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K, MG, CA, NA BALANCES IN A CLOSED SYSTEM COMBINING AEROPONIC LETTUCE CULTIVATION SUPPLIED WITH GREY WATER

MELISSA CONFERENCE 2020

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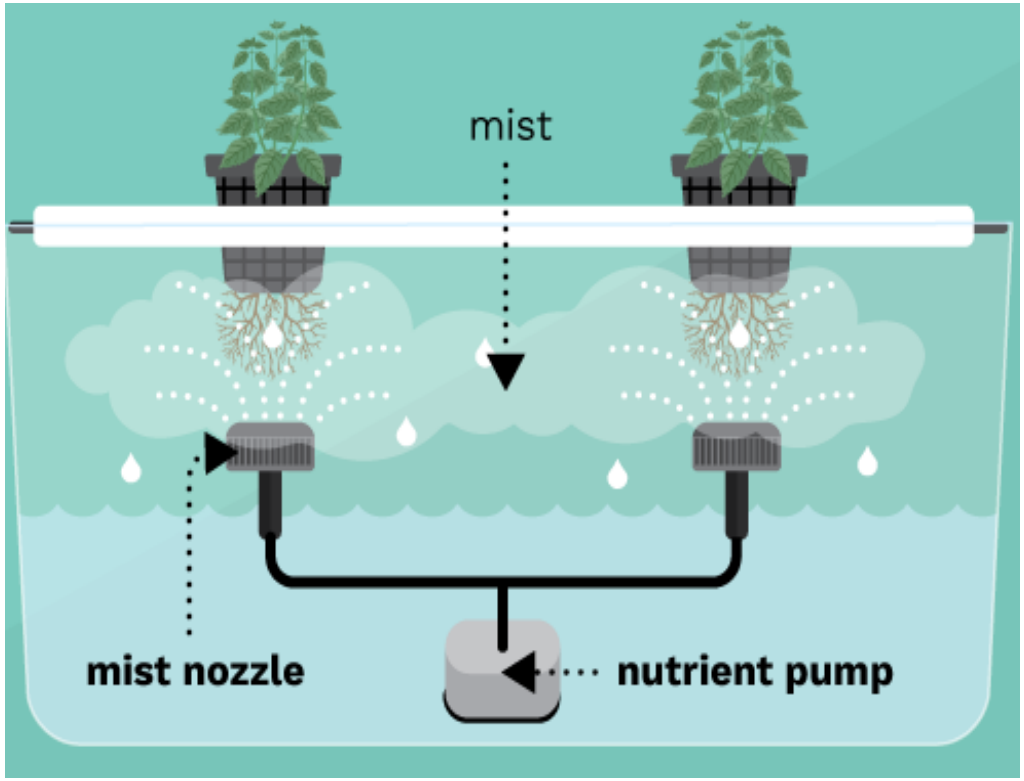
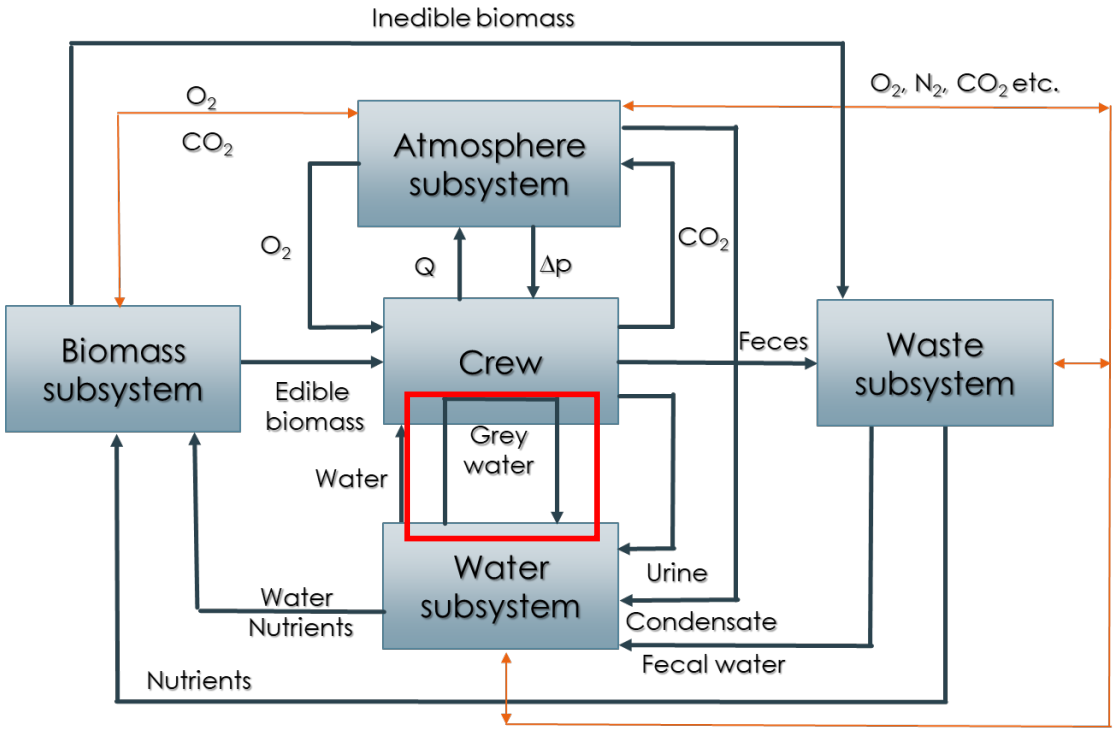
Aeroponics and hydroponics



