inagro

ONDERZOEK & ADVIES IN LAND- & TUINBOUW

FIRST RESULTS OF A SEMI-PRACTICE COMBINATION OF TOMATO AND FISH GROWTH

Peter Bleyaert

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Inagro:
a short introduction

inagro
ONDERZOEK & ADVIES IN LAND- & TUINBOUW

Inagro location

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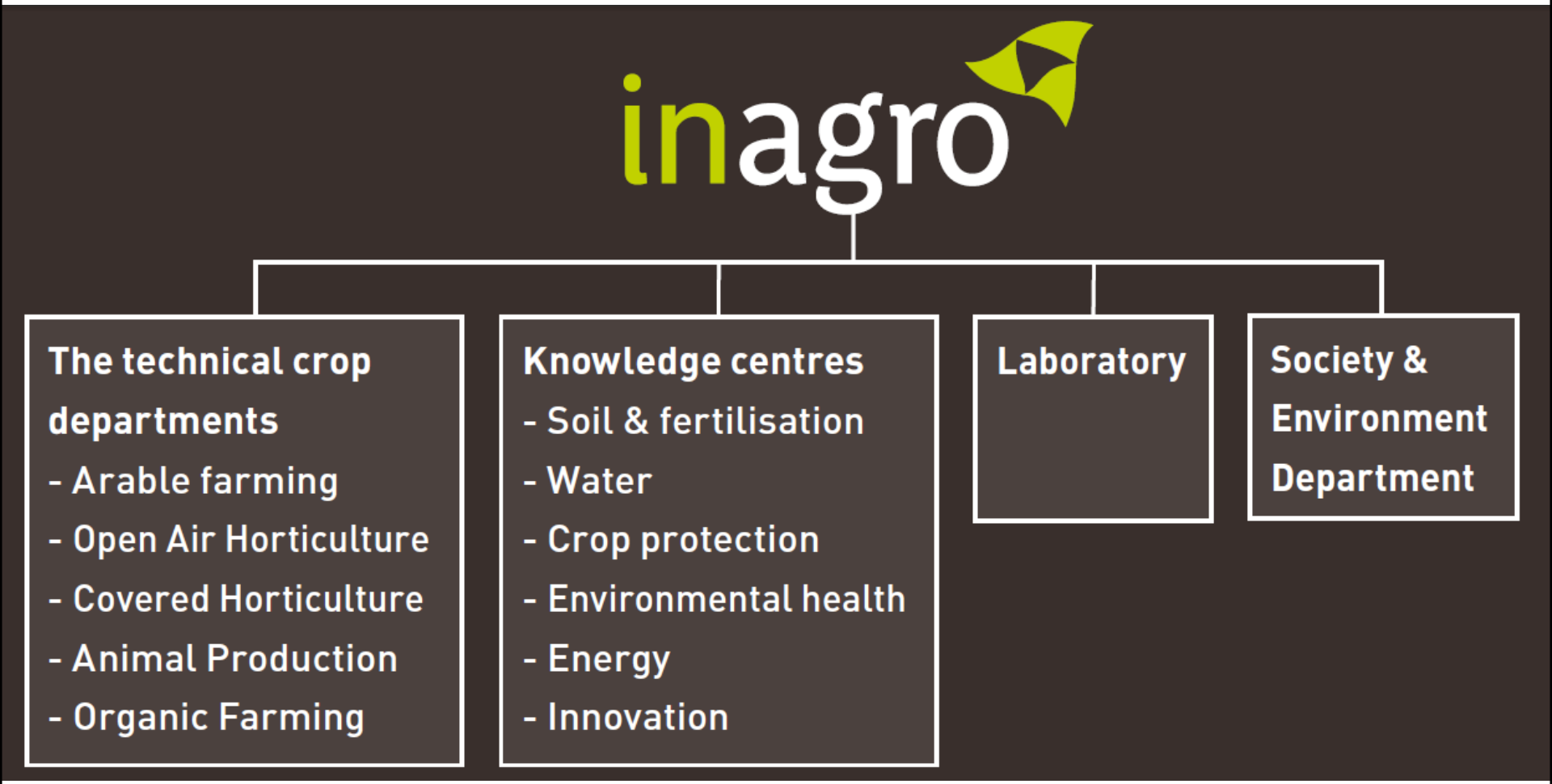
Inagro mission

Inagro delivers the appropriate **advice** *at the right time in the most appropriate way to the* **farming** *and* **horticultural** *sector with a due focus of attention going out to economy, ecology and society.*

Inagro is a **sustainable** *organisation that places a premium on networking whilst pursuing a reputation of* **excellence.**

Inagro structure



Inagro staff

STAFF

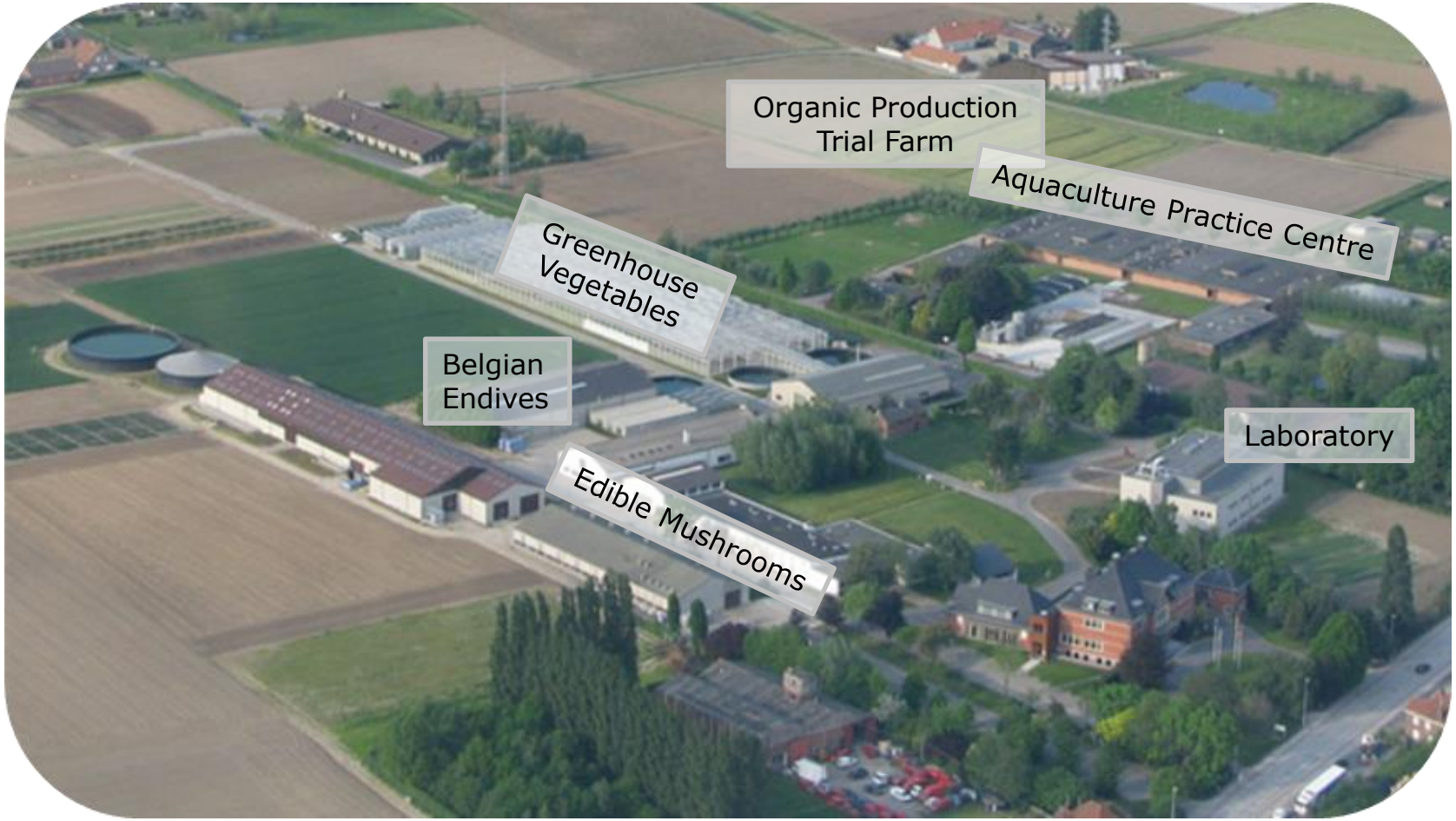
A solid educational background in agriculture, either at Master level for the researchers or at Bachelor or technical level for the technical staff is usually a secure foundation for a career with Inagro. In fact, quite a few members of staff have their roots in the agricultural and the horticultural sector.
Inagro's staff policy is aimed at ensuring the continuous in-service training of the organisation's human capital.

