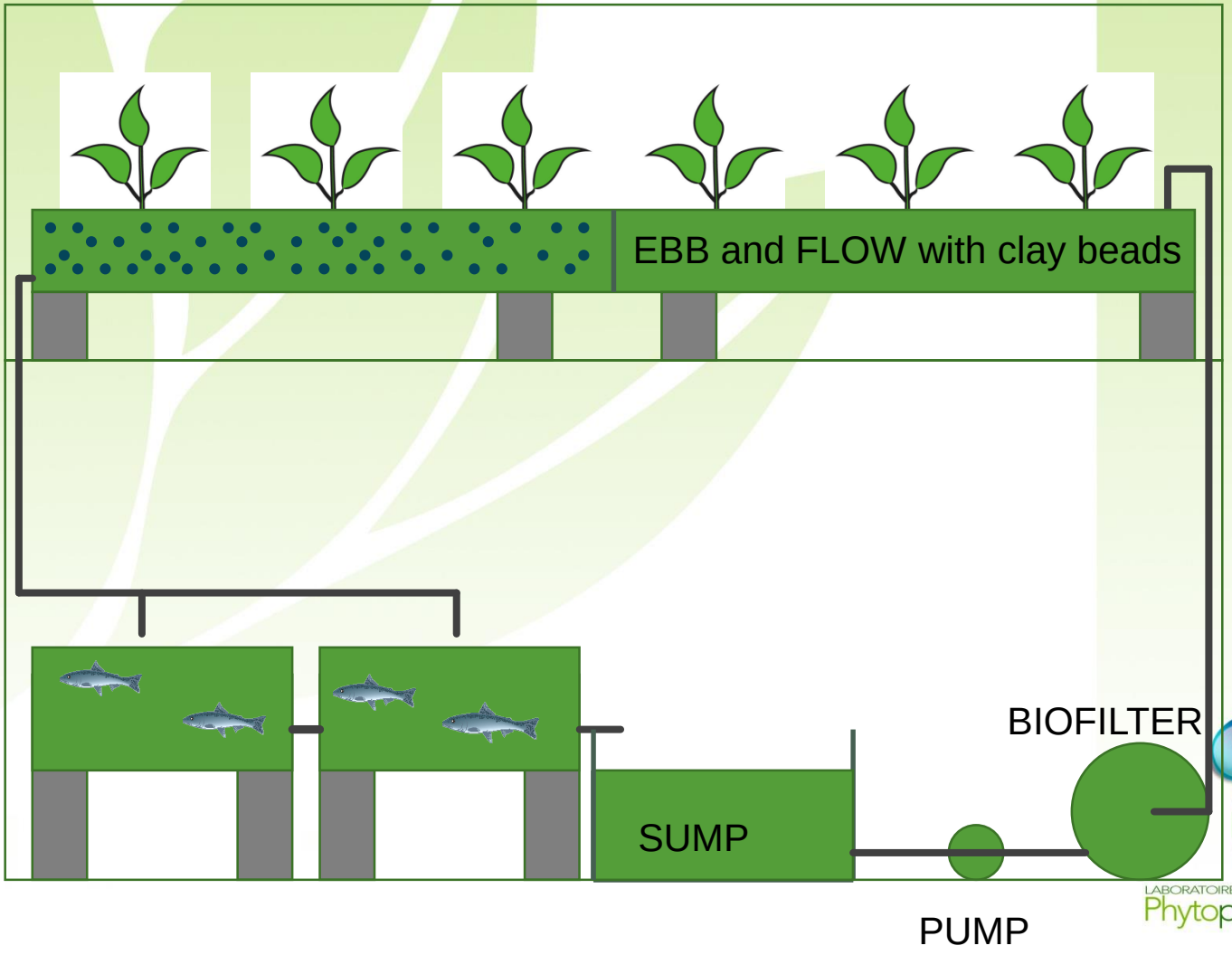
- PAFFBox 2013



- Conclusions PAFF BOX 2013:
  - Able to produce *Tilapia*

  - Able to produce lettuces, basil, tomatoes,…

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- Objectives PAFF BOX in 2014:
  - Improvement of the aquaponic system
  - Evaluation of water quality
  - Evaluation of plant and fish production
  - Evaluation of water and electricity consumption

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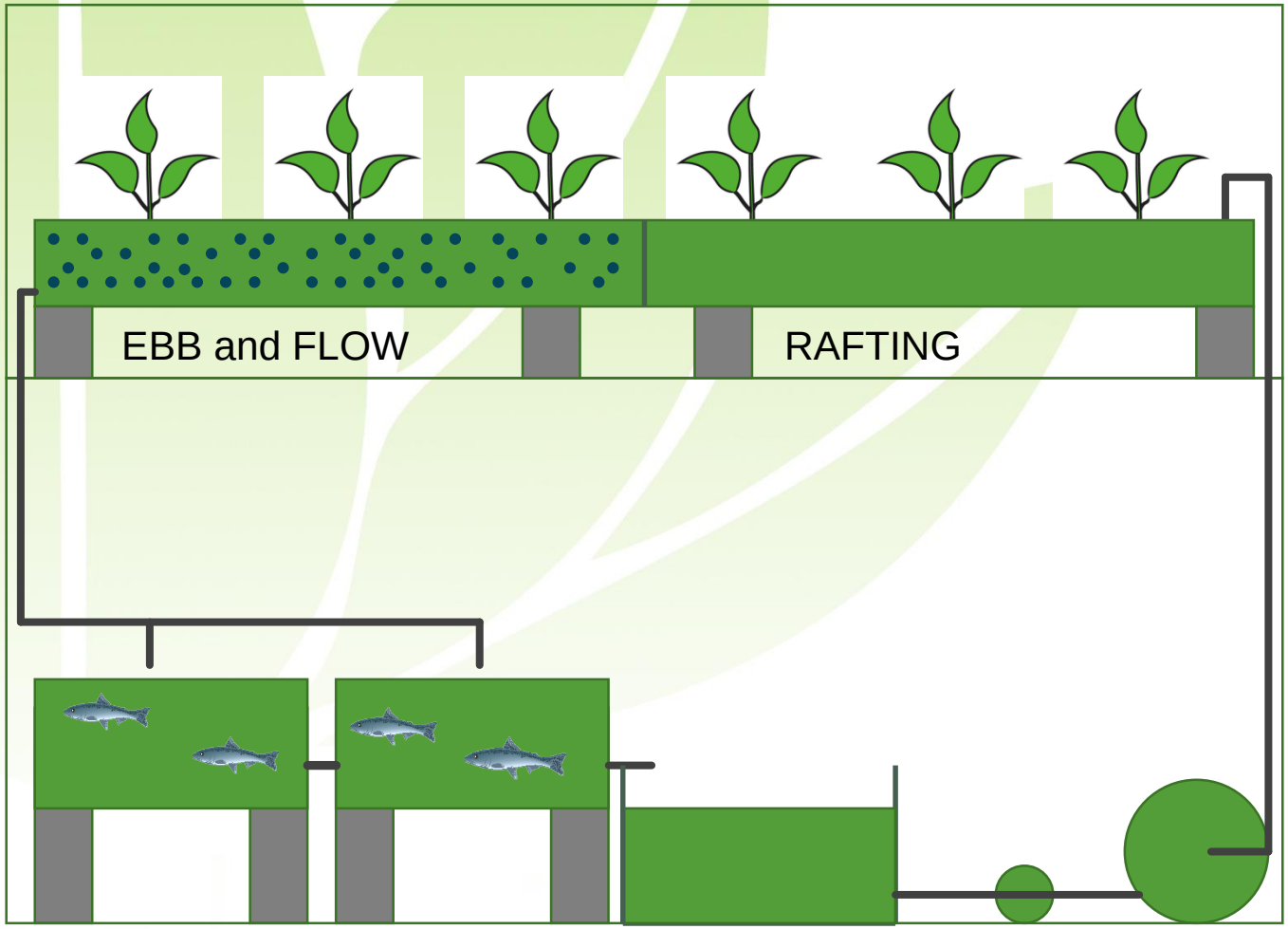
- Improvement of PAFFBox in 2014

