INTERNATIONAL SYMPOSIUM ON ADVANCED TECHNOLOGIES AND MANAGEMENT FOR INNOVATIVE GREENHOUSES

GreenSys 2019

16th to 20th June 2019 ANGERS FRANCE

Reuse of cucumber drainage nutrient solution in 'secondary' crops in greenhouses: preliminary results

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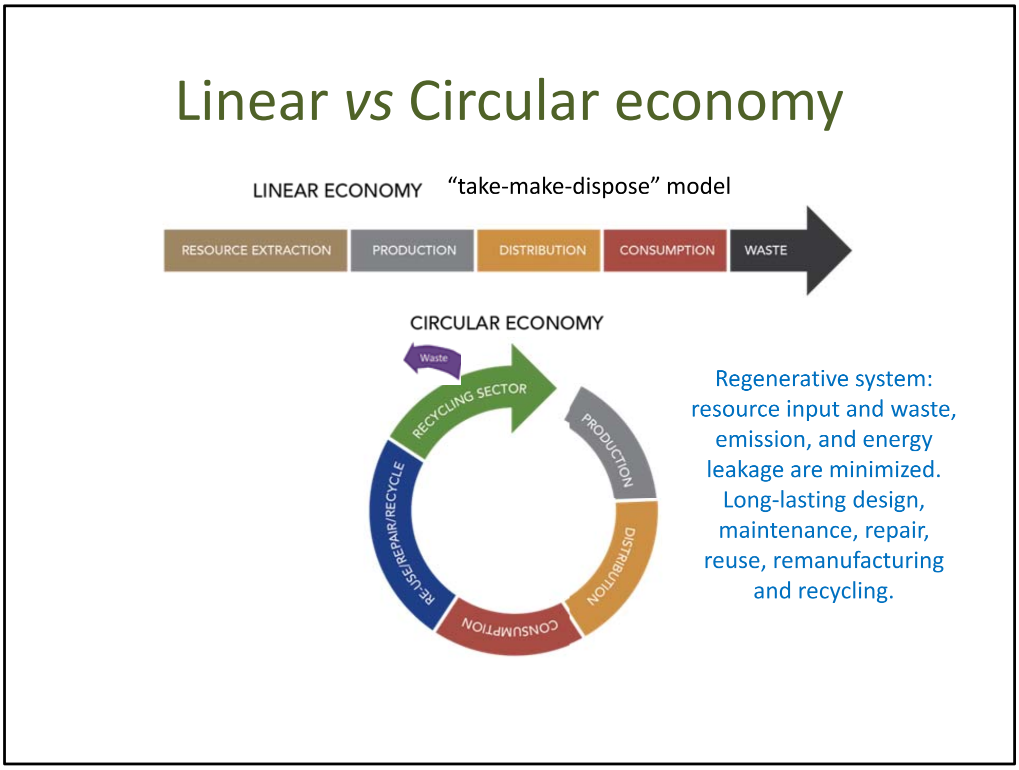
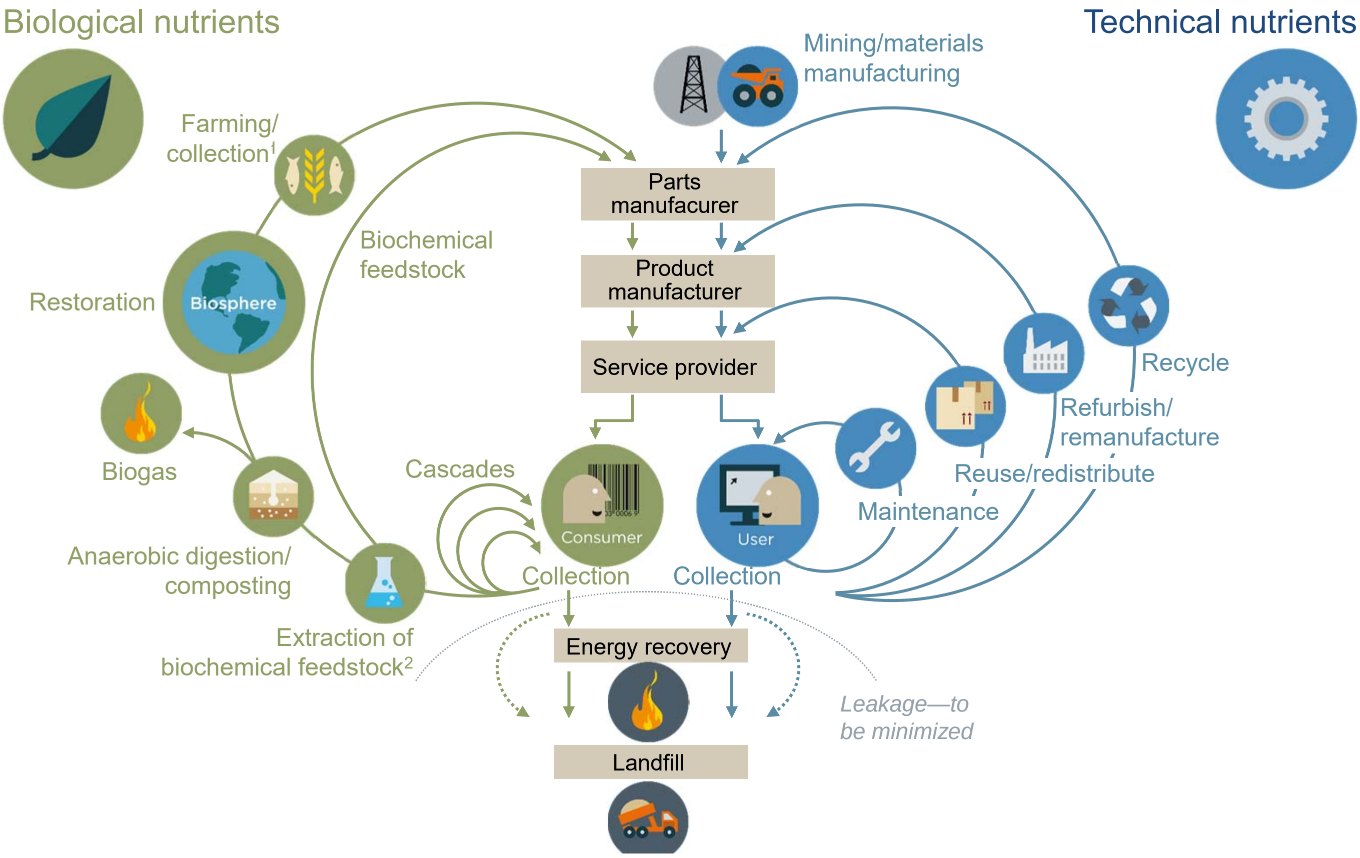
Co-financed by Greece and the European Union