32.5 FTE
Support staff

71 FTE
Researchers & agricultural extension officers

75.5 FTE
Technical staff

Inagro infrastructure



The INAPRO project

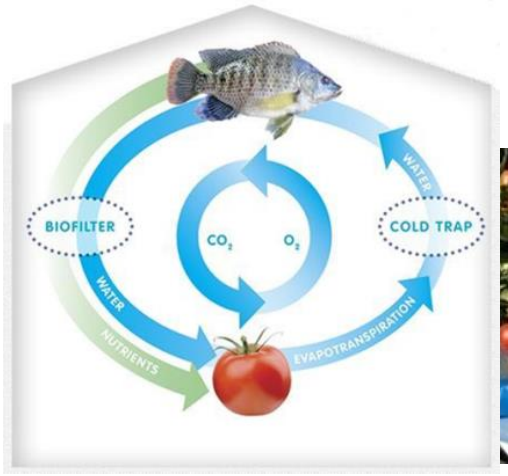
This project has received funding from the European Union´s **Seventh Framework Programme** for research, technological development and demonstration under grant agreement no 619137

INAPRO - Aquaponics


INAPRO: Innovative aquaponic production

Proposal full title:	Innovative model & demonstration based water management for resource efficiency in integrated multitrophic aquaculture and horticulture systems
Work Programme Topic	Water innovation demonstration projects
Coordination	Forschungsverbund Berlin e.V. – Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB)
Project duration	01.01.2014 – 31.12.2017

Project objectives of INAPRO



- combining fish and vegetable production within an innovative aquaponic system
- using water & nutrients by value added chains and reducing emissions
- INAPRO-system as modular and scalable facilities, adaptable to local conditions
- Testing, optimization and validation under different conditions by rural & urban demo-objects

Combining aquaculture and hydroponic culture

Aquaculture

- high environmental impacts (emissions)
- intense use of water resources

➡ recirculating aquaculture system (RAS), BUT 5 to10% vol. of nutrient rich waste water/day

Hydroponic

- high specific demands of nutrients
- high demand of freshwater

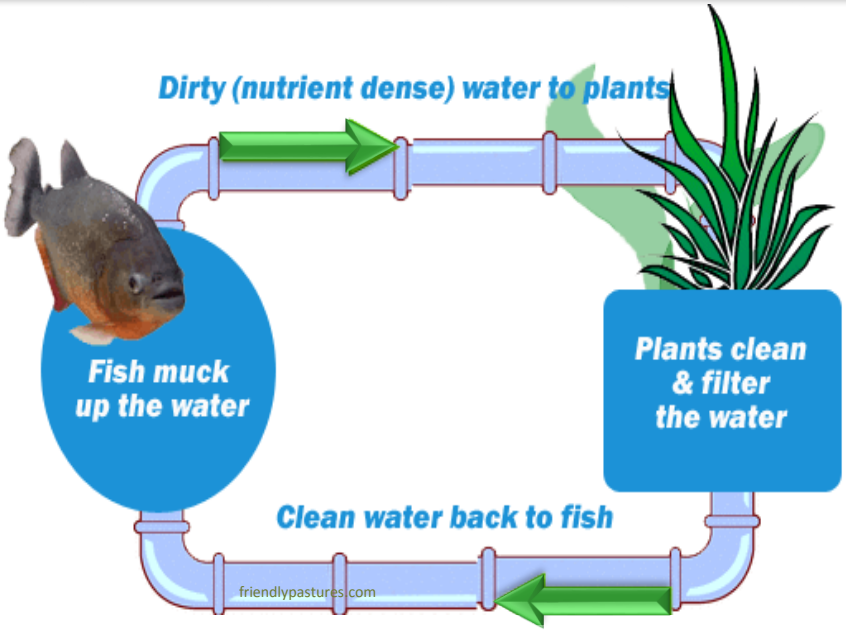
Aquaponics

waste water by RAS ➡ **plant nutrition**
plant irrigation

Aquaponics – conventional systems

resource efficiency → environmental friendly → sustainable food production

small/medium scale → local food production, mostly backyard (hobby) systems

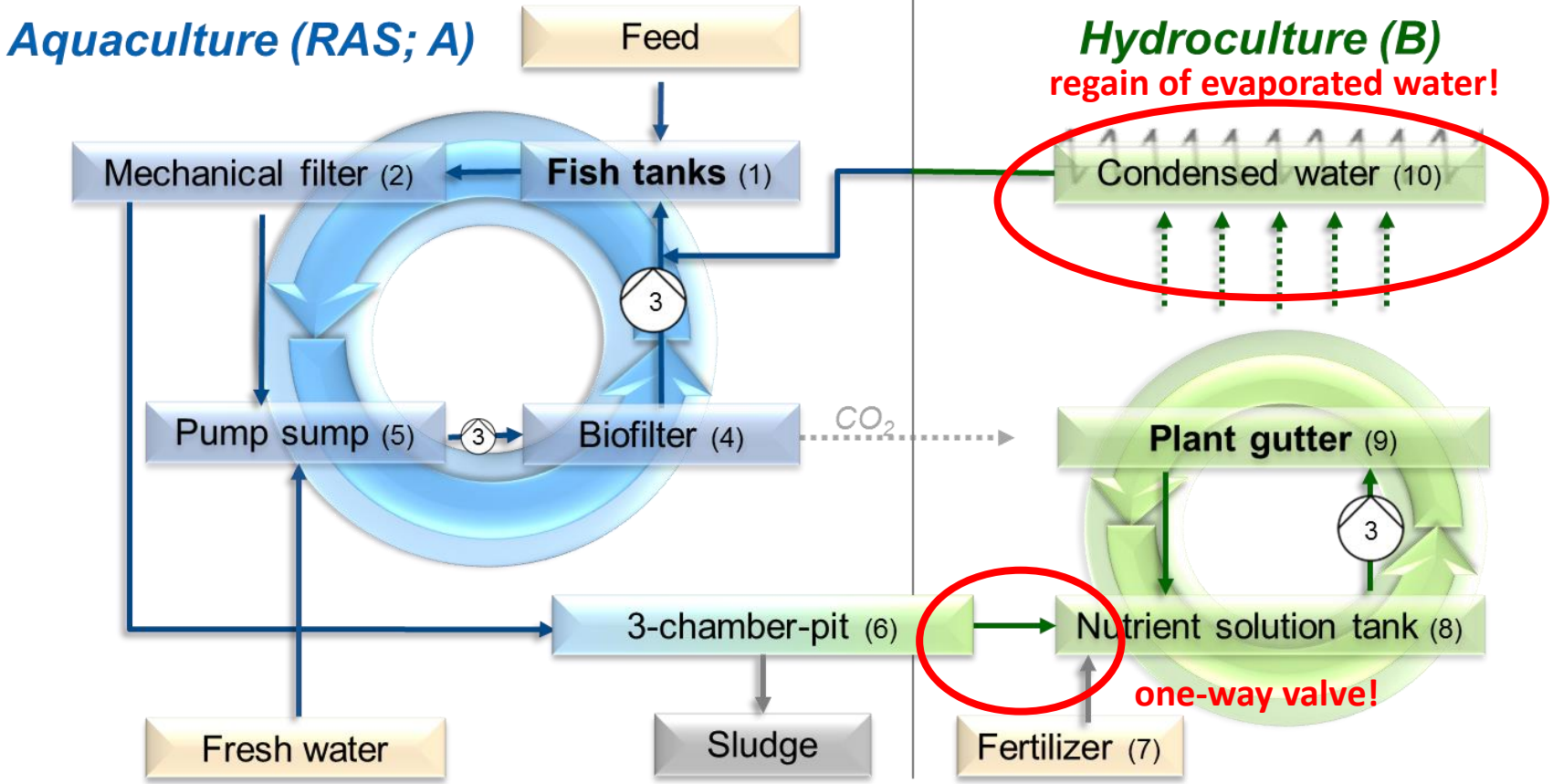


- **<u>single</u> recirculation aquaponic system (SRAPS)**
  10-20% vol. freshwater/day

