The Jordan Hydroponic Green Farming Project

Workshop modules 2015 08 18 and How to control risks when recirculating water and nutrients

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Overview

1. What is hydroponic farming?
2. Why hydroponics?
3. Some economics of hydroponics
4. Potential water and input saving

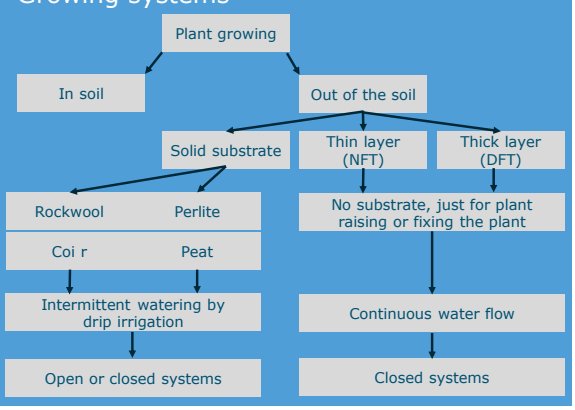
5. Hydroponic farming developments worldwide
6. Hydroponic opportunities in Jordan
7. Hydroponic techniques (systems, substrates, fertiliser recipes, close vs open systems)
8. Feedback, control and fail safety

Soilless Culture

- "...rooting media other than soil in situ": A. Steiner 1968
  - Including solid rooting media
  - Including water cultures
- NB: Internationally "hydroponics" include solid media

Gerbera on coir, Brazil | Lettuce on running water (NFT), Spain | Pepper on rice husks, Indonesia

Growing systems



Irrigation is needed to grow plants

How to do it efficiently?

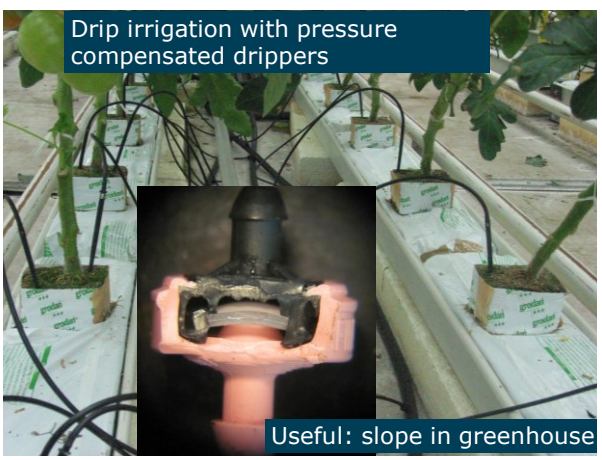
Overhead irrigation

Furrow irrigation

Solid substrates

- Investments
  - Equipment
  - Knowledge





ROOTING SYSTEMS NFT

Trend: Lettuce on water world wide

ROOTING SYSTEMS DFT

Leek and lettuce

note: propagation plugs still present

ROOTING SYSTEMS AEROPONICS (MIST)

ROOTING SYSTEMS SUB IRRIGATION (ebb and flood)

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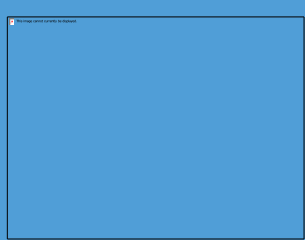
Advantages of Soilless Culture

1.Yield +10-50%

- Disease control
  - Nematodes, Agrobacterium, Phytophtora, Fusarium, etc
- Nutrient control
- Water content control
- Standardization = learning



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Advantages of Soilless Culture

2. Environmental / sectoral / public advantages
   - Re-use of Water (ground water saving, pump energy)
   - Use of waste water (filtration and RO)
   - No nitrate contamination of groundwater
   - No phosphorous contamination of soils
   - Energy efficient
   - Area efficient
   - Land efficient (slope, salinity)
   - Potentially: rain water harvest (2000 m^3/ha)

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Disadvantages of soilless culture

1 Water quality

- Excellent quality required: low sodium, disease free
- Higher level of technical knowledge required

2 Diseases

- Faster/wider spreading of pathogens

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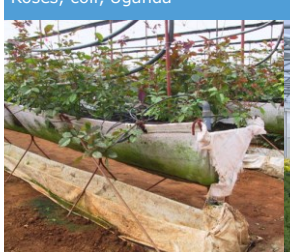
Recirculation versus free drainage