The concept of a circular economy
In a circular economy the value of products and materials is maintained for as long as possible; waste and resource use are minimised, and resources are kept within the economy when a product has reached the end of its life, to be used again and again to create further value.

A circular economy is a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling.[1] This is in contrast to a linear economy which is a 'take, make, dispose' model of production
The term encompasses more than the production and consumption of goods and services, including a shift from fossil fuels to the use of renewable energy, and the role of diversity as a characteristic of resilient and productive systems. It includes discussion of the role of money and finance as part of the wider debate, and some of its pioneers have called for a revamp of economic performance measurement tools.

The circular economy



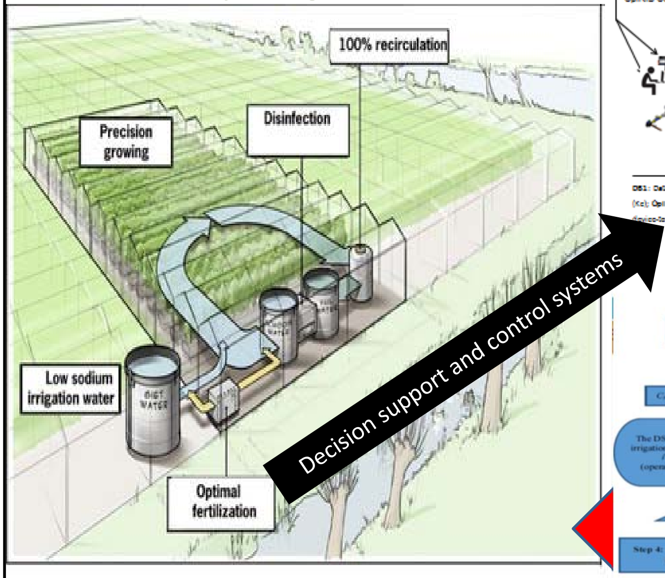
A circular economy is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times.
A concept that distinguishes between technical and biological cycles, the circular economy is a continuous, positive development cycle. It preserves and enhances natural capital, optimises resource yields, and minimises system risks by managing finite stocks and renewable flows. A circular economy works effectively at every scale.