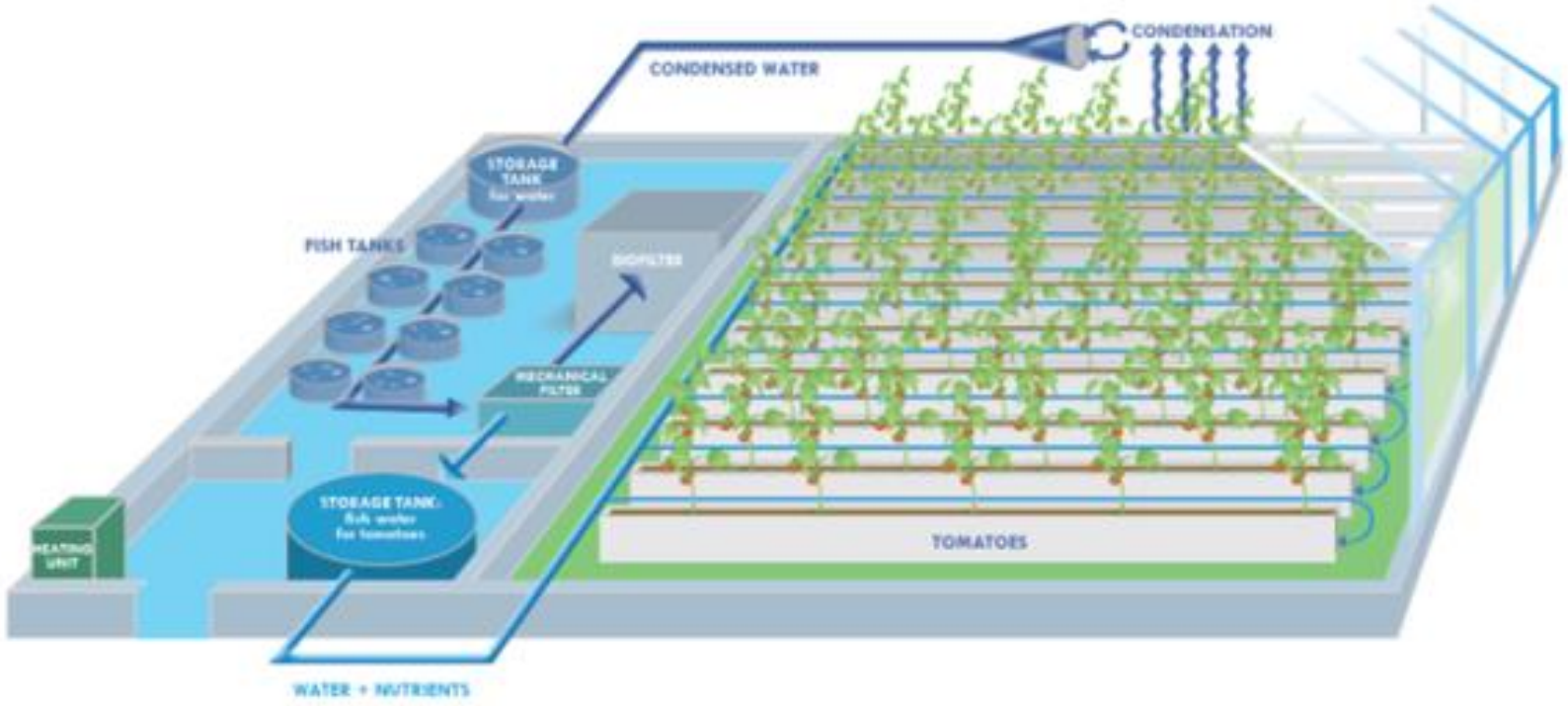
BUT: fish and plants require different water qualities (pH, nutrients) → low yields!

Hightech INAPRO aquaponic system

- **<u>double</u> recirculation aquaponic system (DRAPS) -> optimal conditions for both parts**
  Kloas et al. (2015) Aquacult Environ Interact doi: 10.3354/aei00146
  gain in efficiency and economy of water (1-3% vol./day) and nutrients (NO_3, P, CO_2), NO waste water!



The INAPRO concept



INAPRO a new concept for aquaponics

improves sustainability by

- drastic reduction of water use (1-3% vol./day or even lower) by regain of plant evaporated water, use of alternative energy and waste heat!

increases productivity by

- using DRAPS instead of SRAPS for aquaponics allows fish production as in conventional RAS but provides also optimum conditions for hydroponic units

reduces environmental impacts by

- lowering drastically emissions of nutrient (N, P) rich fish waste water that is used for hydroponics and plants are even a net sink for CO_2 released by fish

INAPRO transfers "tomatofish" into application!

INAPRO work packages (WP)

WP 1: Concept and modelling

WP 2: Design and development of components and modules

WP 3: Integration and testing

WP 4: Demonstration of the INAPRO system at different geographical locations: Germany and Belgium, Spain, China