Comments	
	Soilless
95%	Water savings for irrigation
85%	Fertilizer savings
>300%	Yield per m^2 in comparison to soil culture
>30	Number of species that already can be cultivated in aeroponics

Grey water based aeroponics

Reason behind experiment



Idea

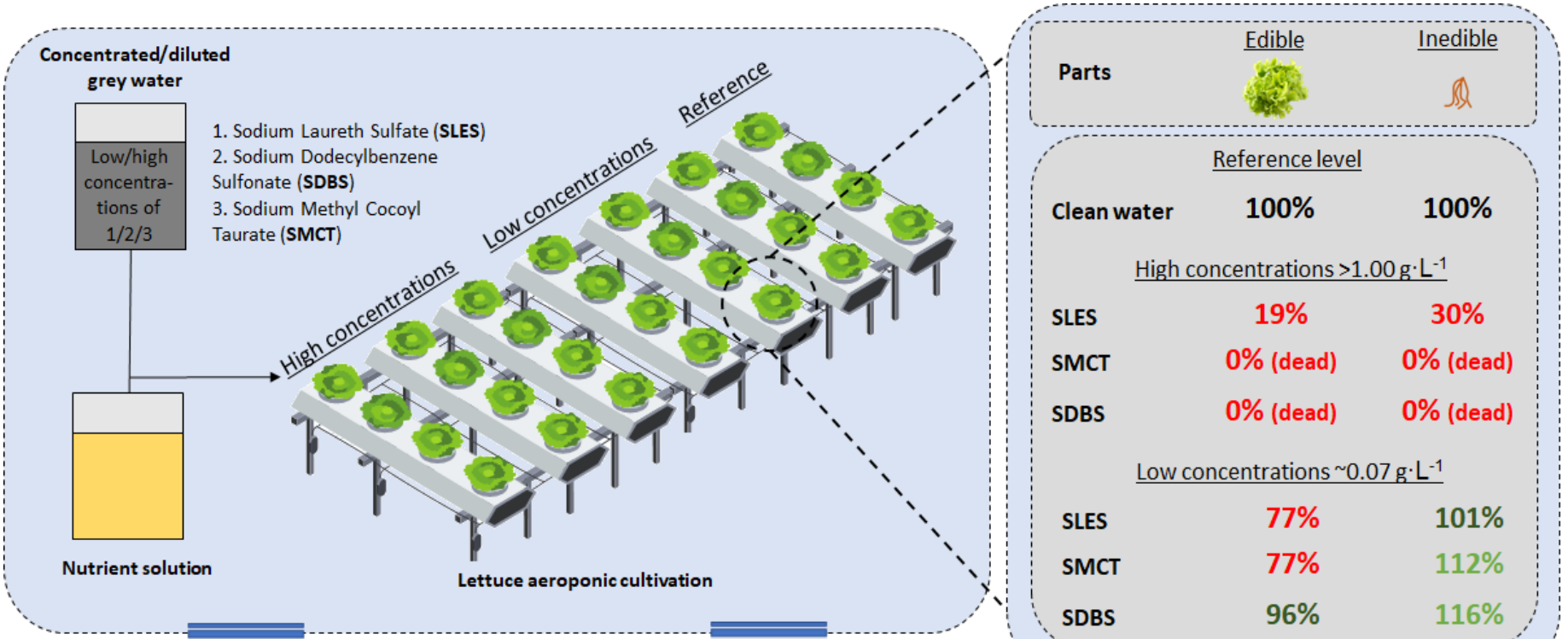
Grey water have to be treated

Perhaps grey water can be treated by bacteria thriving in roots

