GHG assessment of aeroponic lettuce cultivation

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The aim is to…

Evaluate greenhouse gases (GHG) emissions

Resulting from

aeroponic lettuce cultivation

Aeroponic cultivation in general is …

- The most modern method of farming technology

- vegetables grow faster

- zero run – off (dripping) to the environment (in closed-loop systems)

Advantages

- environment rich in oxygen for plant roots
- low requirements in water, nutrients, pesticides & energy

- **reduces usage of :**
  - water
  - Fertilizer
  - pesticides

- **also :**
  - rapid growth & maturation
  - higher plant density
  - Increased yields year round at least 30% more than hydroponics

- **Is a:** green technology
- **With:**
- Disease-free environment
- Zero environmental pollution
- ideal working conditions
- healthier and potentially more nutritious products

exist and some disadvantages

- ✓higher initial cost
- ✓lack of farmers expertise in new technologies
- ✓sensitive system
- ✓demands back up system with electric generator
- ✓demand continuous control for pH and nutrient density ratios

Plants and roots

- maximize their yields

- hanging in the air in closed trays
- sprayed with water and nutrients

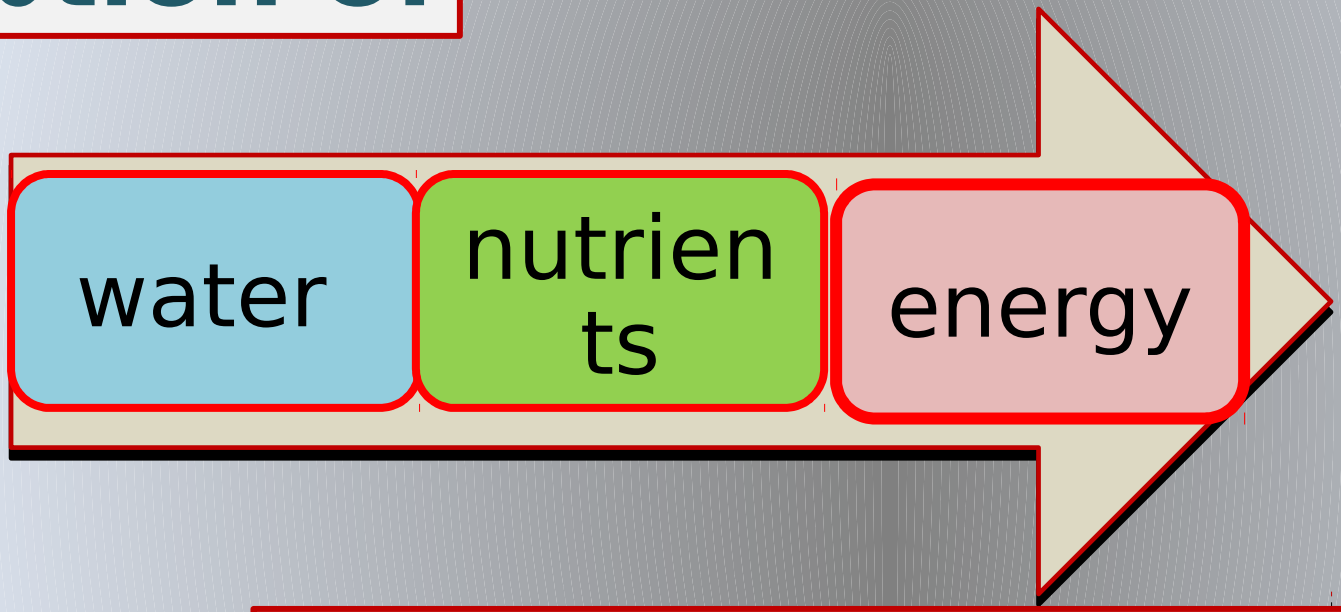
with

- droplets and help of high pressure (mist)

Because plants

maximize their yields

Consumption of



is kept to a minimu

Case study: aeroponic lettuce cultivation

3 cultivations conducted: K1, K2, K3

K1

in winter with 480 plants, yield 120 kg and days of cultivation 36

K2

in spring with 720 plants and yield 226.8 kg with cultivation days 43

K3

in autumn - winter with 950 plants and yield 279.3 kg and days of cultivation 42.