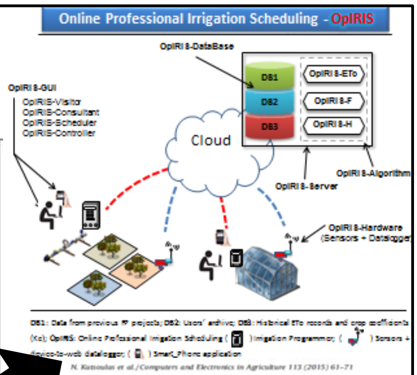
Inputs-waste: degree of circularity?

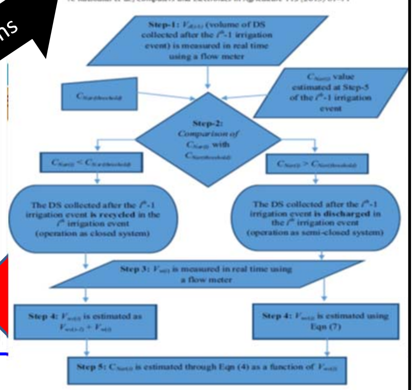
Input
Water
Nutrients-fertilisers
Energy
Soil-substrate
Plastic
Paper

Waste
Water
Nutrients-fertilisers
Energy
Substrates
Plastics
Biomass

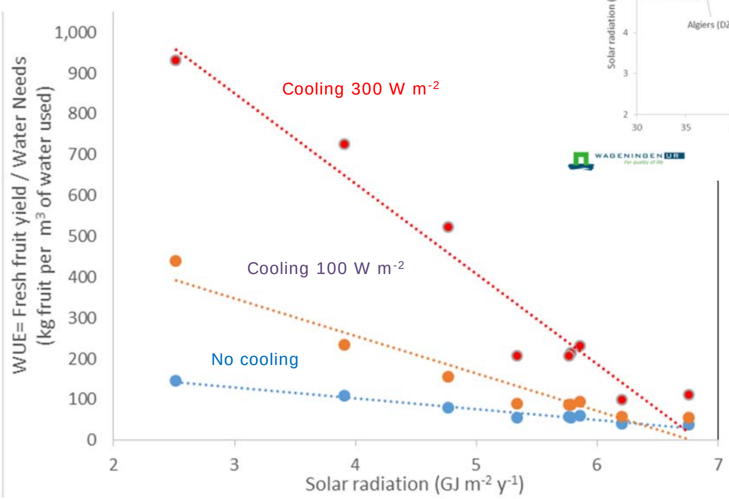
Water and nutrients circularity in greenhouses

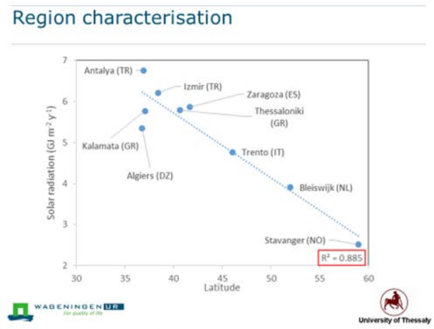




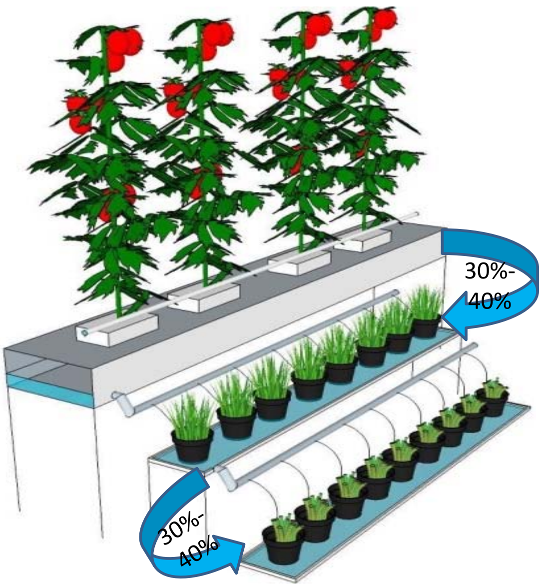


Effect of location on greenhouse WUE





Cascade hydroponics



The nitrogen balance for the two combined systems shows an important decrease in N leachate.