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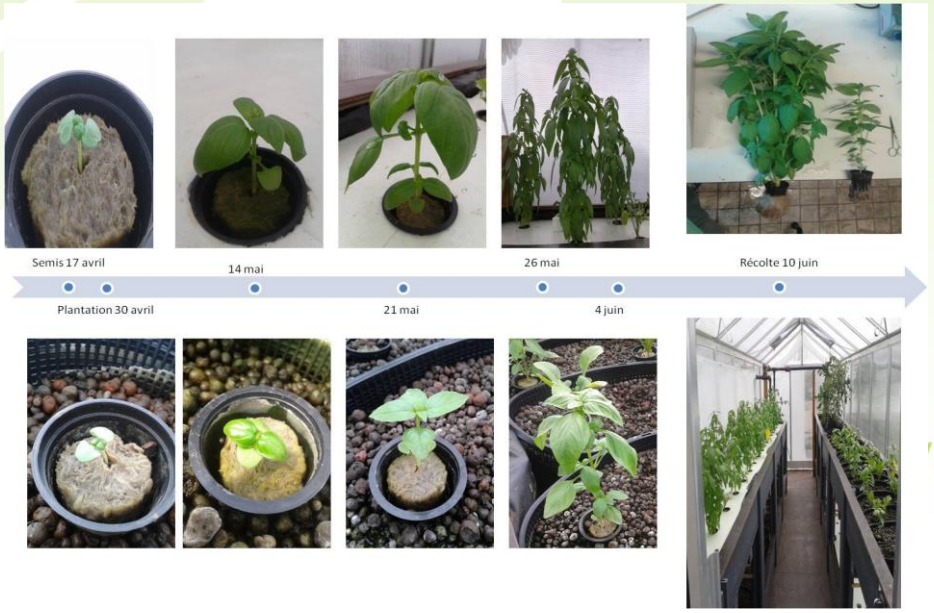
## Lettuces

# Ebb & flow < Raft

- ➔ Statistical yield differences during 2 or 3 cycles
- ➔ Stress due to system adaptation ?
- ➔ Interaction between roots and solution not optimal ?

Ratio Root / Shoot
R/S Ebb >>> R/S Raft

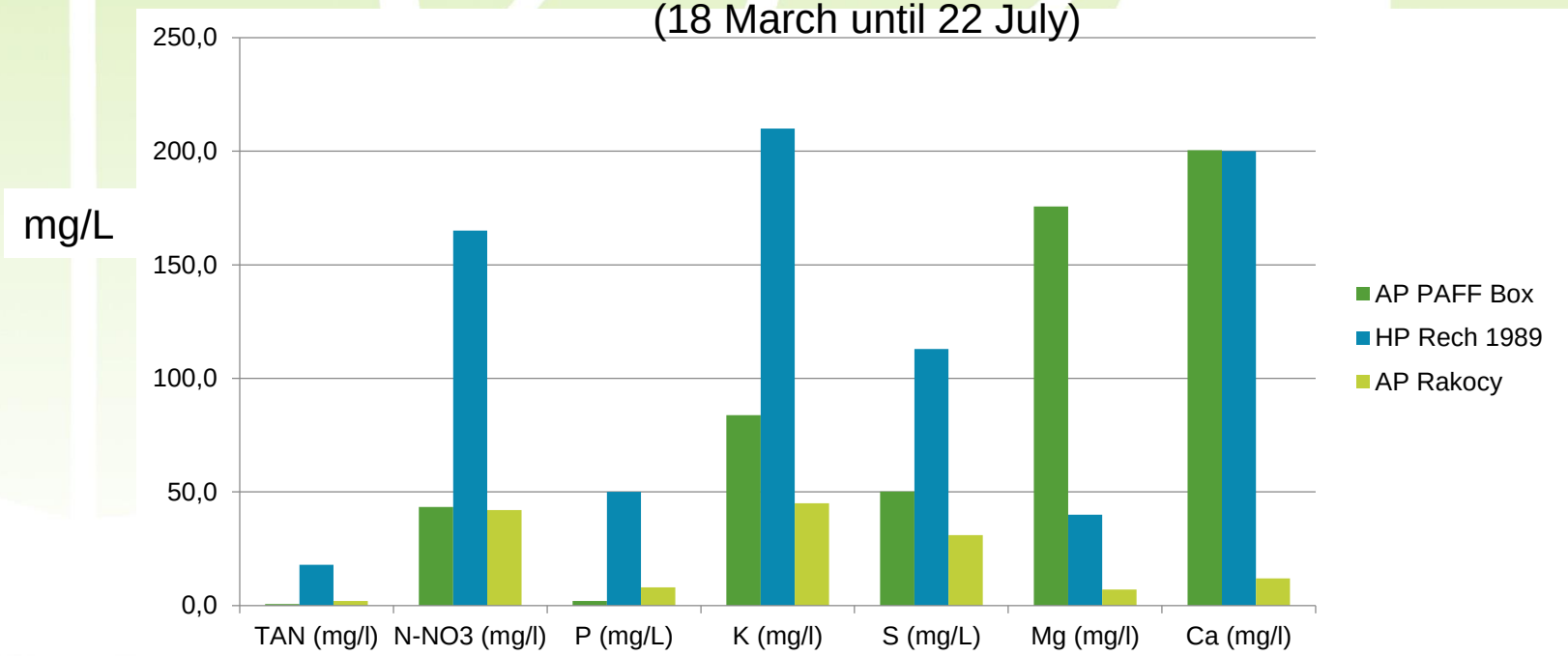
## Basils



- Water quality in 2014

| | T° (C) | pH | EC sump (µS/cm) | DO (mg/L) | TAN (mg/l) |
|---|---|---|---|---|---|
| Mean | 24,33 | 7,06 | 1754,18 | 4,80 | 0,63 |
| SD | 2,34 | 0,30 | 161,33 | 1,25 | 0,77 |

Concentration mean for 4 months period of PAFF BOX
(18 March until 22 July)