WP 5: Dissemination and exploitation

The INAPRO research facility

Completion: January 2015

INAGRO experiments

within the INAPRO project

Task Inagro in WP 4:
demonstration projects in rural areas

Testing and optimization of
water and nutrient exchange

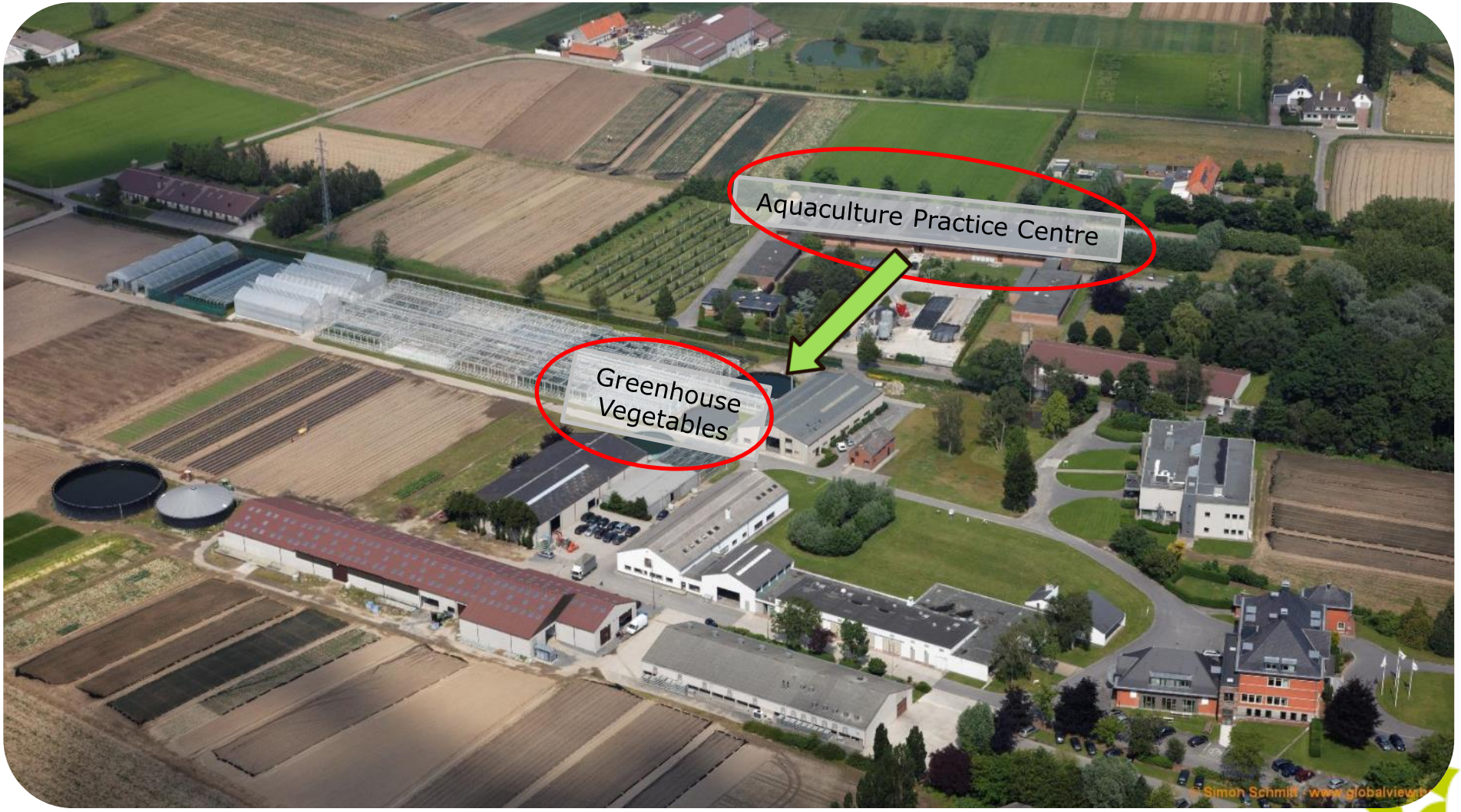
Fish → tomatoes

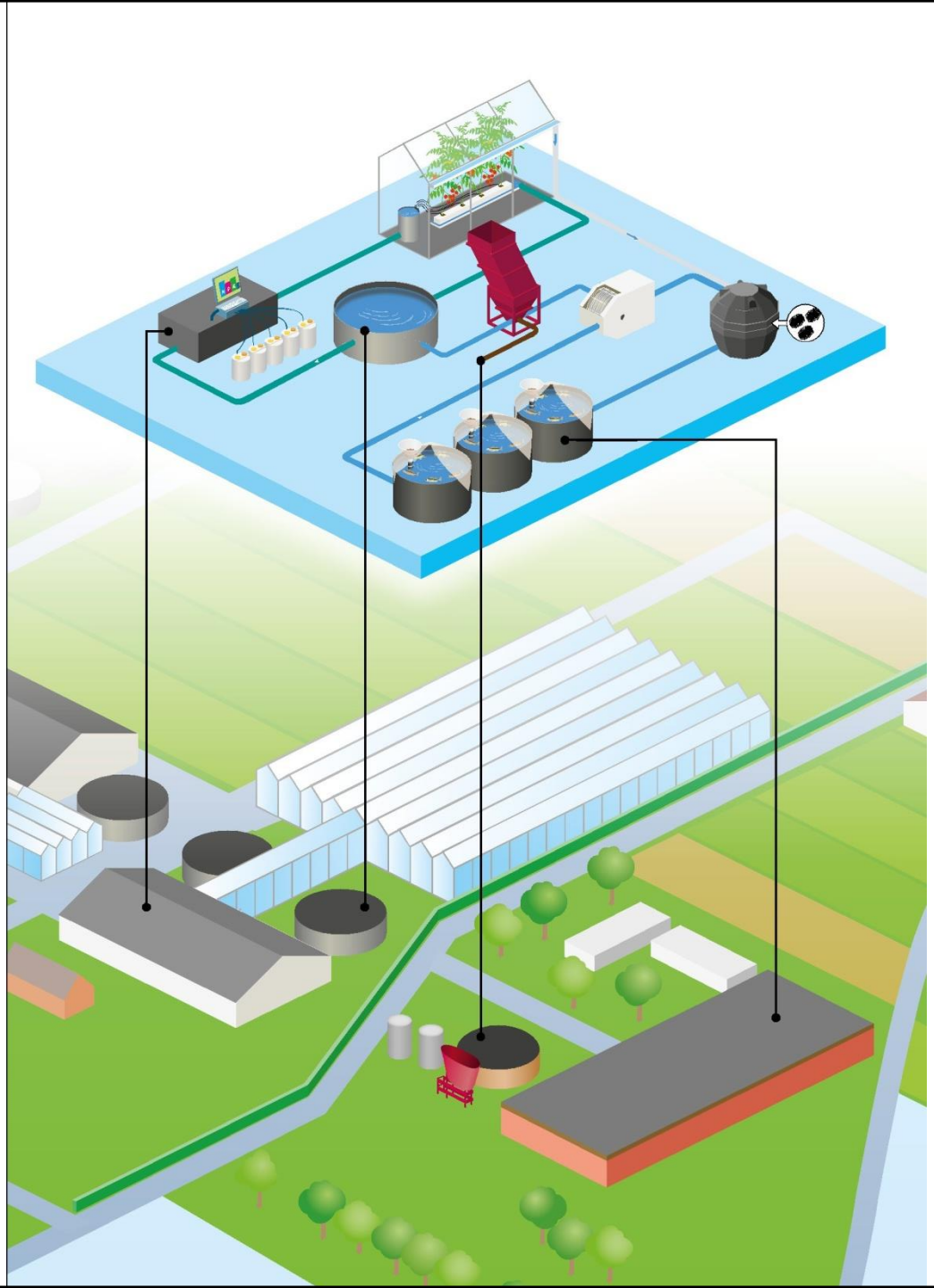
"Early in the project a comparison will be installed of tomato grown on
(1) nutrient solution made with aquaculture enriched water and
(2) standard nutrient solution made with rain water + tap water."

Task Inagro in WP 4

This setup can, together with the experimental unit at IGB, deliver system data for the development and test of models and concepts.
The facility can be run as control before building the 3 other rural farms and can be extended later.

Combining aquaculture and tomato





Characteristics of Inagro aquaculture

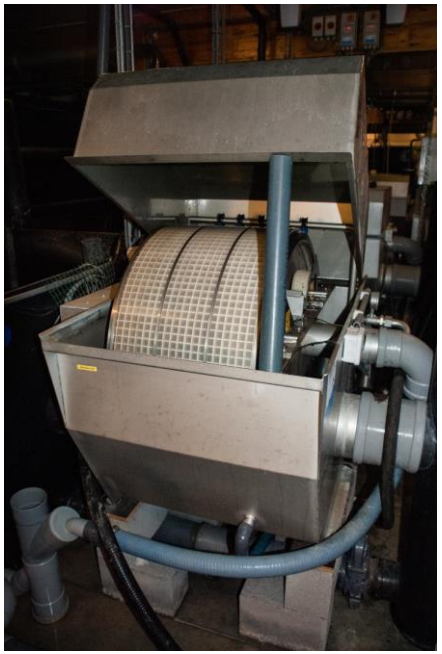
Fish:

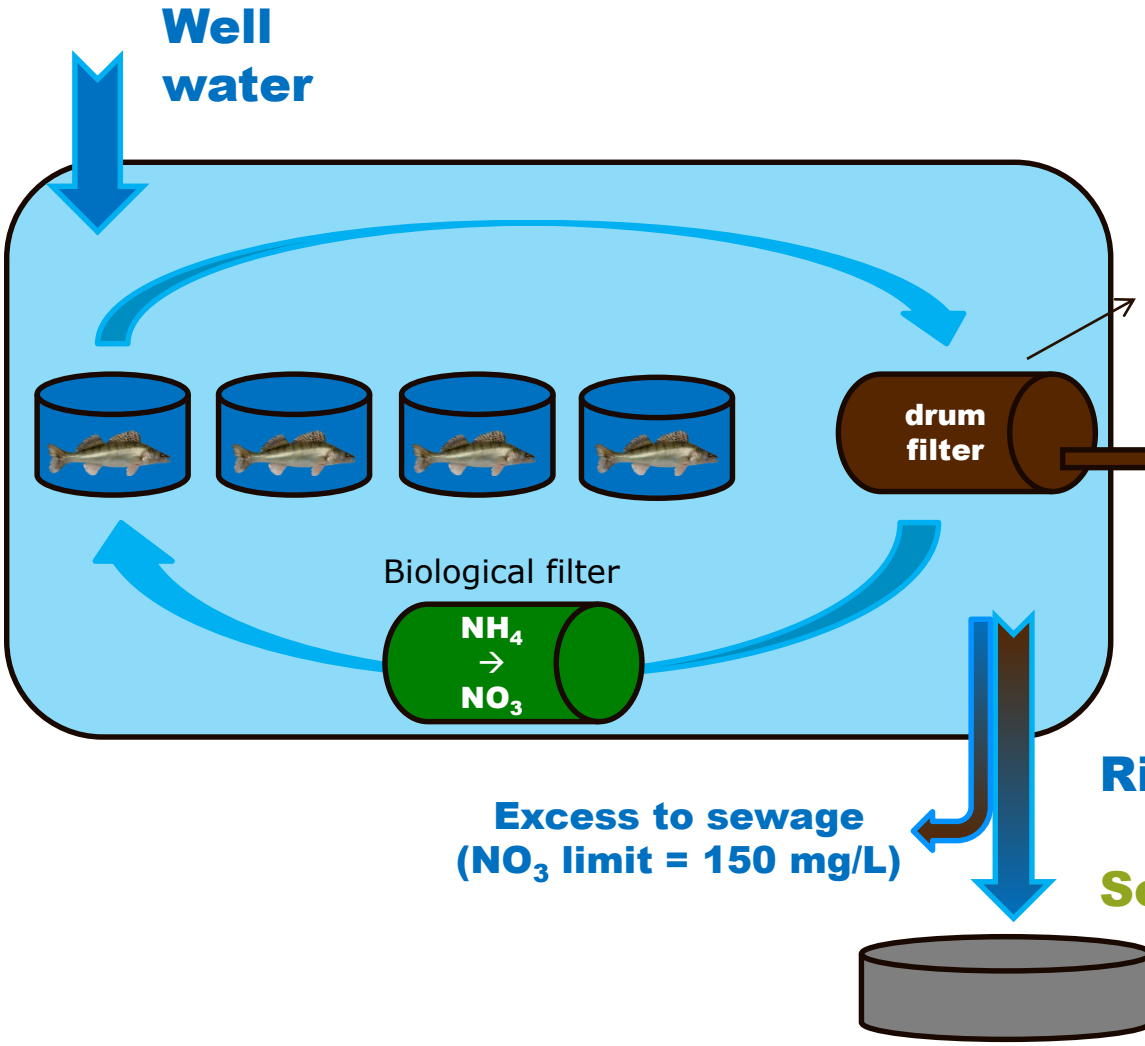
pike perch
(*Sander lucioperca*)

Recirculating system (RAS)

Water source:
superficial well water (5-10 m)
(EC = 0,8 mS/cm
contains Na (25-30 ppm), NO_3 (40 ppm) and Ca (120 ppm)