The adoption of the 'cascade' crop system reduced environmental impact for climate change category by 21%, but increased eutrophication category by 10% because of the yield reduction.
Muñoz et al. (2012)

From a greenhouse to an open field crop

Greece-Germany bilateral project:

Cascade Hydroponics: an integrated approach to increase productivity, resource use efficiency and sustainability of protected cultivation-CasH

- Develop and investigate “cascade” fertigation approaches as novel, integrated production concepts for intensive greenhouse soilless horticulture.
- Tomato and cucumber will be used as main (=”primary”) crops, less demanding,“secondary” crops (e.g. basil) will be integrated and fertigated using the drainage nutrient solution of the primary crop. Salt tolerant vegetables will conclude this serial production system at the “downstream-end” as the “tertiary” crops.

Co-financed by Greece and the European Union

Objective of this work

- Creation of multiculture hydroponic system and reuse the drainage solution of a “primary” crop for the fertigation of a “secondary” and “tertiary” crop so that drainage leaching to the environment is minimized.
- Assessment of “secondary” crop productivity (basil, rosemary, mint)

MATERIALS AND METHODS

Greenhouse facilities

Experimental farm of the University of Thessaly, Volos, Greece
(39º 44' N, 22º 79' E)

- Plastic single-span greenhouse, 160 m^2
- Experimental period: September to December

- Soilless crop in perlite slabs
- Fertigation and drainage management automatically controlled

Plant Material

- **Main crop:** cucumber (*Cucumis sativus*)
  - 2 crop lines: 2 plants/m^2

  Target EC=2.8 dS m^{-1} and pH=5.6

- **Secondary crops:**
  - Rosemary (*Rosmarinus officinalis*),
  - Basil (*Ocimum basilicum*) and
  - Mint (*Mentha* x piperita)

- **3 fertigation treatments:**

  plants irrigated with
  - FS: standard nutrient solution
  - D+FS: 15% drainage solution + 85% standard solution (15 - 85)
  - D+W: 30% drainage solution + 70% water (30 - 70)

  - Each treatment: 3 slabs/crop (totally 9 perlite slabs/line)
  - 3 plants/slab (totally 9 plants/crop/treatment)
  - 2 replications (totally 18 plants/crop/treatment)