Simplification of system would be achieved

Grey water based aeroponics

Experiment description and general results



Impact in most cases on balances of:
- Elements: Na, Ca, Mg

Lack of impact on balances of:
- Water
- Carbon
- Elements: N, P, K

Surfactants have severe impact on aeroponic lettuce yield

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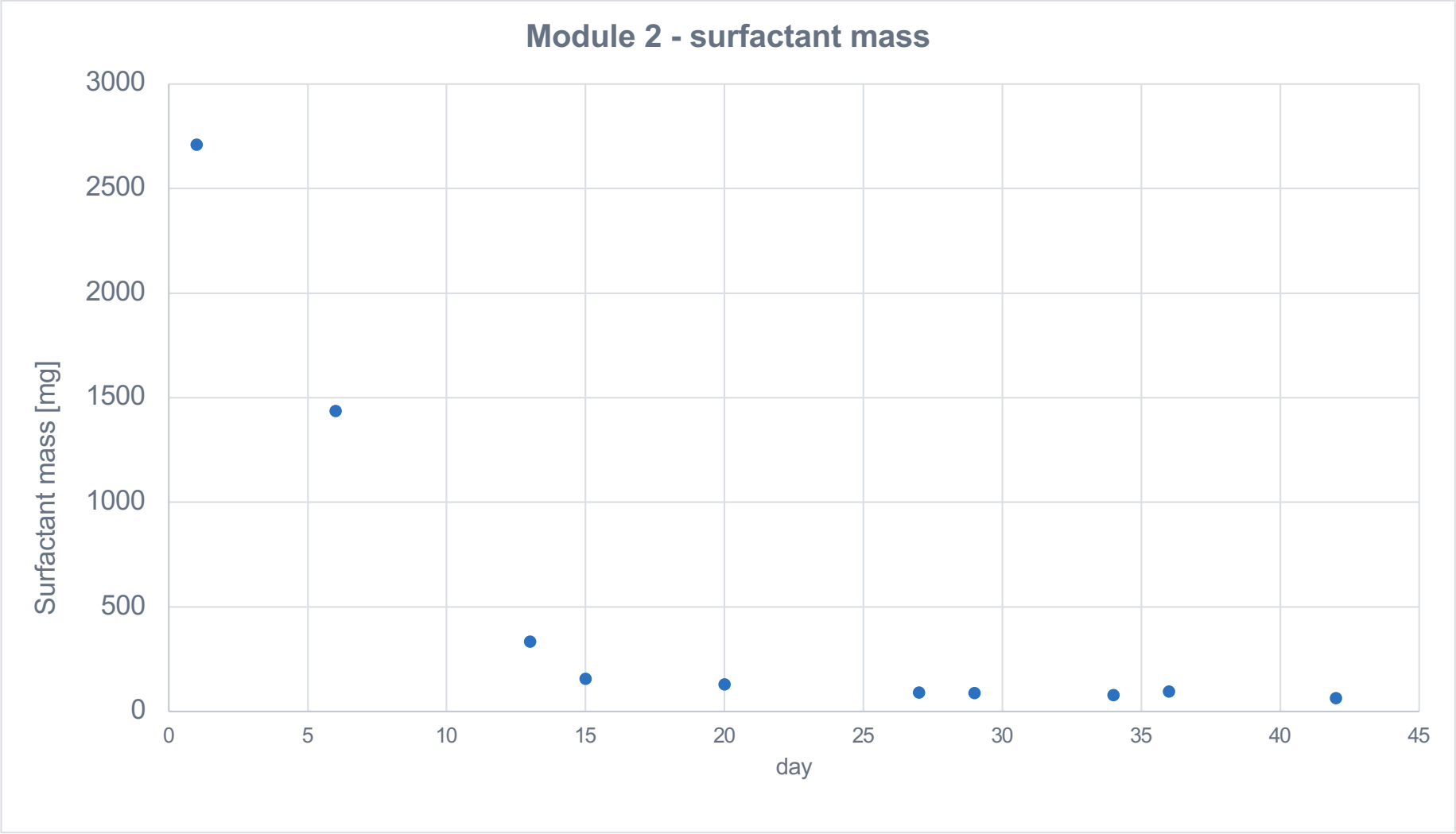
Biodegradation of surfactants