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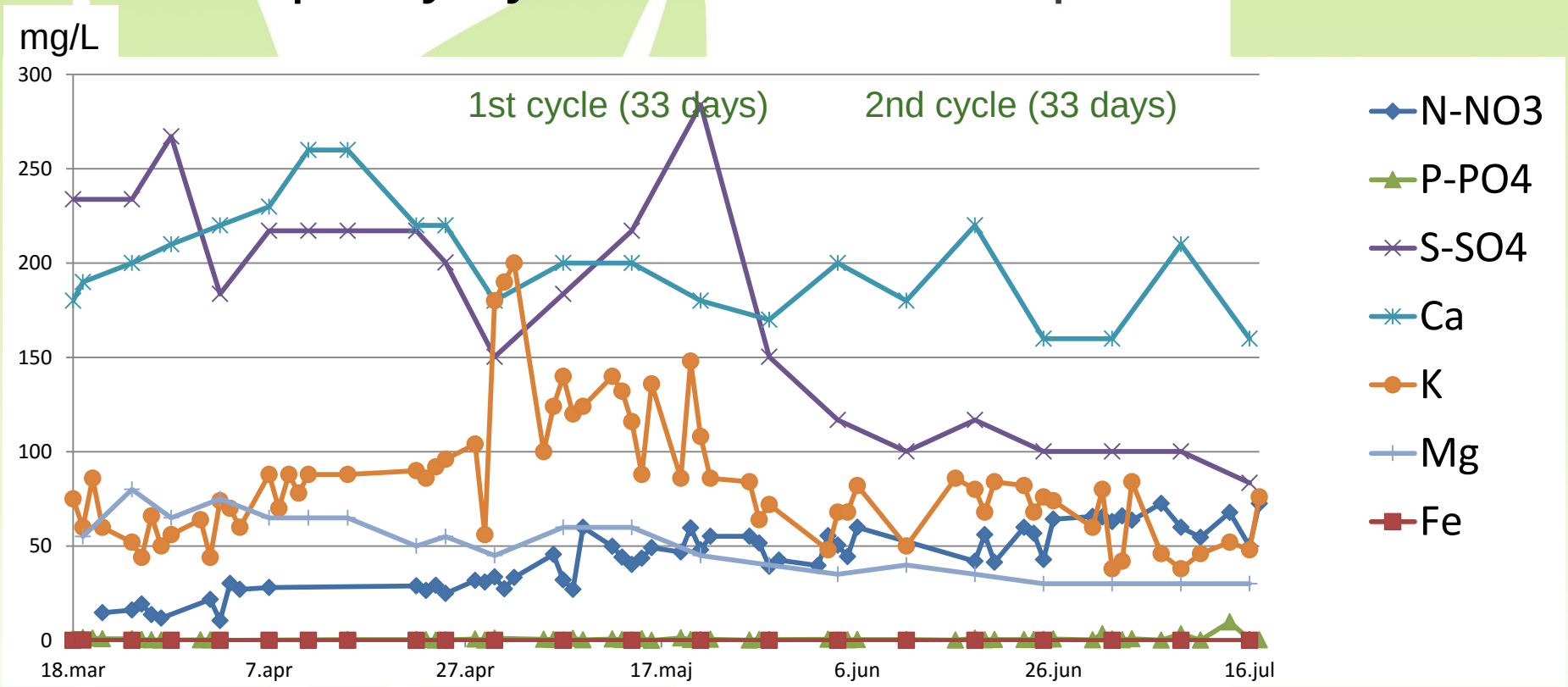
- Water quality dynamic and lettuce production

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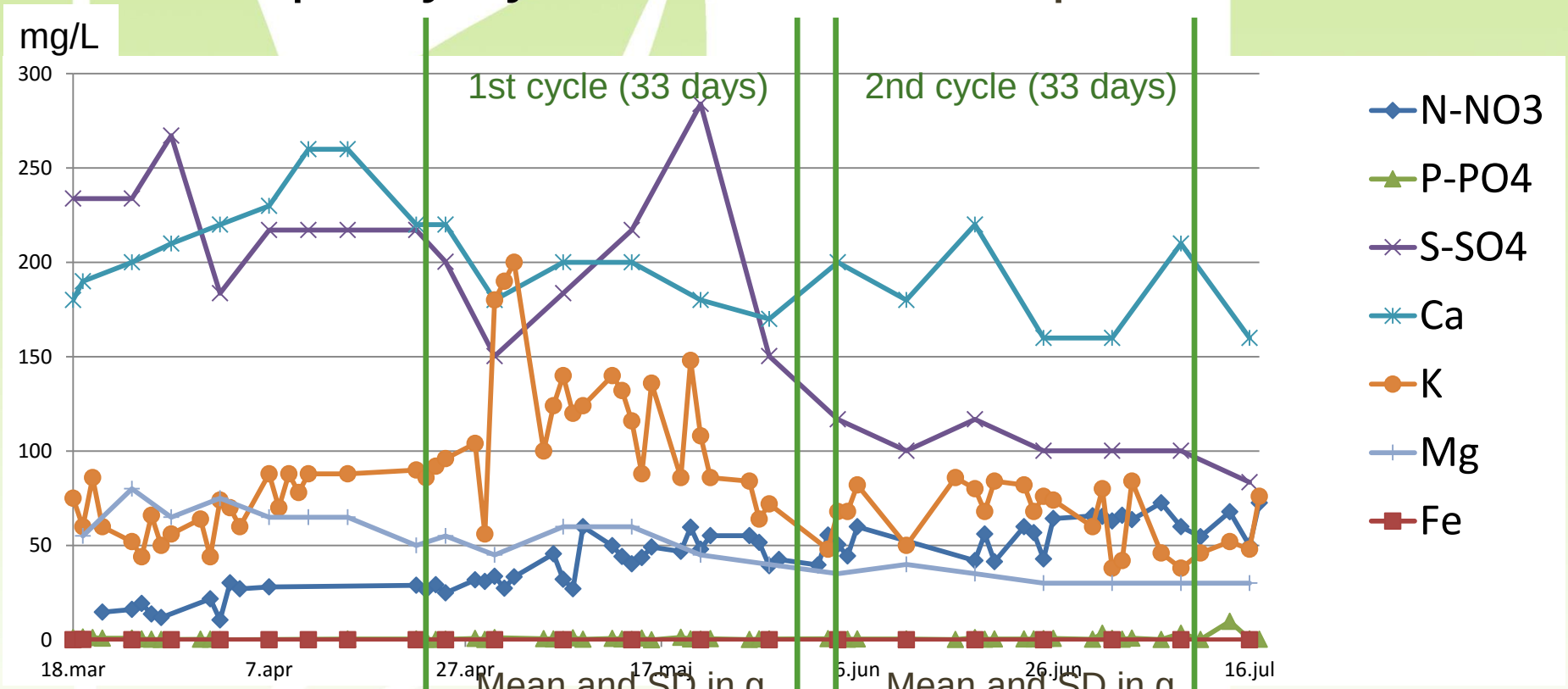
# • Water quality dynamic and lettuce production




| | Mean and SD in g | Mean and SD in g |
|---|---|---|
| | 1st cycle (33 days) | 2nd cycle (33 days) |
| Lettuce : cv. Blond | 204.80 ± 46.45 | 179.14 ± 39.29 |
| Lettuce : cv. Sucrine | 106.14 ± 24.44 | 106.76 ± 17.64 |