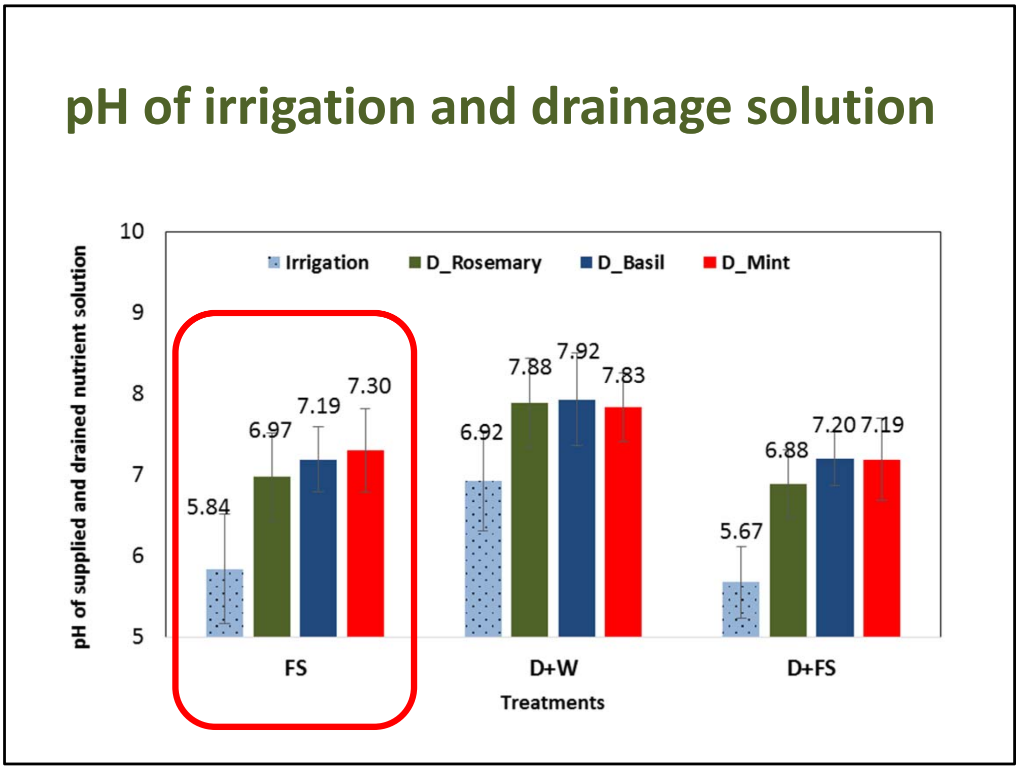
Measurements

- **Irrigation and drainage solution:**
  Electrical Conductivity, pH, volume of water supplied and drained from the primary and secondary crops, nutrients concentration
- **Plant measurements:**
  Plant height
  Fresh-Dry matter
  Nutrients content

New greenhouse

New greenhouse

RESULTS

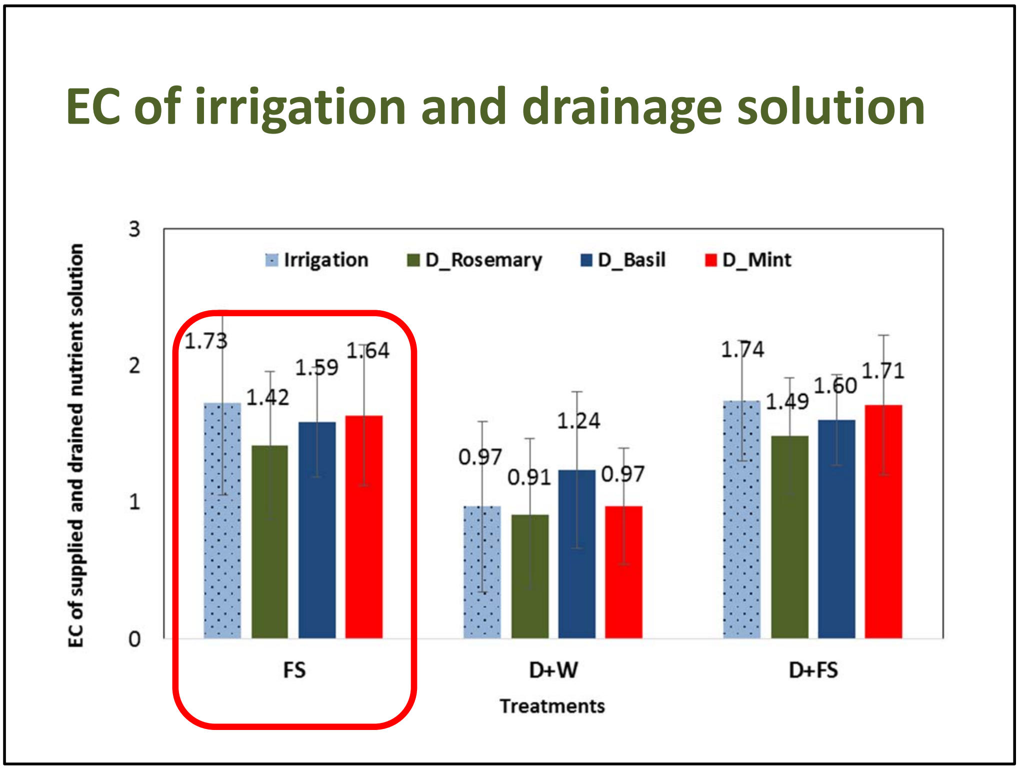


In treatment FS, the pH of the drainage solution significant increased around 19% in rosemary, 23% in basil and 25% in mint ($p<0.05$) from the mean values of the irrigation solution.