Details of the Inagro RAS





Characteristics of the tomato cultivation

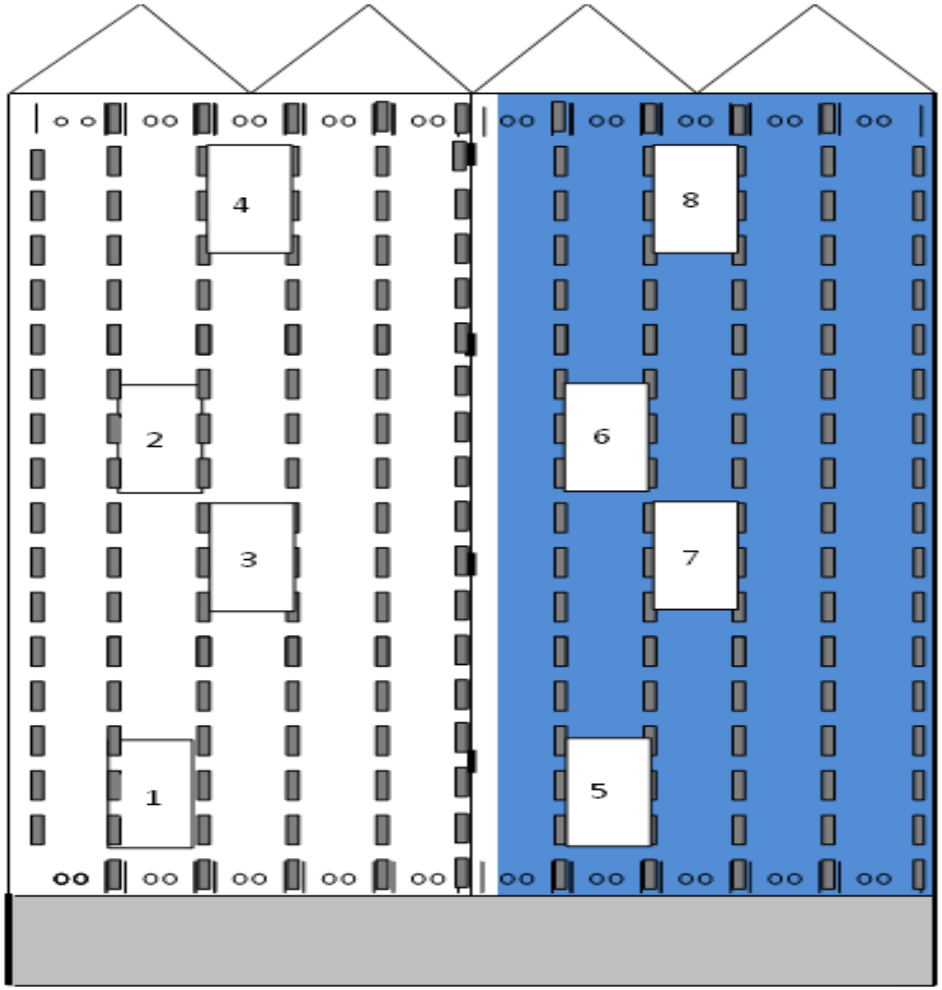
Greenhouse compartment of 320 m²

Variety: truss tomato Foundation (Bayer–Nunhems)