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- Tilapia production

| | Fish number | Total Biomass (g) | Average weight (g) |
|---|---|---|---|
| 18 March | 75 | 12 213 | 162.8 |
| 22 July | 71 | 29 218 | 411.5 |

| | |
|---|---|
| FCR | 1.34 |
| | |
| total feed (kg) | 22 807 |
| total days of rearing | 126 |
| | |
| mortality (%/d) | 5.33 |
| Growth Rate (g/d): | 1.97 |

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- Electricity and water consumption

| |
|---|
| 16 June => 23 July |
| 25 kWh/d in average |

| | |
|---|---|
| Total recharge water use (L) | 7,808.1 |
| Water use to fill up system (L) | 2000 |
| Average daily water recharge (L) | 62.0 |
| Daily water exchange (%) | 3.1 |
| Daily water exchange (L/kg feed) | 342.5 |

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- Objectives PAFF BOX 2015:
  - Improvement of the aquaponic system
  - Evaluation of water quality
  - Evaluation of plant and fish production
  - Evaluation of water and electricity consumption
  - Comparison between 2014 and 2015

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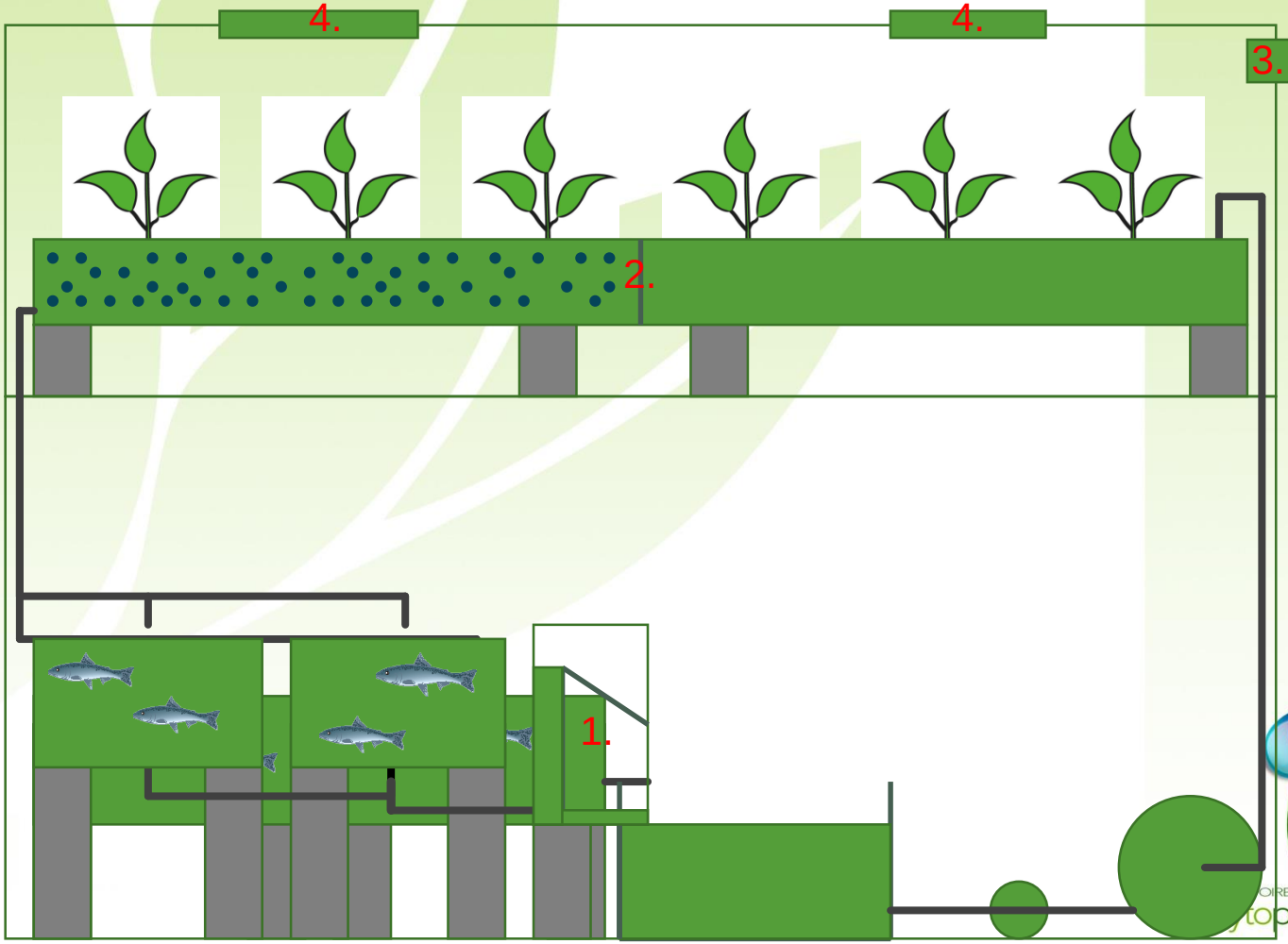
- Improvement of PAFF Box in 2015