Location: Amaliada, Western Greece

- Department of Agricultural Science, University of Patras

- Automatic greenhouse
- Electronically controlled system

Data collection

Focus

- on the consumption of water
- nutrients &
- energy

Also other estimated

- construction of
  - greenhouse &
  - control room
- distance of seedling transportation

Description of system

1

- controlled electronically

and

Prepares & make different nutrient solutions for various treatments at same time

2

- the system is closed-loop

So…

no dripping

to the environment

3

- contains a drain tank

So..

drained solution collected, rectified and reused

4

- used zero pesticides and fungicides

Only

Nutrient solution decontamination

Plant roots

5

- hung in a canal (vessel) and watered by spraying the nutrient solution onto them

And they

6

- sprayed for 30’’

every 5’during daytime

&

every 10’during night

Canals - vessels

7

- placed with a slight slope for natural flow for drainage

&

8

- In the up side of the canals polysterene sheets are placed and plants, planting in holes with special plastic pots and neoprene discs

Heating - lighting

9

- The greenhouse does not need heating for the requirements of lettuce

But

10

- The fixable temperature is that of the nutrient solution to the root system.

That

adjust the root zone atmosphere temperature offering ideal root growth conditions for each plant species

11

- natural lighting

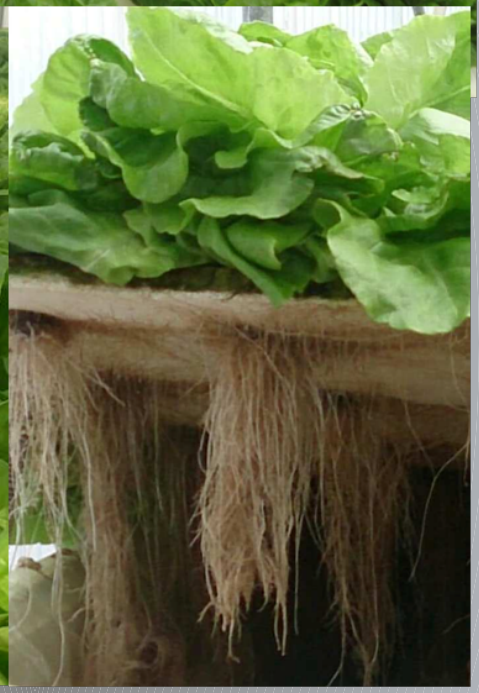
Life Cycle Assessment

LCA was used to evaluate the three cultivations of lettuce

Impact assessment

with Simapro 8 software and CML 2 impact assessment method

Aeroponic lettuce cultivation



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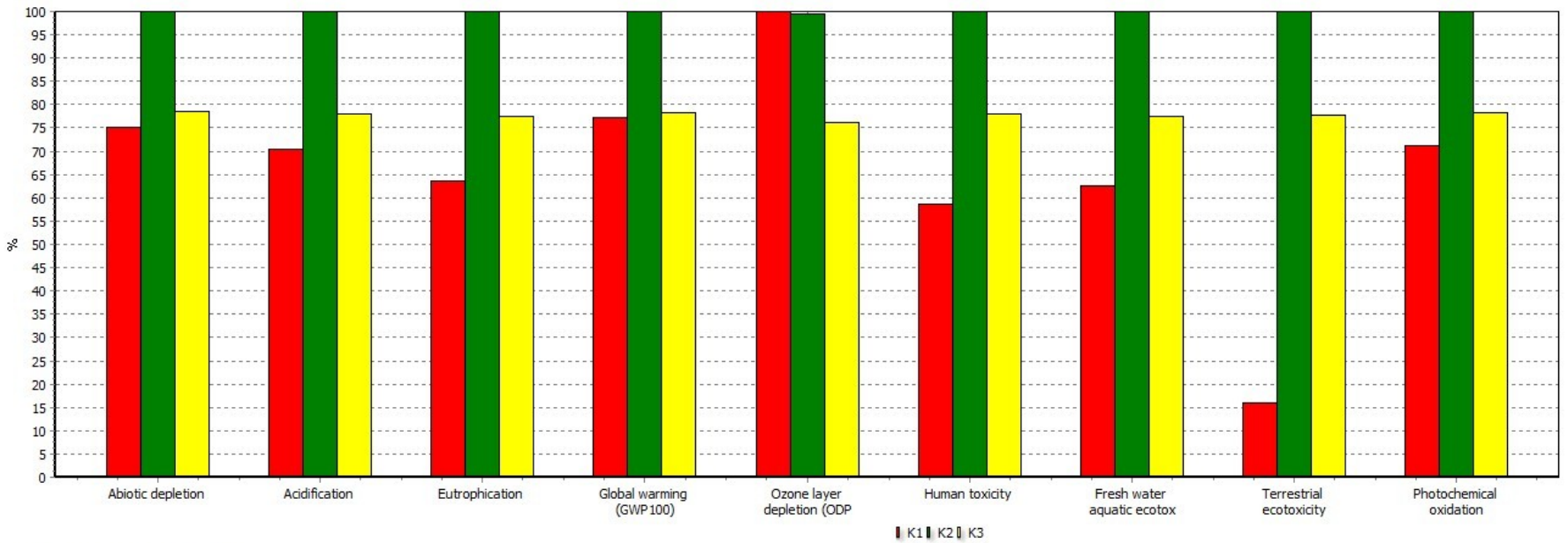
K1, K2, K3 characterization