Substrate: rockwool

Reuse of drainage water

Experimental set-up tomato greenhouse



Standard nutrient solution

Fish water based nutrient solution

Standard nutrient solution:
made with rain water
+ 20% tap water

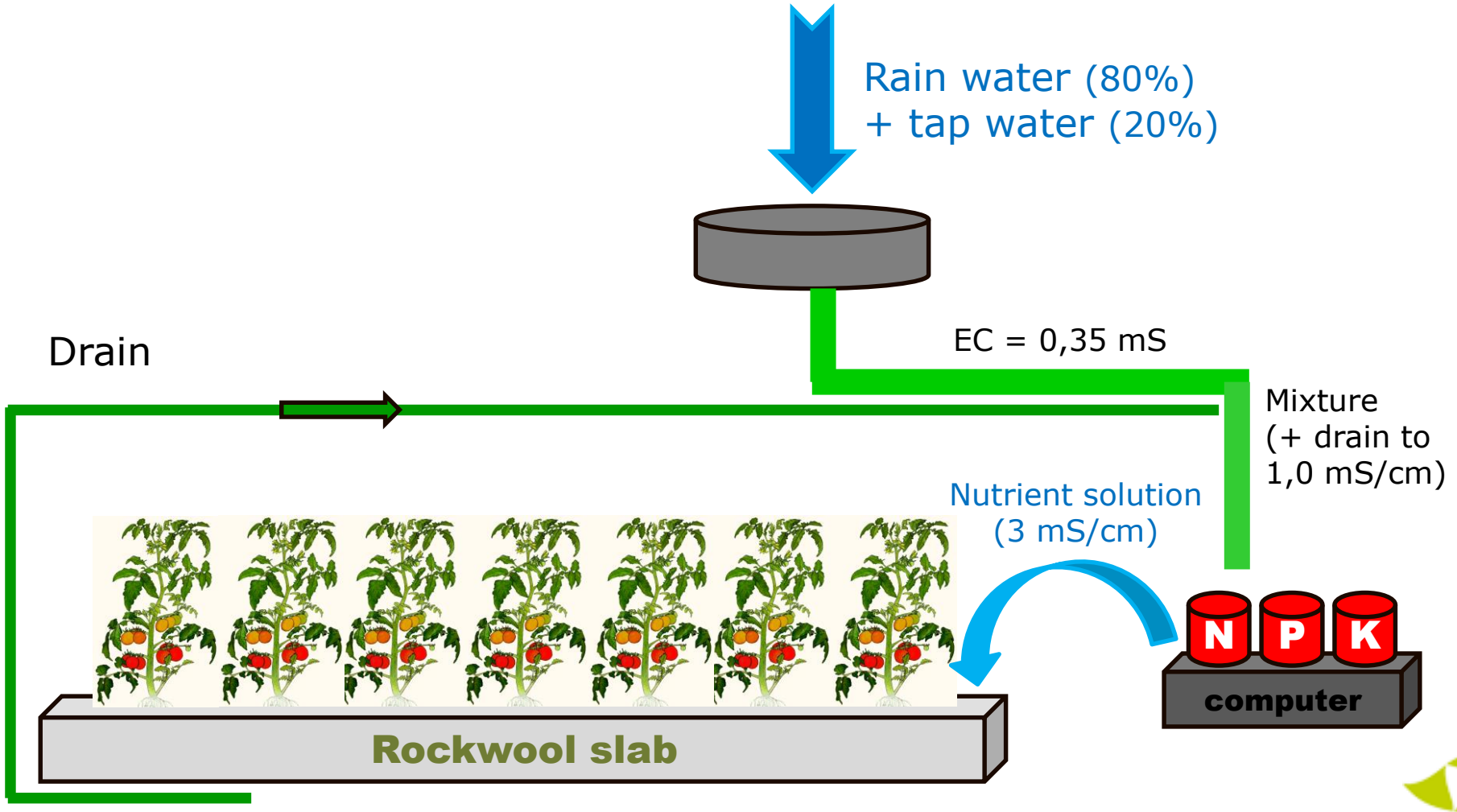
Experimental plots:
10 plants = 4,4 m²

Tomato planting:
January 6th

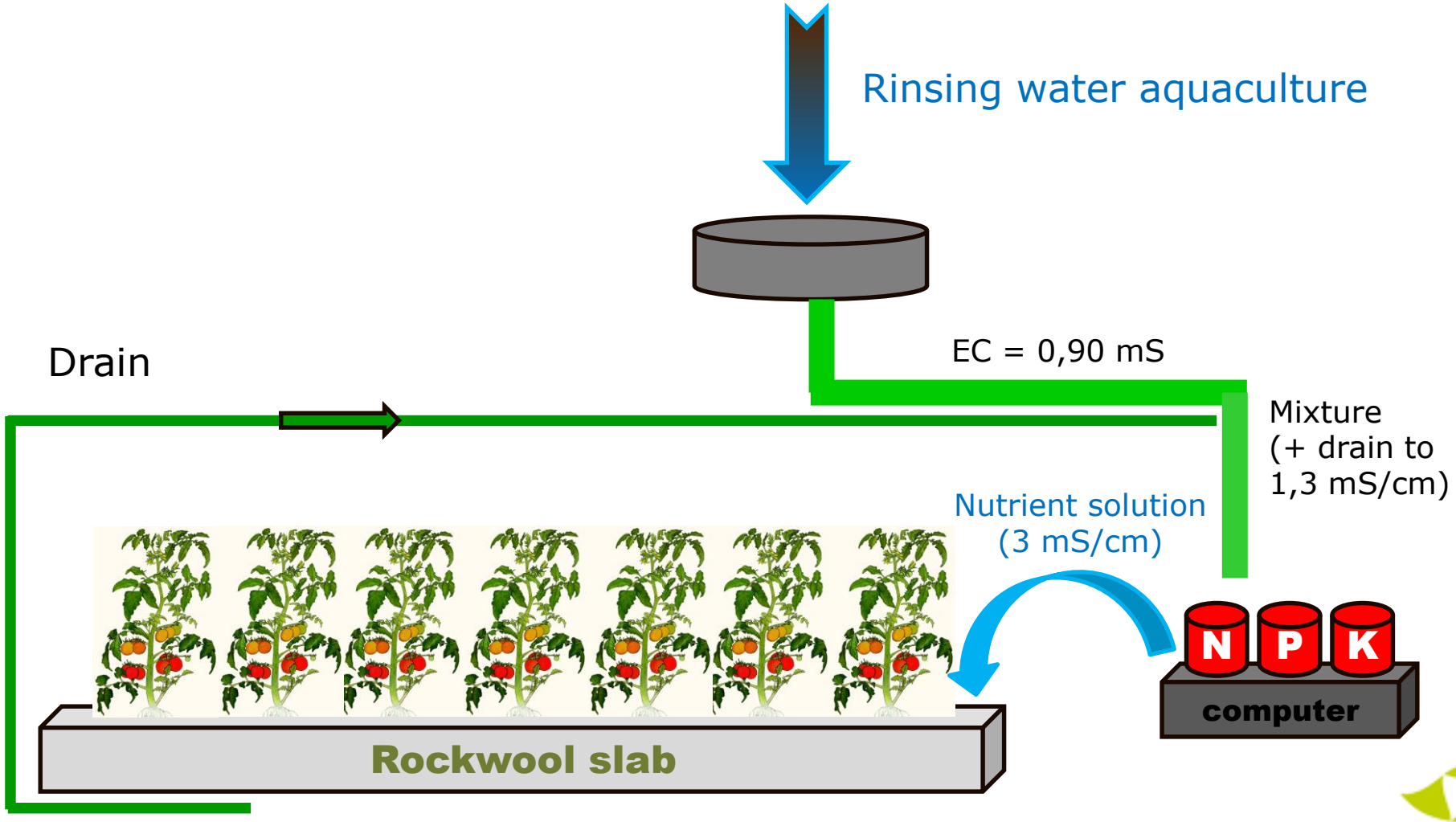
Start fishwater usage:
April 3rd

Harvest: 30/03 – 4/11

Treatment 1:
standard nutrient solution



Treatment 2:
= fish water based nutrient solution



Parameters monitored

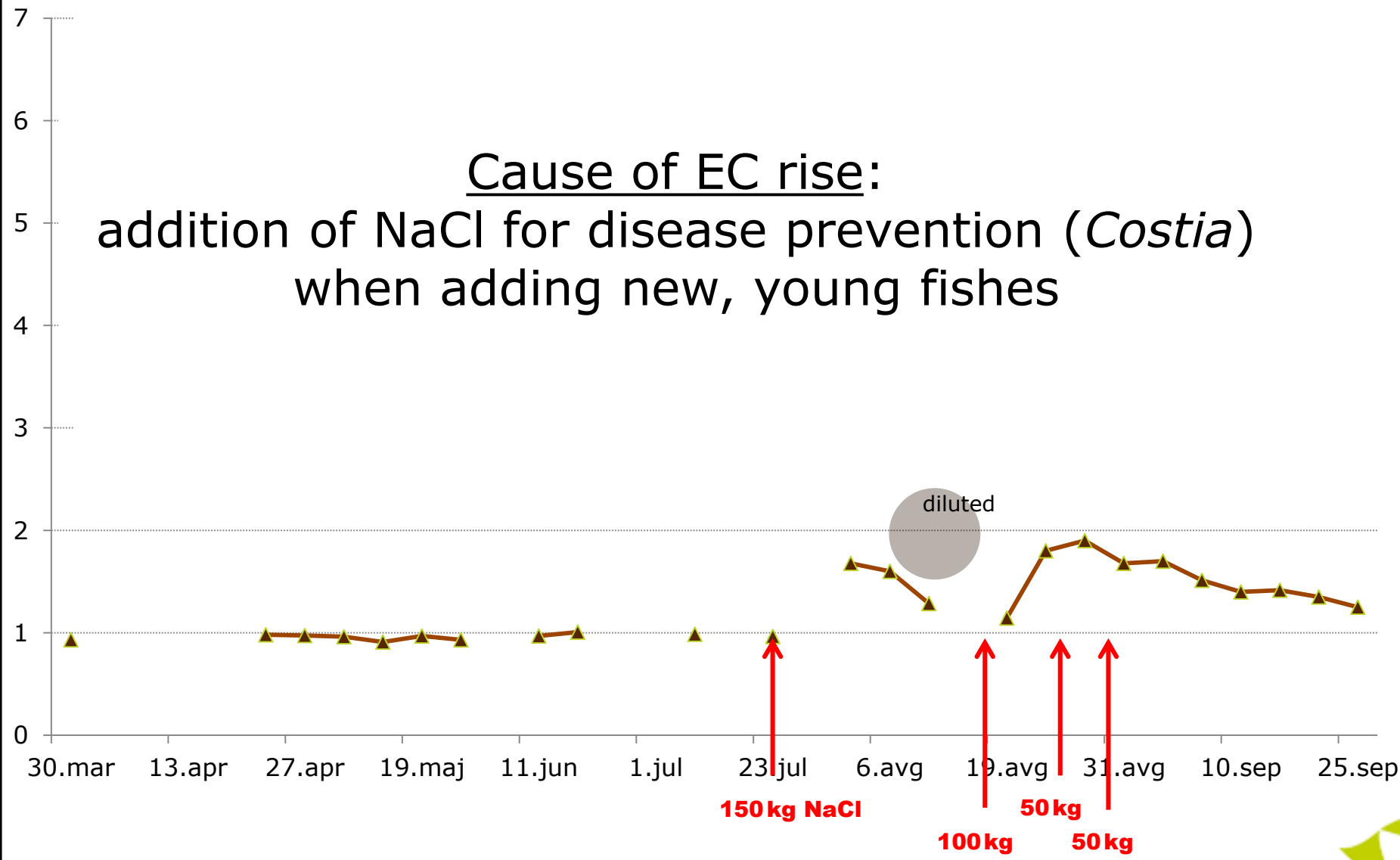
- Plant growth and development
- Tomato yield and quality
- Nutrient concentrations in the substrate (rockwool)

Results

Fish water: nutrient content

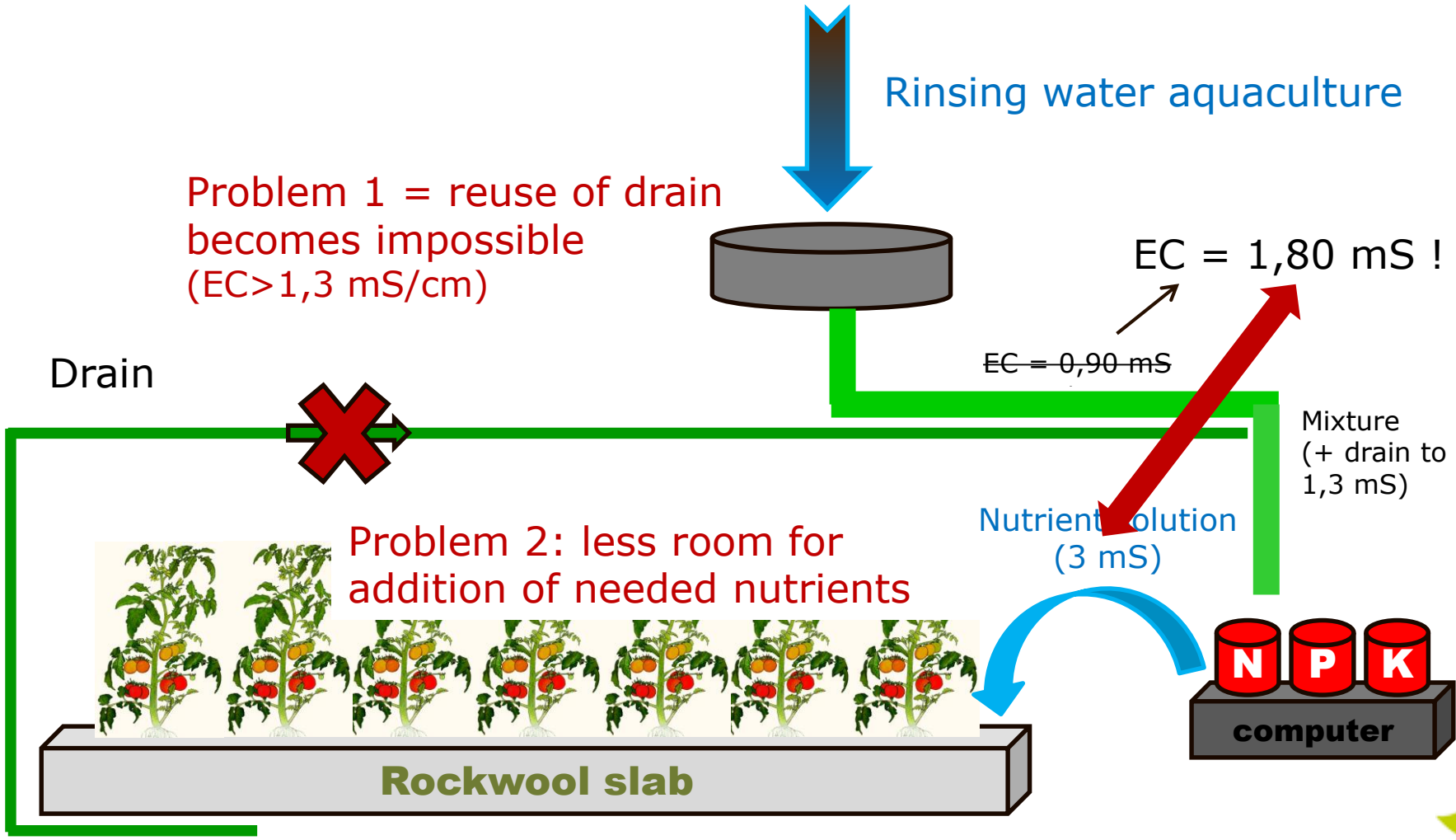
Nutrient	Content (mmol/L)
pH	7,70 – 8,00
NO_3	0,50 – 2,50
SO_4	0,80 – 1,35
PO_4	0,05 – 0,10
K	0,20 – 0,30
Ca	3,00 – 4,40
Mg	0,65 – 1,00