1 Filter

2 Only Raft system

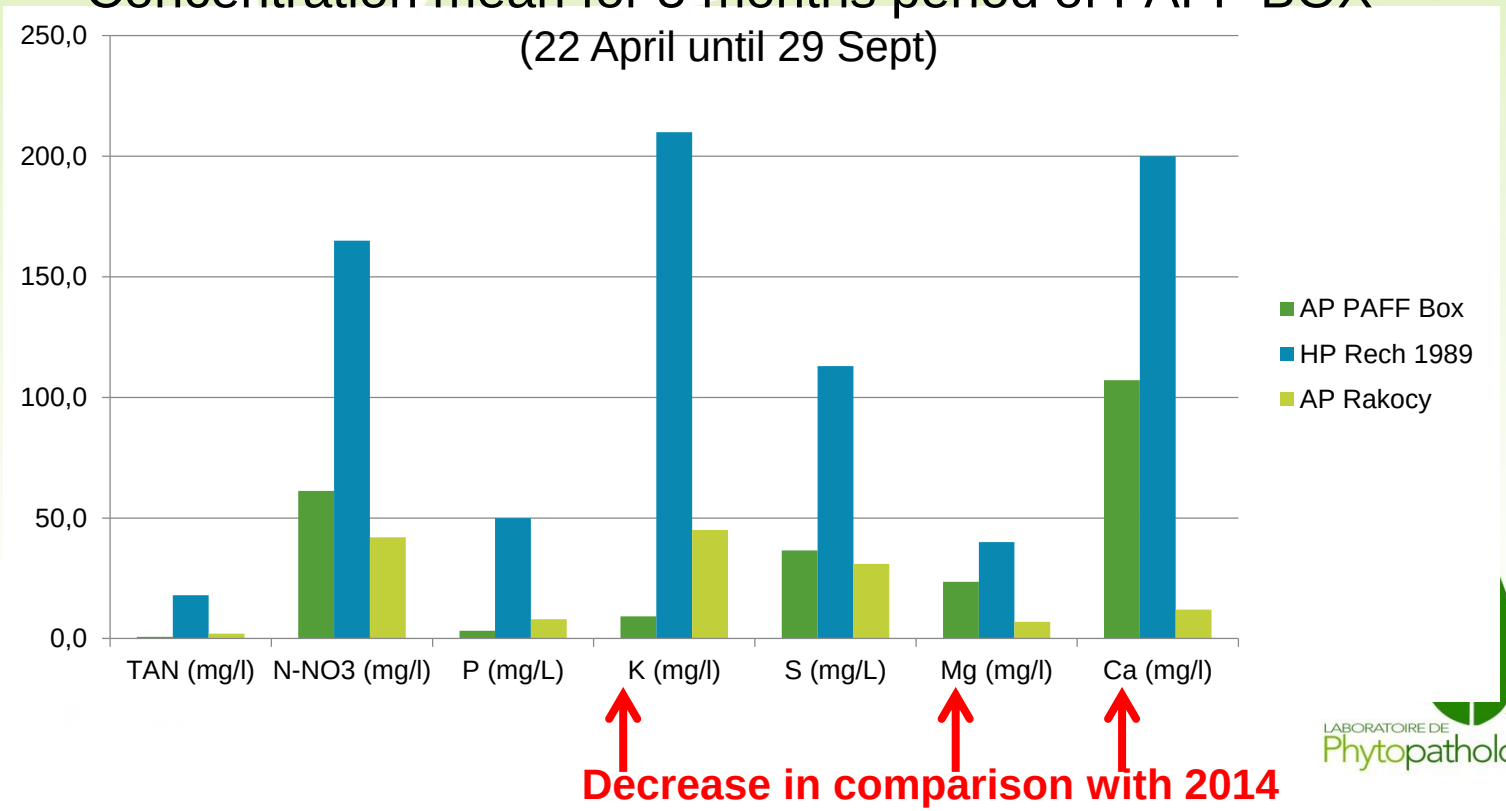
3 Air extractor

4 Ventomax

- Water quality 2015 : Macronutrients

| | T° (C) | pH | EC sump (µS/cm) | DO (mg/L) | TAN (mg/l) |
|---|---|---|---|---|---|
| Mean | 25.6 | 7,3 | 1052.8 | 4,38 | 0.71 |
| SD | 2.54 | 0,70 | 159.70 | 0.80 | 0.52 |

Concentration mean for 5 months period of PAFF BOX
(22 April until 29 Sept)

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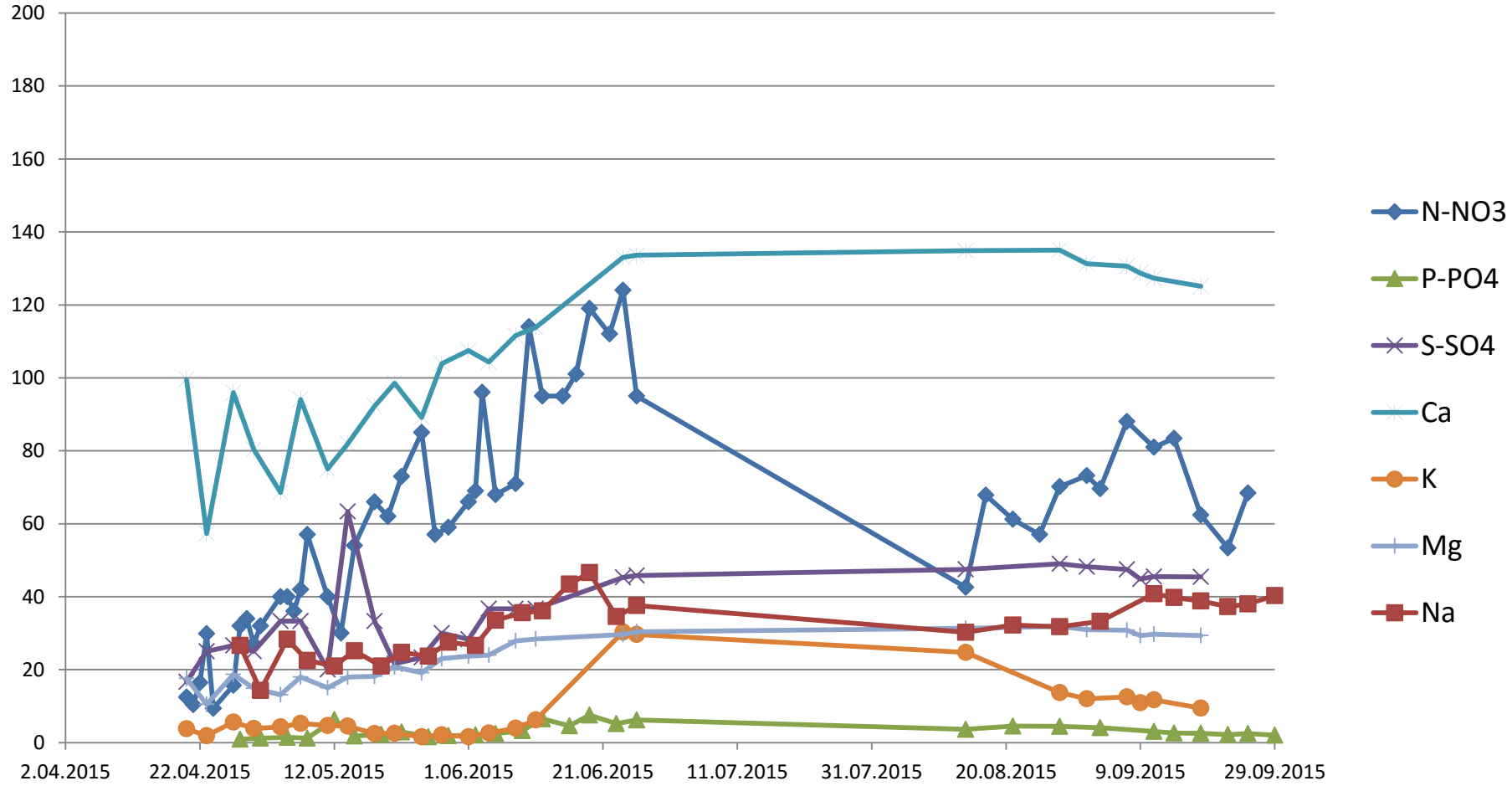
# • Water dynamic quality in 2015 : Macronutrients