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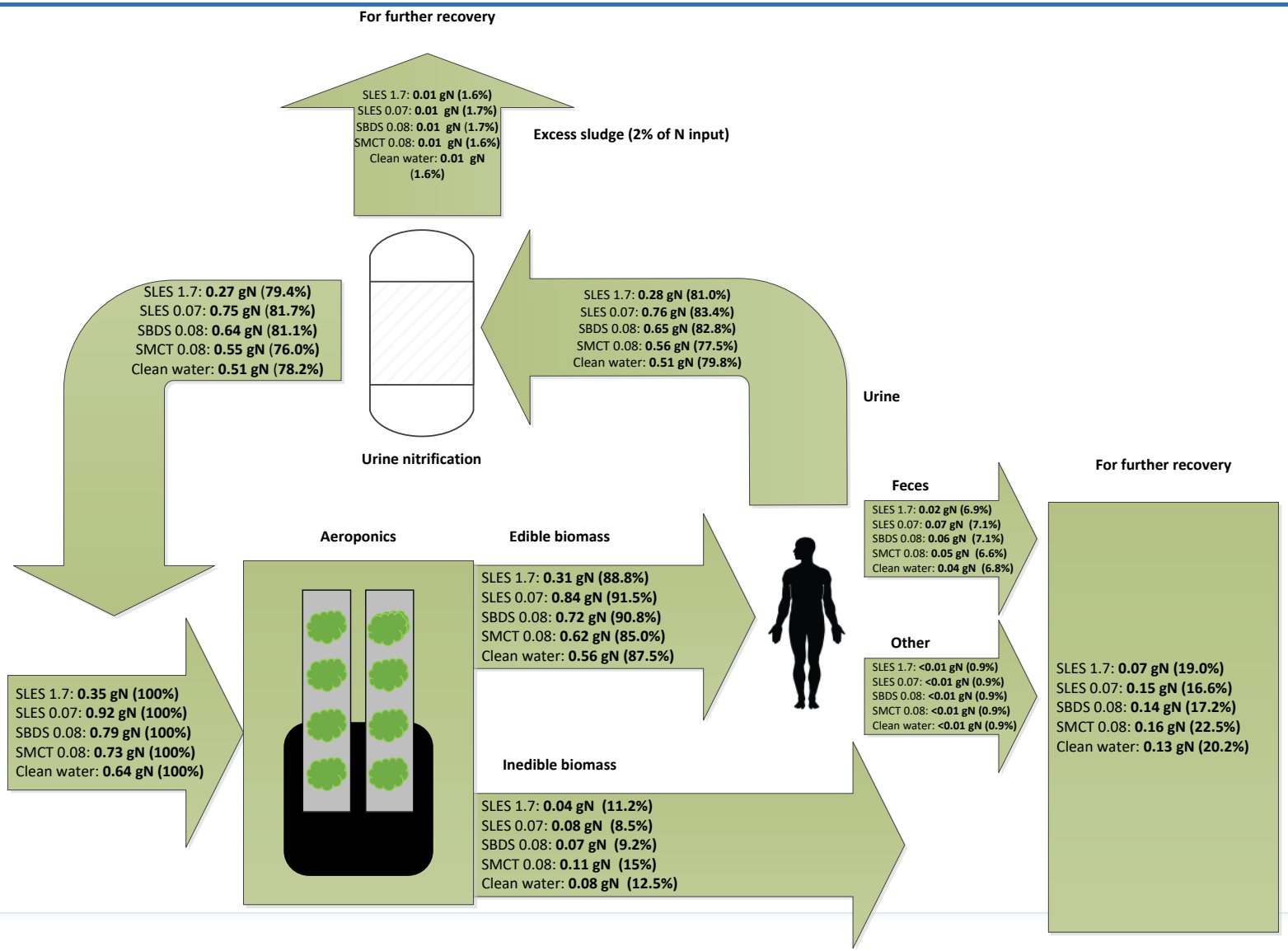
Mass balance – nitrogen as an example



Grey water based aeroponics

Mass balance – possible recovery rates

Recovery rate	Module 7, Reference (clean water)
N	78.2%
P	49.4%
K	69.1%
Mg	22.5%
Ca	9.5%
Na	56.5%
Water	39.6%
C	30.1%

Grey water based aeroponics

Transport costs

Module	Percent efficiency in comparison to clean water cultivation	Required area	Mass	Transport cost to Mars
		m^2	kg	mln dollars
Module 1 (SLES, 1.70 $g \cdot L^{-1}$)	18.6%	1.84	187	112
Module 2 (SLES, 0.07 $g \cdot L^{-1}$)	76.7%	0.45	45	27
Module 4 (SMCT, 0.08 $g \cdot L^{-1}$)	77.2%	0.45	45	27
Module 6 (SBDS, 0.08 $g \cdot L^{-1}$)	95.6%	0.36	36	22
Module 7, Reference (clean water)	100.0%	0.34	35	21

lettuce yield is 131 g of fresh mass$\cdot d^{-1} \cdot m^{-2}$
lettuce dietary requirement is 7.5 g of fresh mass$\cdot d^{-1} \cdot$crewmember^{-1}.
The number of crewmembers is assumed to be 6.
The mass of 1 m^2 of cultivation is assumed to be 101.5 kg
The cost of transporting 1 kg to Mars is estimated to be 600 000 dollars

Full results are available in
„Surfactants effect on aeroponics and important mass balances of regenerative life support system – Lettuce case study”
Science of the Total Environment 718 (2020) 137324