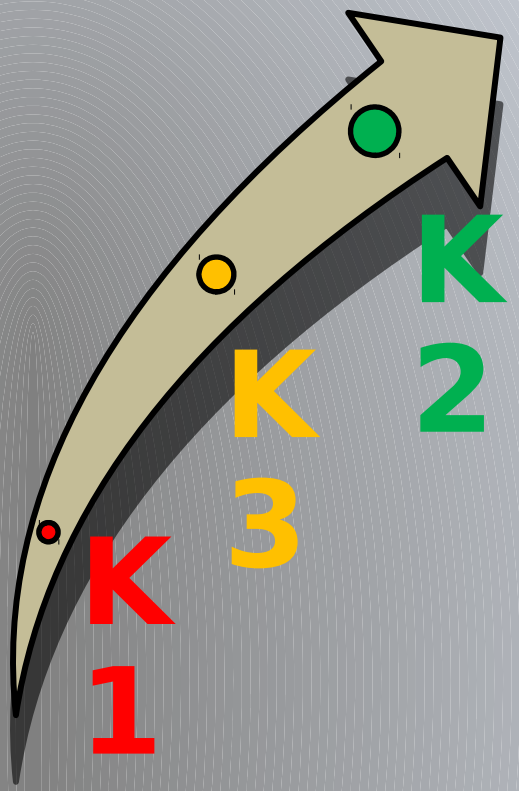
Comparing 1 p 'K1', 1 p 'K2' and 1 p 'K3';
Method: CML 2 baseline 2000 V2.05 / World, 1990 / Characterization

characterization

K1 with fewer plants, has the smallest carbon footprint

K2 consumes more water and energy because of the seasonal planting, has the highest carbon footprint in comparison with the other two cultivations

K3 with most plants of all, affected somewhat the same with K1, because of the yield and seasonal planting, as also the carbon footprint was about the