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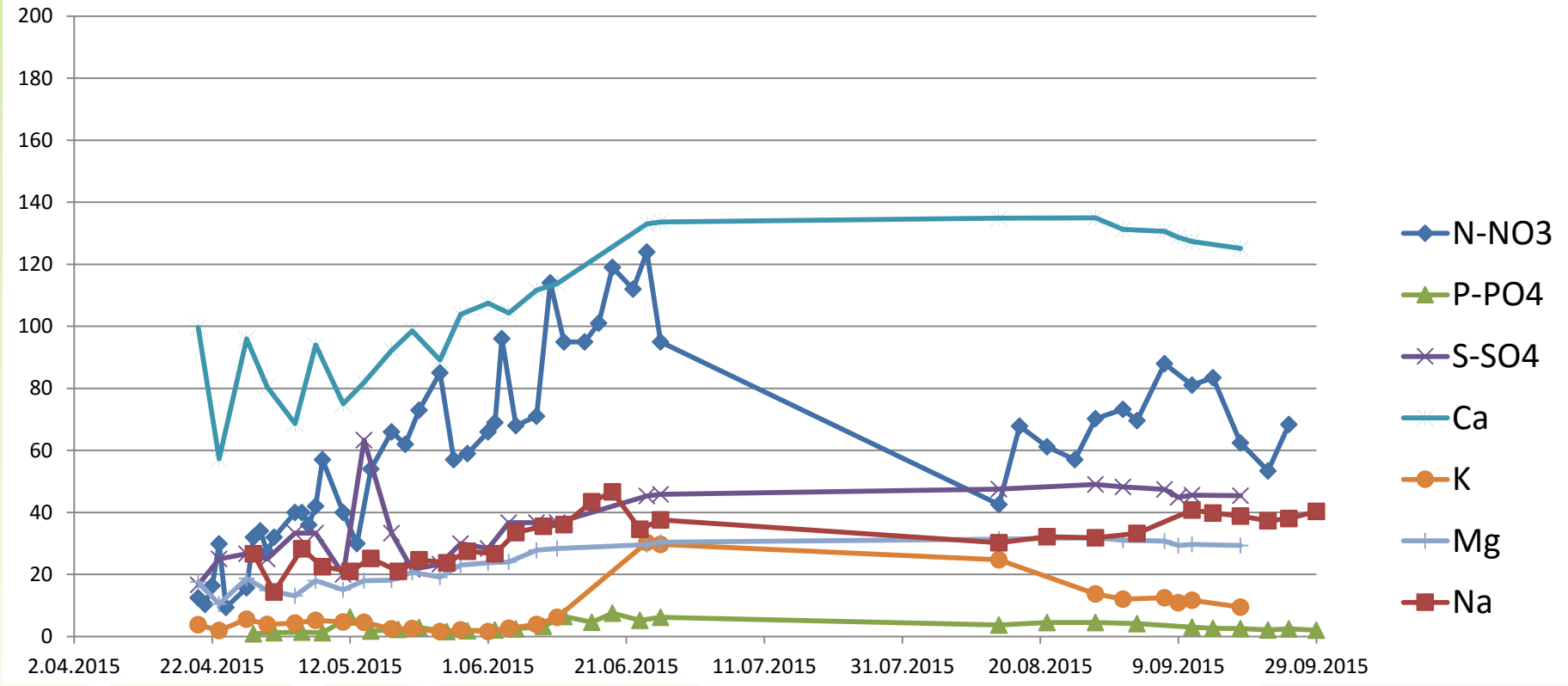
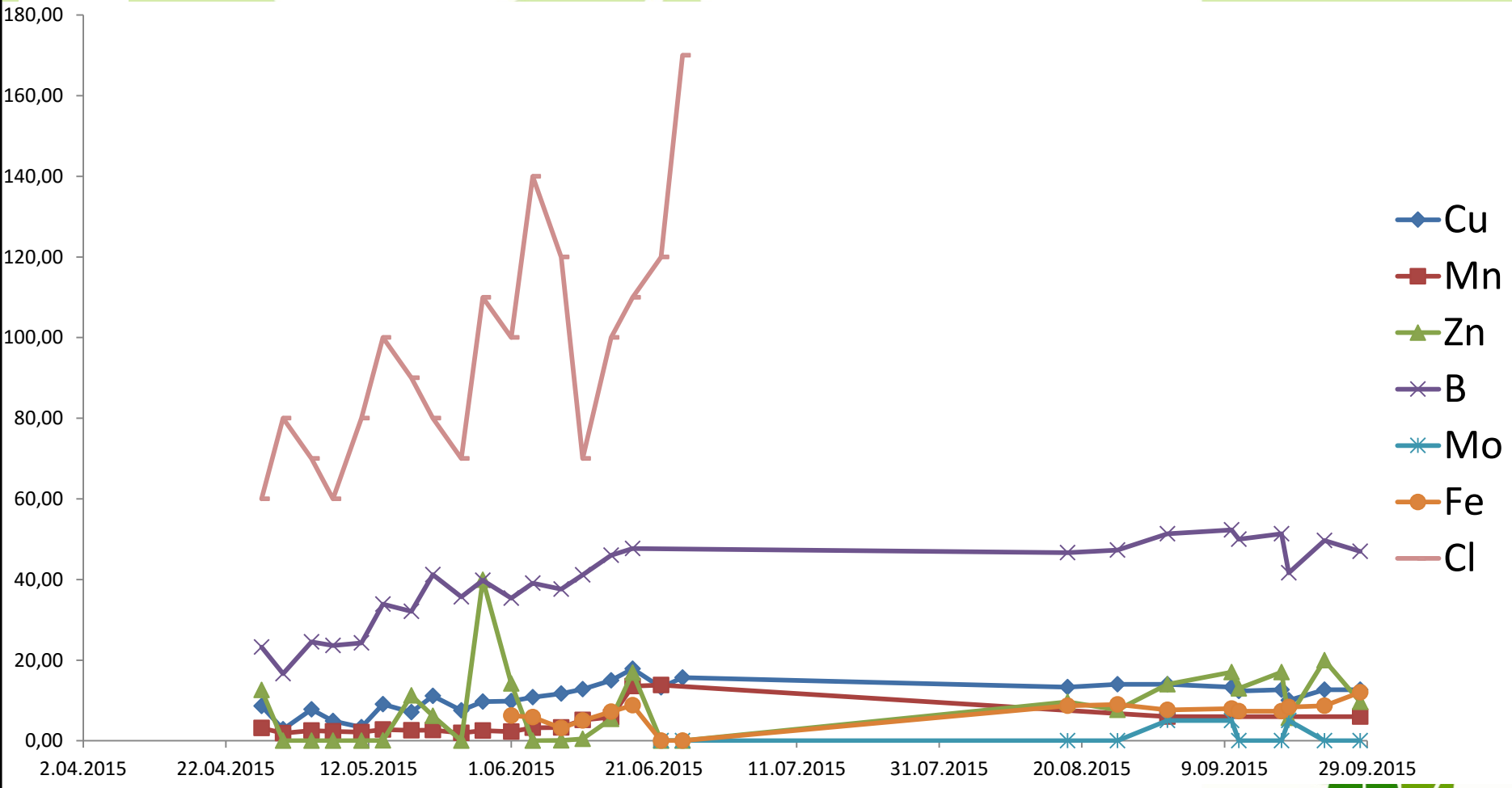
# Water quality dynamic in 2015 and lettuce production




| CV. Blonde | 1st cycle | 2nd cycle | 3rd cycle |
|---|---|---|---|
| Mean (g) | 176.5 | 181.3 | 19.6 |
| SD | 44.25 | 46.78 | 7.73 |

| CV. Blonde | 4st cycle | 5th cycle | 6th cycle |
|---|---|---|---|
| Mean (g) | 256.8 | 233.8 | 106.3 |
| SD | 41.98 | 45.18 | 18.80 |