Evolution EC fish water (mS/cm)



Cause of EC rise:
addition of NaCl for disease prevention (*Costia*)
when adding new, young fishes

Treatment 2: fish water based nutrient solution
Problem of EC rise



Remediation of EC rise of fish water

Adaptation of settings:

6-14/08: dilution of the fish water with 50% rain water

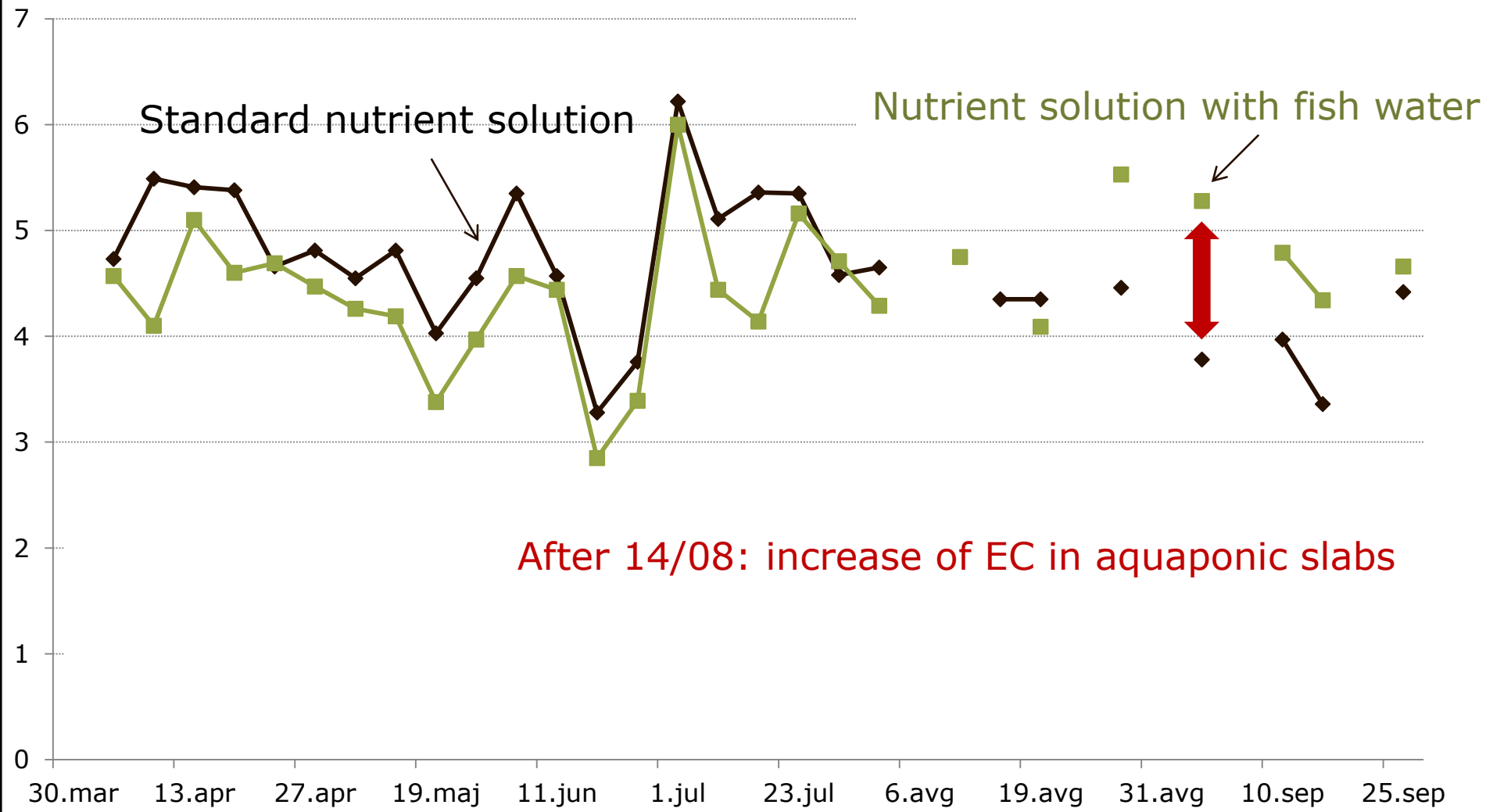
=> EC falls from 1,8 to 1,2 mS/cm.

Disadvantage: higher water consumption of the aquaponics system = opposite of project objective !

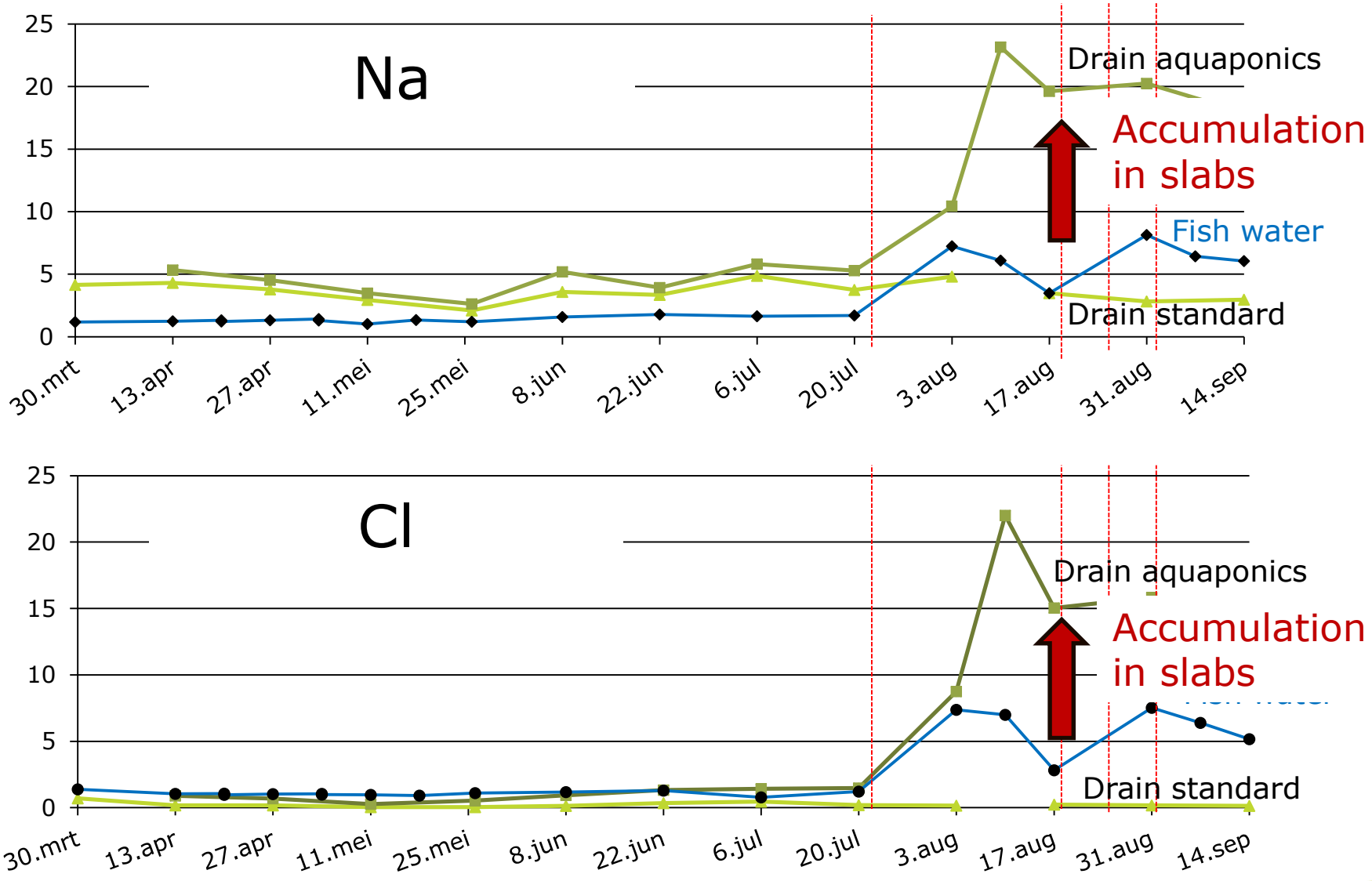
After 14/08: increase of EC nutrient solution from 3,0 to 3,8 mS/cm