Similar increases equal to 21%, 26% and 27% were performed to drainage solution run off from rosemary, basil and mint, respectively cultivated in treatment DFS ($p<0.05$).

On the other hand, in case of treatment DW, less but still significant, was the pH variation observed between the irrigation and drainage solution. Therefore, in each drainage solution the pH was slightly alkaline, higher than 7.

Similarly, to pH trend followed the EC values. Overall, the EC values of basil and mint crop followed more less the same trend.



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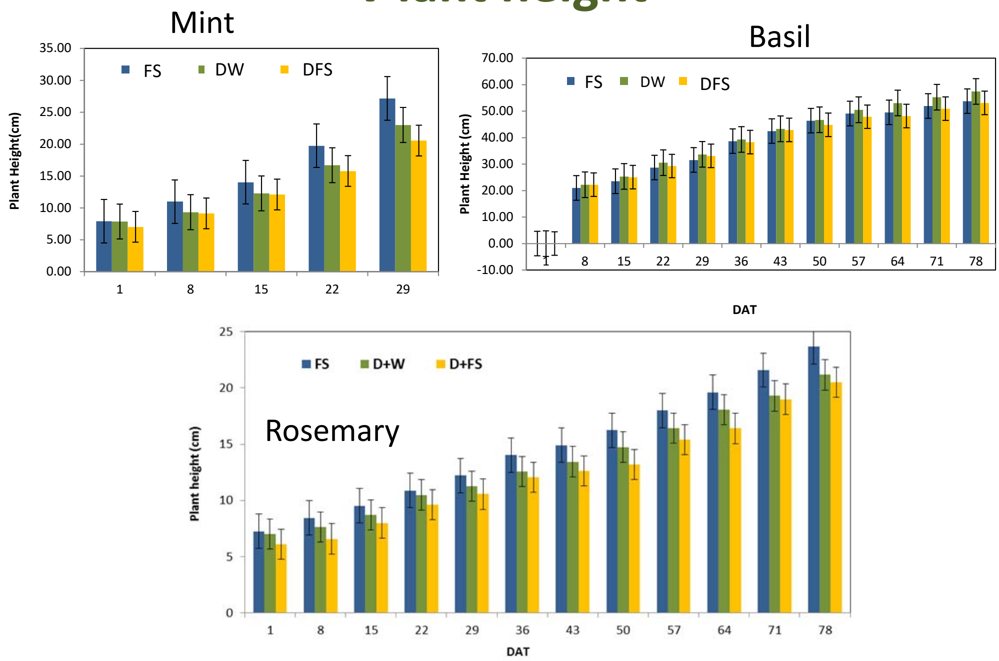
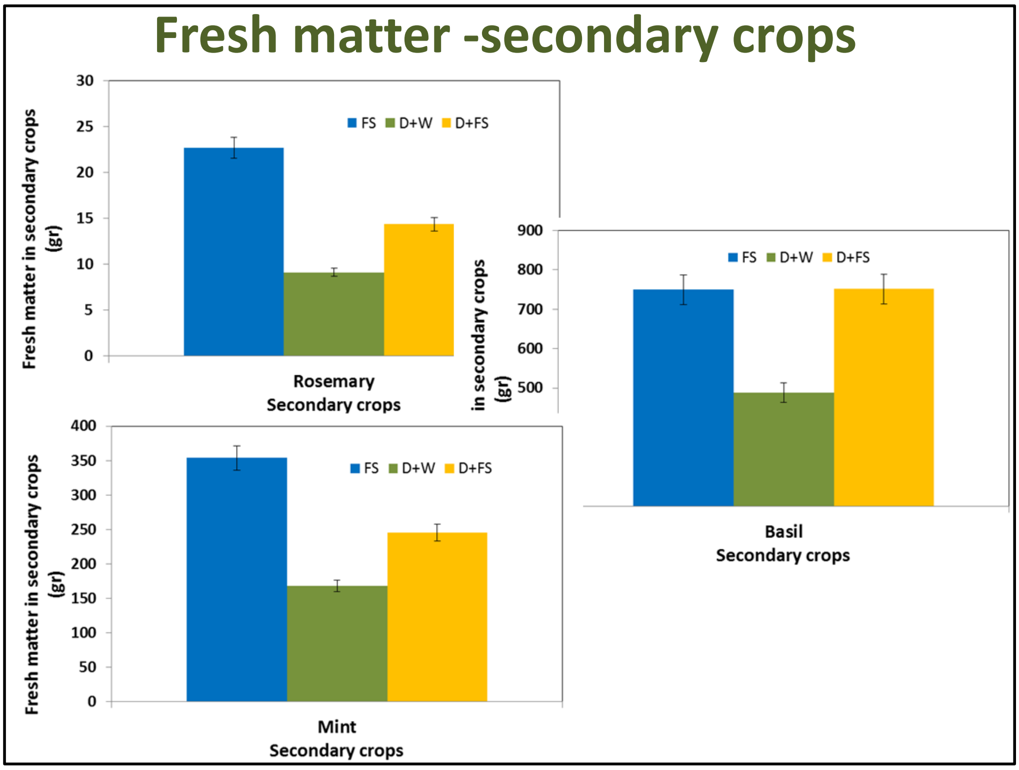
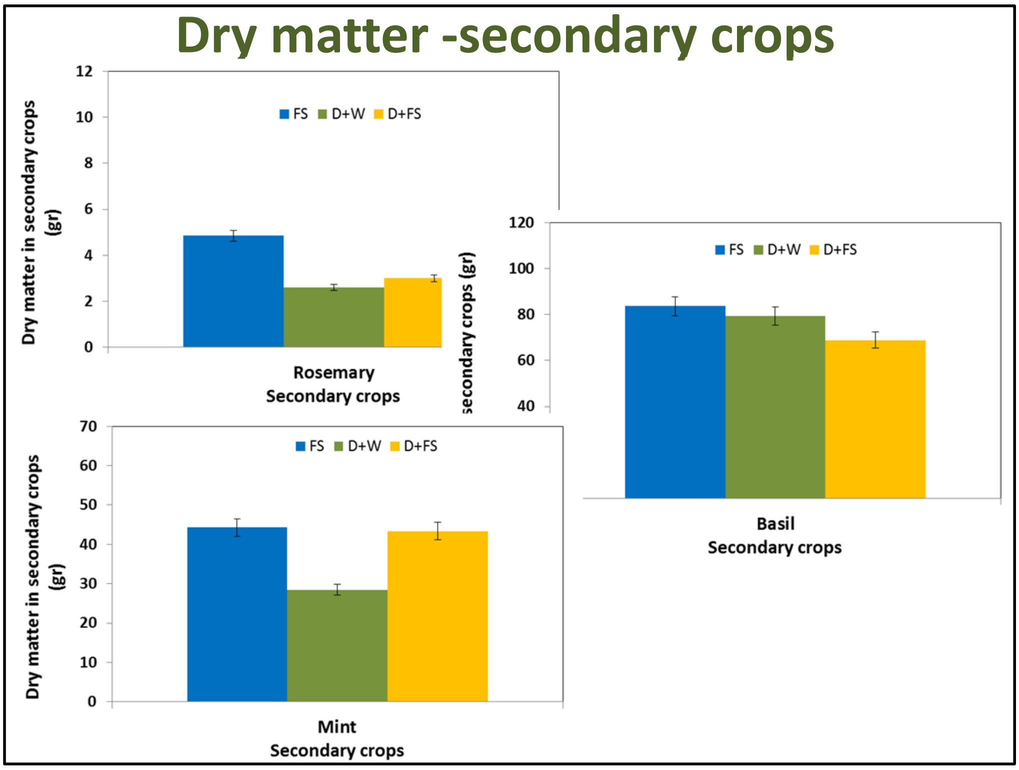
Plant height





The fresh mass (gr) for each treatment and crop at the end of crop cycling is shown below.
the plants irrigated with FS and DFS solution produced more fresh mass than the plants irrigated with DW solution