# • Water quality 2015 : Micronutrients

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- Tilapia production

| | Number of fish | Total Biomass (g) | Average weight (g) |
|---|---|---|---|
| 20 April | 200 | 14 785 | 73.9 |
| 29 Sept | 191 | 44 834 | 236.0 |

| | **2014** | **2015** |
|---|---|---|
| FCR | 1.34 | 1.56 |
| | | |
| total feed (kg) | 22.81 | 46.90 |
| total days of rearing | 126 | 164 |
| | | |
| mortality (%/d) | 5.33 | 5.0 |
| Growth Rate (g/d): | 1.97 | 0.99 |

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- Electricity and water consumption

22 April June => 29 Sept
37.8 kWh/d in average

| | 2014 | 2015 |
|---|---|---|
| Total recharge water use (L) | 7,808.1 | 16,154.9 |
| Water use to fill up system (L) | 2000 | 2673.4 |
| Average daily water recharge (L) | 62.0 | 97.3 |
| Daily water exchange (%) | 3.1 | 3.6 |
| Daily water exchange (L/kg feed) | 342.5 | 243.3 |

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- PAFF BOX conclusions :

  - Able to produce fish's and vegetable
  - Comparison between 2014 and 2015
    - Slight differences for *Tilapia* rearing performance could be explained by feed composition
    - Differences in water quality (EC and macro-elements)
    - However no or slight difference for lettuce growth
    - Except 2 cycles in 2015 due to toxic support or light intensity decrease
  - Development of plants with reasonable yield despite low concentrations in nutritive elements (N, P, K, Fe) whatever the year

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- Objectives :
  - Comparison of aquaponic (AP), hydroponic (HP) and complemented aquaponic (CAP) with additional nutritive elements
  - Impact of water quality and nutrients level on lettuce growth

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- Methods :
  - Aeroflots systems :

  - Each week : change of water
    - Aquaponic : 1/10 of RAS water + 9/10 rain water + mineral salts to reach Rakocy values
    - Hydroponic : 100 % rain water + mineral salts to reach Resh values for hydroponic lettuces
    - Complemented aquaponic : 100% RAS water complemented with mineral salts

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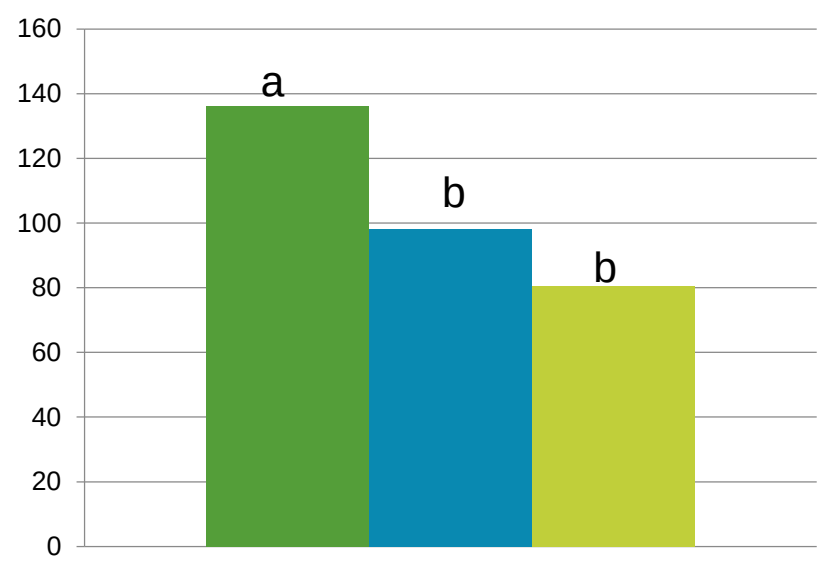
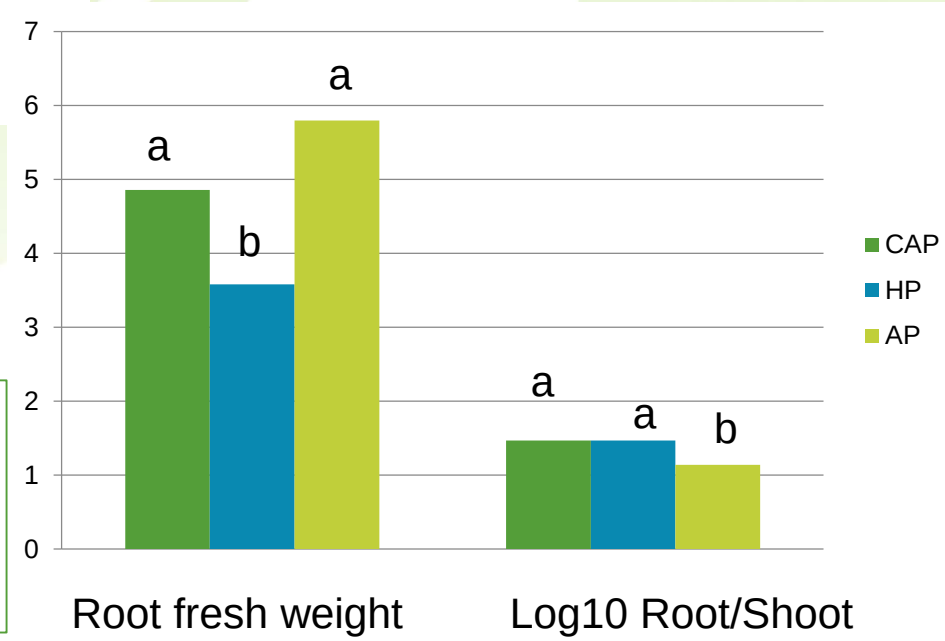
- Growth performance of cv. Sucrine :




CAP = Complemented aquaponic water
HP = Hydroponic water
AP = Aquaponic water

Weight mean of cv. sucrine




2 trials with same trends and an increase of 39 % of weight between CAP and HP

- Comparison of water quality : Macroelements and TAN

| | | Mean | SD |
|---|---|---|---|
| N-NO3 | CAP | 215,54 | 28,13 |
| | HP | 193,29 | 12,35 |
| | AP | 50,31 | 1,80 |
| TAN | CAP | 25,79 | 3,09 |
| | HP | 23,95 | 2,51 |
| | AP | 1,82 | 1,35 |
| P-PO4 | CAP | 52,66 | 2,42 |
| | HP | 50,93 | 4,47 |
| | AP | 7,83 | 0,52 |
| S-SO4 | CAP | 66,72 | 6,97 |
| | HP | 95,36 | 4,72 |
| | AP | 10,99 | 1,17 |
| K | CAP | 219,31 | 39,46 |
| | HP | 242,27 | 36,69 |
| | AP | 59,51 | 7,89 |
| Ca | CAP | 175,09 | 14,87 |
| | HP | 205,68 | 12,58 |
| | AP | 14,72 | 2,03 |
| Mg | CAP | 43,02 | 4,44 |
| | HP | 43,11 | 3,15 |
| | AP | 7,36 | 0,64 |