Results per kg of lettuce

general

K2 > K3 > K1

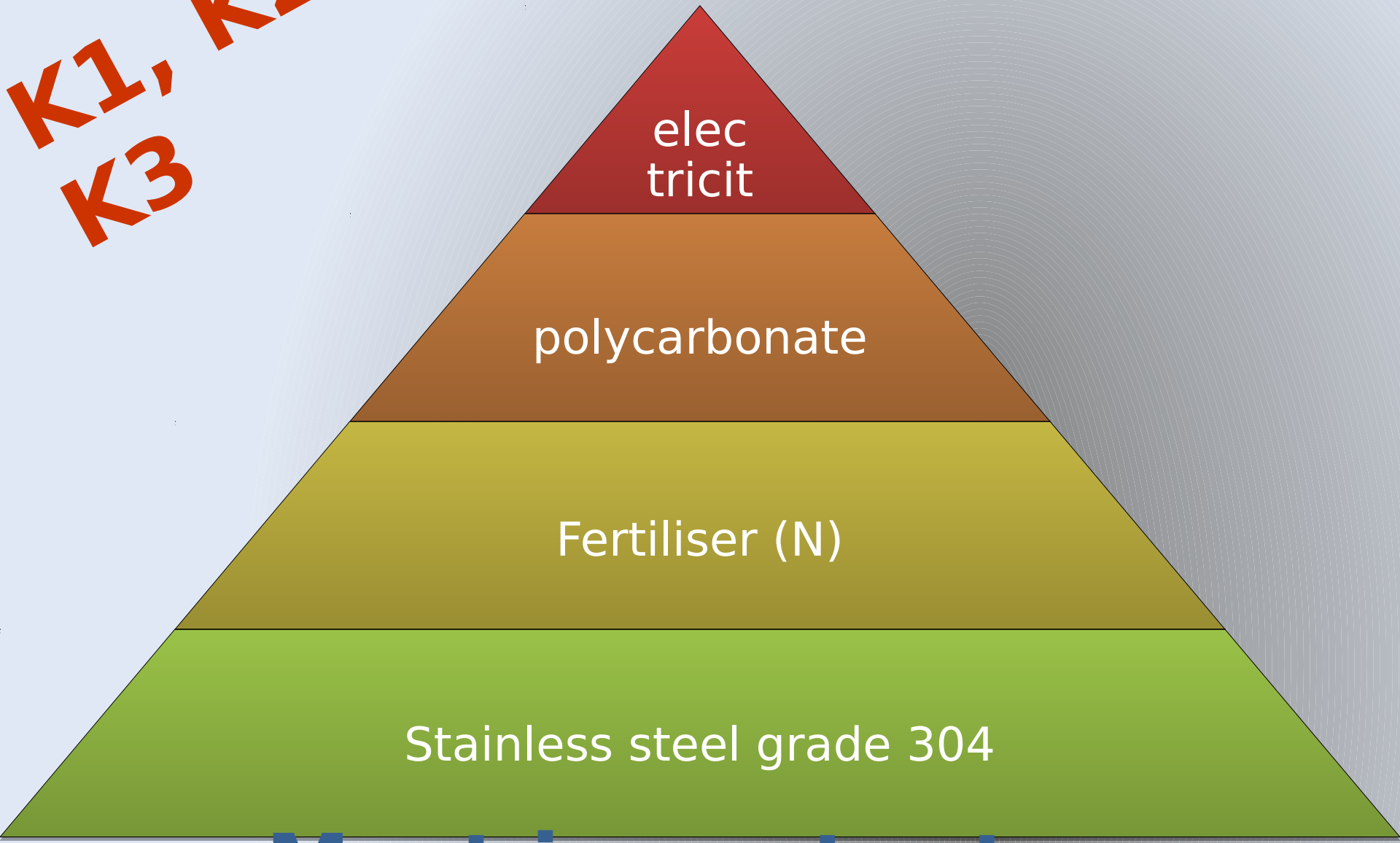
based on the kg CO_2 eq

Impact category	Unit	K1	K2	K3
Global warming (GWP100)	kg CO_2 eq	**2.14**	**2.77**	**2.17**

Product yield

K3 (279.3 kg), K2 (226.8 kg), K1 (120 kg)