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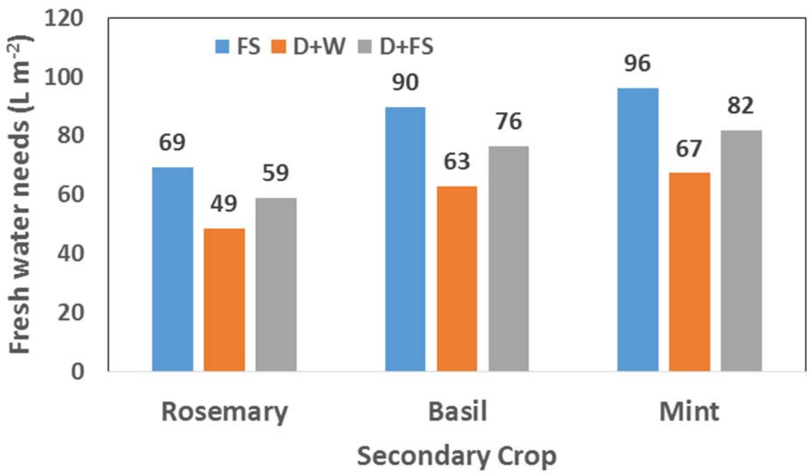
Water needs



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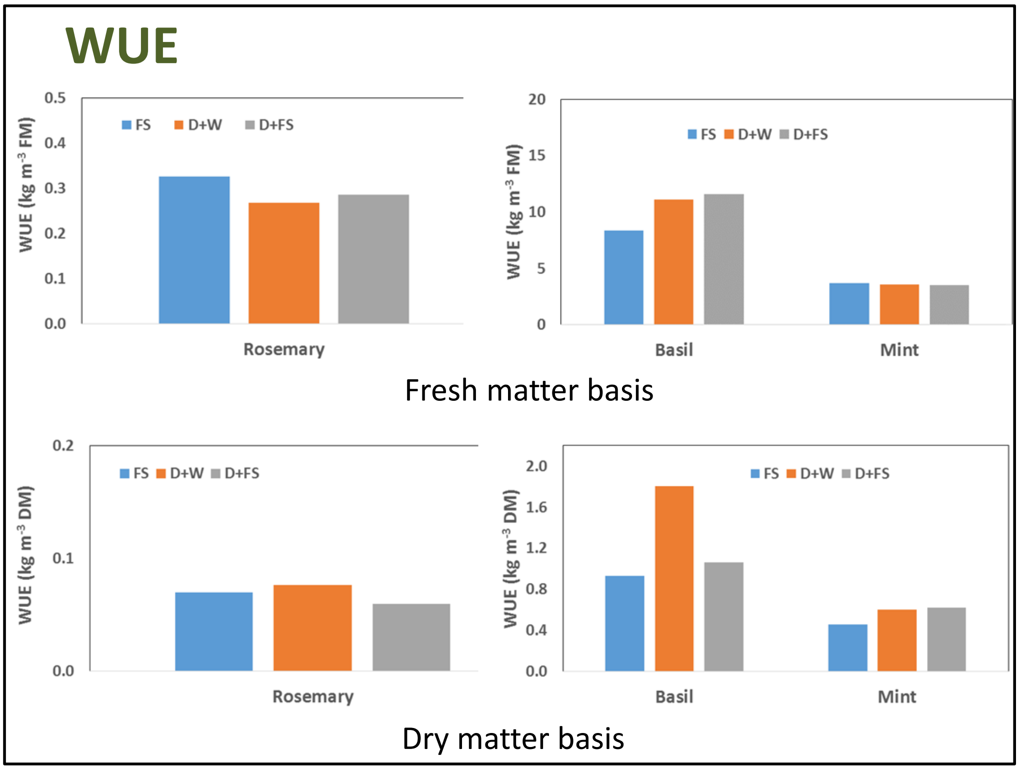

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Concluding remarks

The cascade system

- decreased the needs for fresh water in the secondary crops
- decreased the fresh biomass produced
- did not significantly affected the dry matter production
- did not affected or increased the WUE

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UNIVERSITY OF THESSALY

ANY QUESTIONS
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Hochschule Geisenheim University

The work is carried out in the frame of the CasH project that is co-financed by the European Union and Greek national funds through the bilateral Greece-Germany S & T Cooperation Program, Competitiveness, Entrepreneurship & Innovation (EPANEK) (project code: T2DGE-0893).

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