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- Comparison of water quality : Microelements

| | | Mean | SD |
|---|---|---|---|
| Fe | CAP | 4,40 | 0,20 |
| | HP | 3,83 | 0,29 |
| | AP | 3,47 | 1,05 |
| B | CAP | 0,59 | 0,03 |
| | HP | 0,51 | 0,08 |
| | AP | 0,47 | 0,13 |
| Cu | CAP | 0,12 | 0,01 |
| | HP | 0,09 | 0,01 |
| | AP | 0,09 | 0,03 |
| Mo | CAP | 0,66 | 0,06 |
| | HP | 0,64 | 0,10 |
| | AP | 0,50 | 0,12 |
| Mn | CAP | 0,33 | 0,02 |
| | HP | 0,32 | 0,04 |
| | AP | 0,32 | 0,10 |
| ZN | CAP | 0,16 | 0,03 |
| | HP | 0,15 | 0,01 |
| | AP | 0,14 | 0,03 |
| Na | CAP | 71,67 | 18,24 |
| | HP | 7,95 | 4,52 |
| | AP | 49,73 | 20,98 |

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- Conclusions :
  - PAFF BOX system was yearly improved
  - Using reasonable water and energy, PAFF Box was able to provide fish's and vegetable at a normal yield despite low concentration of nutritive elements (N, P, K and Fe)
  -


39 %

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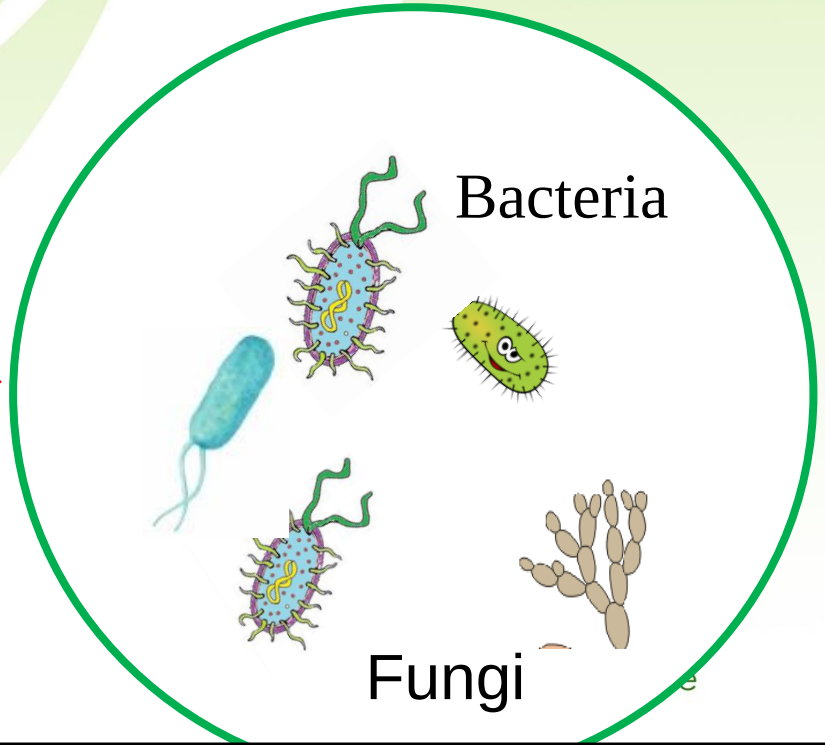
- Perspectives :
  - How to explain such results :
    - Role of organic acids ?
    - Role of microbiota ?

- Perspectives :
  - How to explain such results :
    - Role of organic acids ?
    - Role of microbiota ?


  - Increase of sludge mineralisation
  - Decoupled systems

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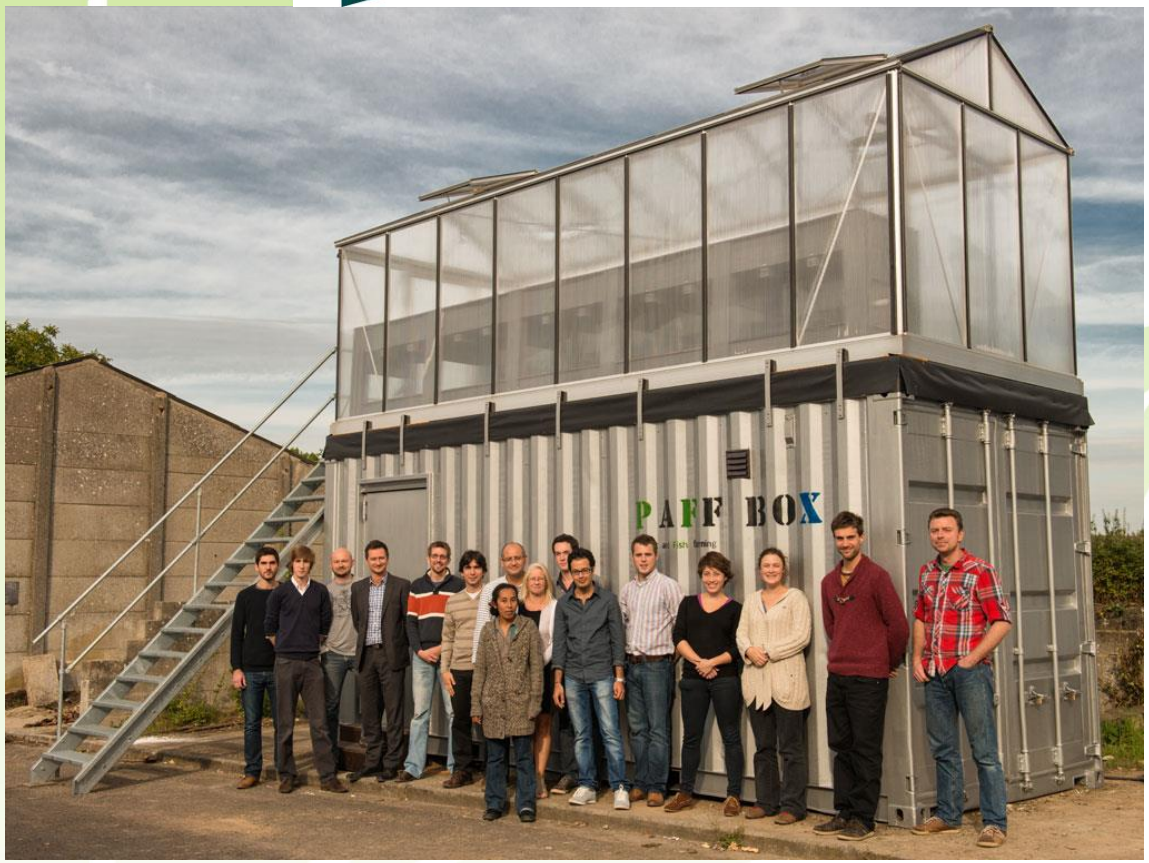


B. Delaide

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S. Goddek

G. Delhaye

J. Gott

**Haïssam Jijakli**

**CONTACT : +32 499 261350**

**mh.jijakli@ulg.ac.be**

*www.**agriculture-urbaine.be***

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