K1, K2, K3



Most important processes

characterization and normalization showed

That for K1, K2, K3

Electricity input

was the most significant process in all impact categories

Comparison of results with other relevant studies

Literature review reveals a lack of relevant quantitative studies

Sanyé-Mengual E.et al (2015)
Bologna, Italy between 2012 and 201

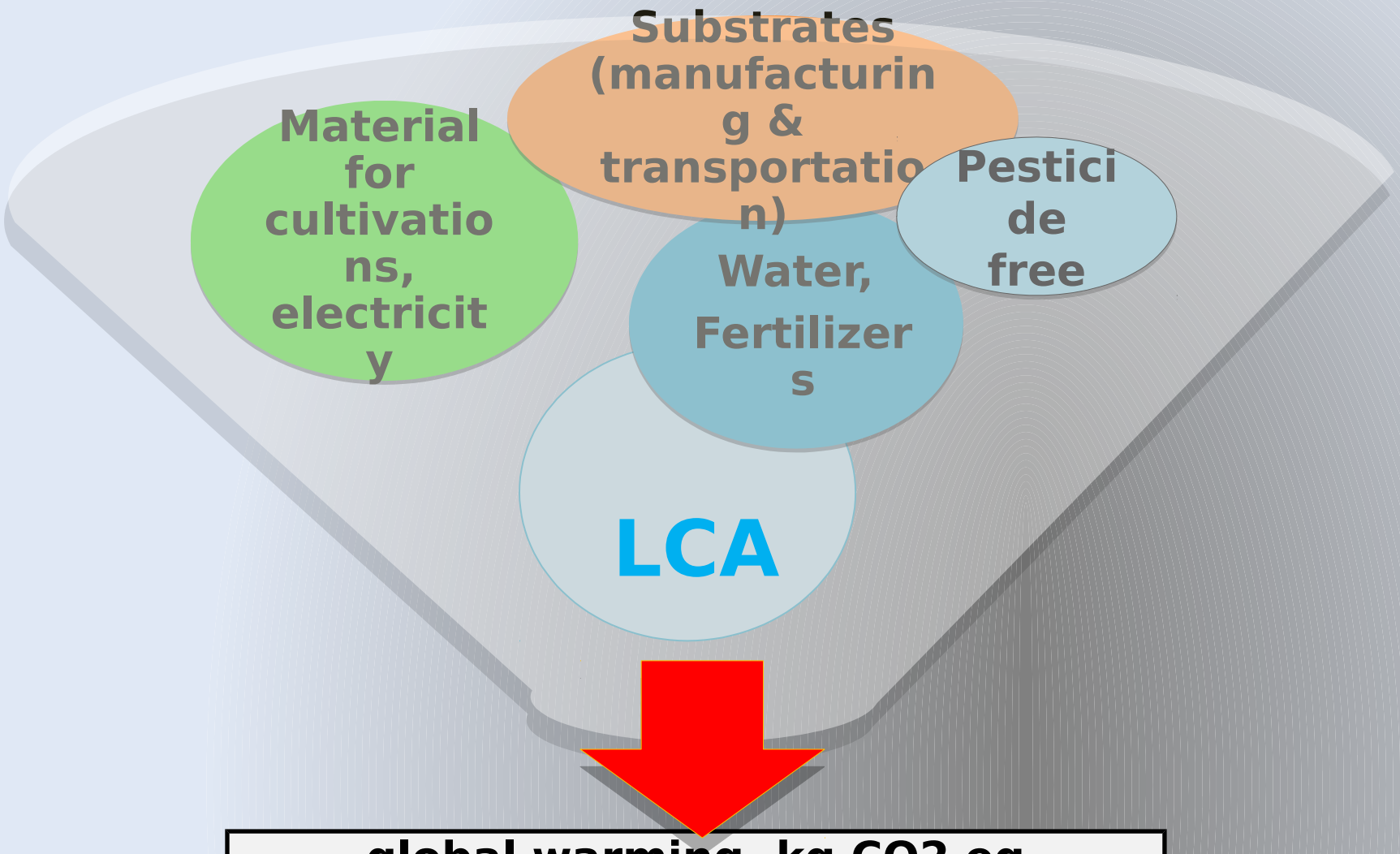
urban agriculture

on the top floor (roof) promotes local food production

Lack of studies

3 different techniques

- ✓ Nutrient film
- ✓ floating hydroponic
- ✓ soil cultivation



global warming, kg CO2 eq			
period	NFT	Floating	soil
2012 (summer)	2.51	0.567	-
2013a			

Comparing

global warming, kg CO2 eq			
period	NFT	Floating	soil
2012 (summer)	2.51	0.567	-
2013a (summer)	4.88	1.19	-
2013b (autumn)	3.97	1.08	0.323

Kg

eq		
K1 (winter)	K2 (spring)	K3 (winter)
2.14	2.77	2.12

Our results are comparable with NFT and floating hydroponic

Conclusions

- An LCA has been conducted for aeroponic lettuce cultivation in Greece
- The results indicate that aeroponic cultivation is a low environmental impact process
- Electricity usage is the key process contributing to the GHG emissions of the aeroponic cultivation

Proposals

or improving the environmental impacts

- ✓ replacement with electricity from renewable sources
- ✓ usage of greenhouse with lighter construction

The greenhouse that was used to conduct this research is for experimental purposes and its construction is complicate, overburdened in structures and expensive.

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Thank you for your attentio

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