+ increase of drain addition level from 1,3 to 2,0 mS

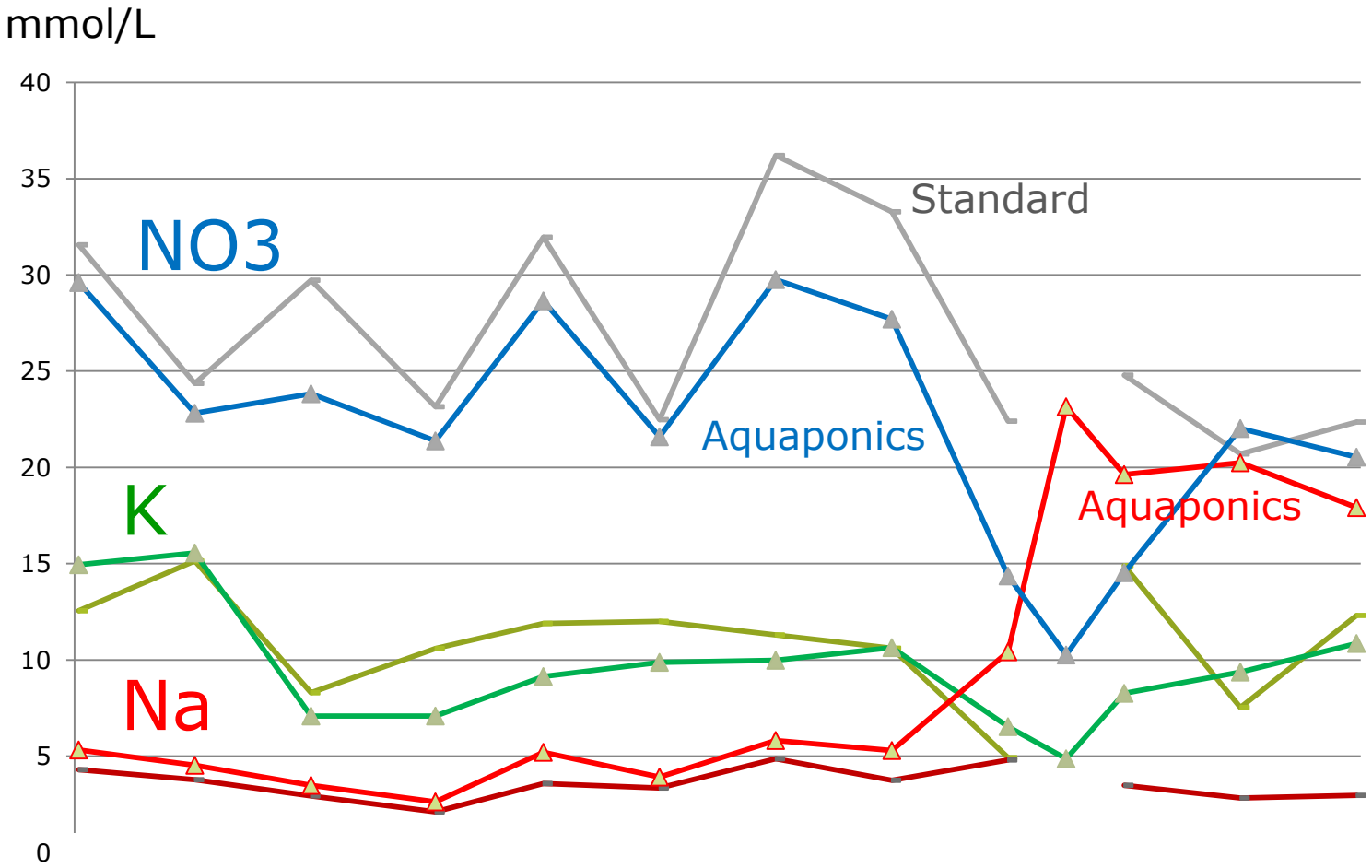
Evolution EC in rockwool slabs (mS/cm)



Evolution Na^+ and Cl^- in slabs (mmol/L)

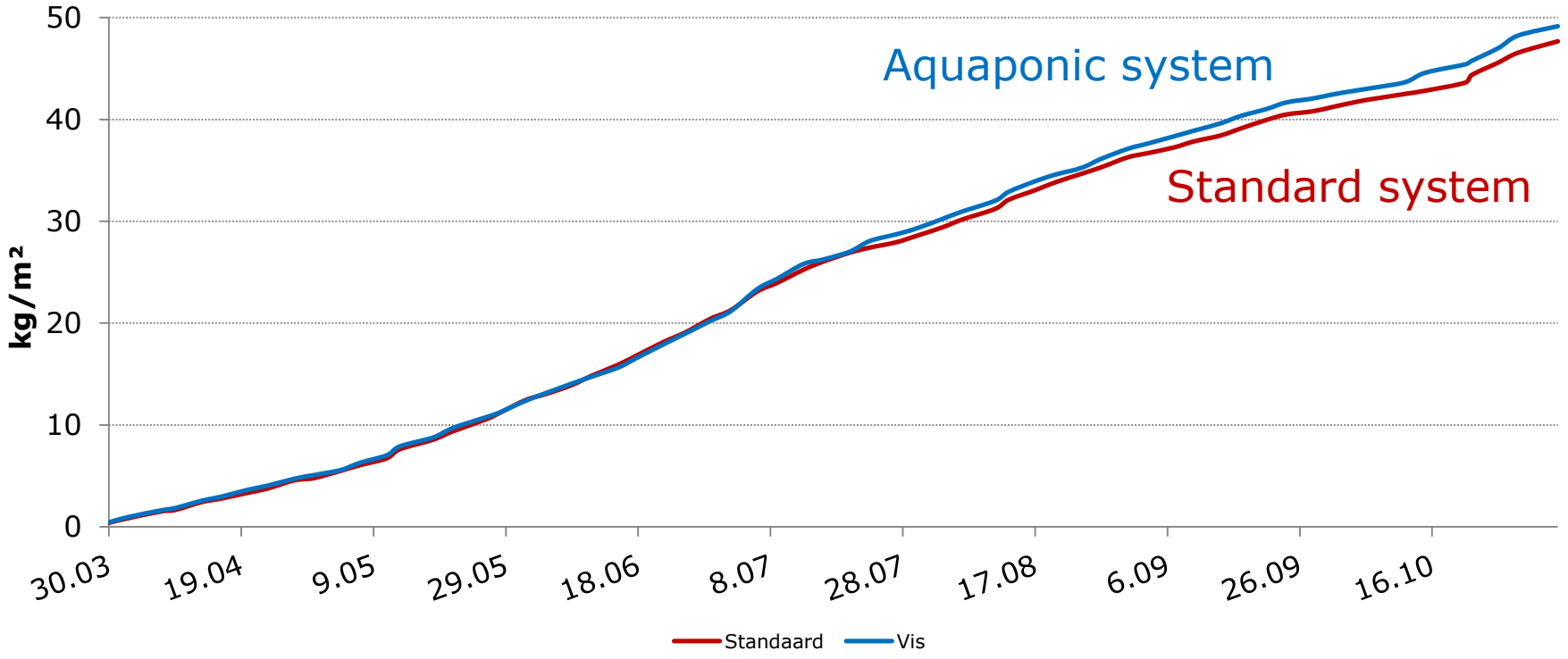


Evolution NO_3 and K in rockwool slabs



Nutrient content in the slabs was quite equal for both Standard and Aquaponic systems, with exception for Na and Cl

Tomato yield



Tomato yield and quality

Yield

- Standard system: 48,4 ± 1,71 kg/m²
- Aquaponic system: 49,5 ± 1,05 kg/m²

difference not significant (*t.test, p = 0,7842 – 4 repl.*)

Blossom end rot

- Standard s.: 0,36% ± 0,19%
- Aquaponic s.: 0,14% ± 0,19%

difference not significant (*t.test, p = 0,2121*)

Conclusion

At the management conditions of the experiment, use of aquaculture rinsing water for hydroponic tomato production was very well possible.

Points to improve

- Aquaculture system has high level of water consumption:
  much water is added in order to obtain fish water that can be released into the sewage system (NO_3<150 ppm)
- Periodic addition of NaCl to the aquaculture disables the possibility of reusing drainagewater in the hydroponic sytem

Adaptations for experiment 2016

Monitoring of water flows:

- Fish water to sewage
- Tomato drainage water to sewage

Aquaculture:

no longer pursuing release into sewage.
Less water addition for rinsing, resulting in higher nitrate content and higher EC.
Installation of a water storage tank to bridge periods with little demand by the tomato plants.

Adaptations for experiment 2016

Aquaculture:

Try out other products for disease control instead of NaCl.

Peroxides ?

Future:
replace well water, containing Na, by other water source, free of Na.

Thank you for your attention