Roses, coir, Uganda



Ornamentals, peat, United Kingdom

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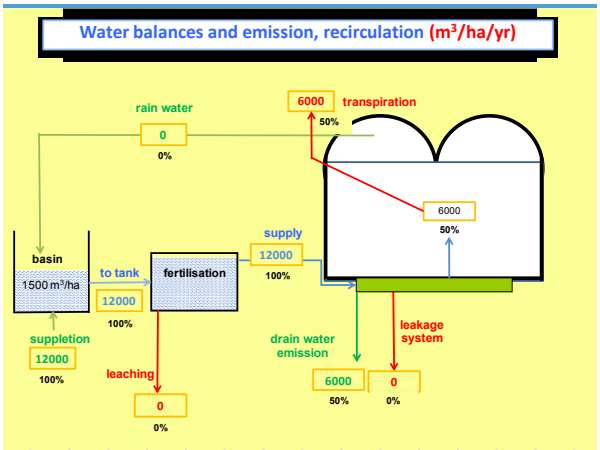

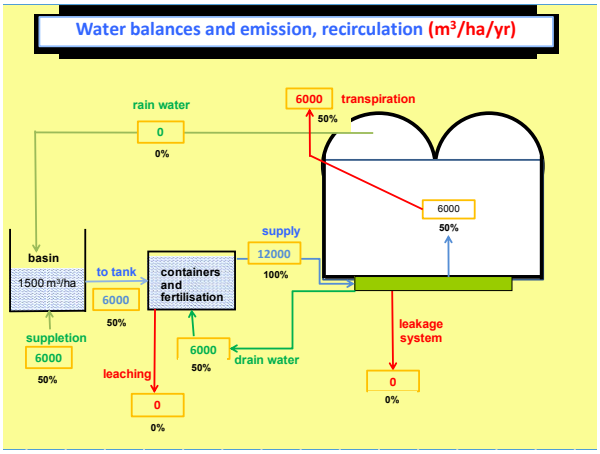

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Difference in yield: soil – soilless

years 1984 - 1987

- Increase compared to soil:
  - Tomato: 10% (32 to 35 kg/m²; now 70)
  - Sweet pepper: 12% (14 to 16 kg/m²; now 35)
  - Cucumber: 20% (40 to 48 kg/m²; now 85)

- Why?:
  - Control of growth
    - Nutrients, salts
    - Steering options
  - Disease free start

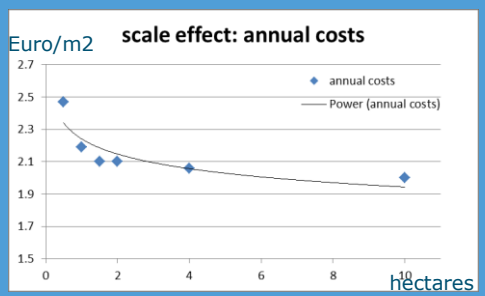
Comparison of costs and profits

			Yield increase	%	12%
Euro	Investment	Amortisation	Maintainence	Cost	Income
	Euro		yr	Euro/ha/yr	Euro/ha/yr
Drip irr.	12000	25%	5%	3600	200000
Nutrient unit	15000	10%	5%	2250	
Substrate	20000	50%	5%	11000	
Plastics	5000	100%		5000	
Levelling soil	5000	14%	5%	964	
Sum				22814	24000
Profit					1186

Nutrient and water saving

	Units	Quantity
Supply	m3/ha/yr	12000
Nitrate	mg/L	630
Drain	m3/ha/yr	6000
Cost RO water	$/m3	0.50
Cost nutrients	$/kg	1.20
Water saved	$/ha/yr	3000
Nutrients saved	$/ha/yr	4536
Total saved	$/ha/yr	7536

Scale effects



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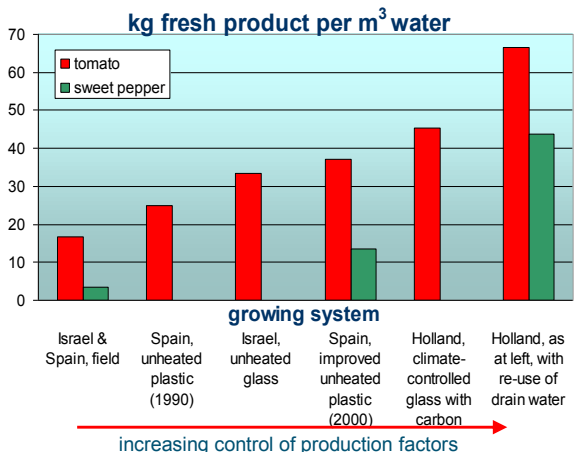
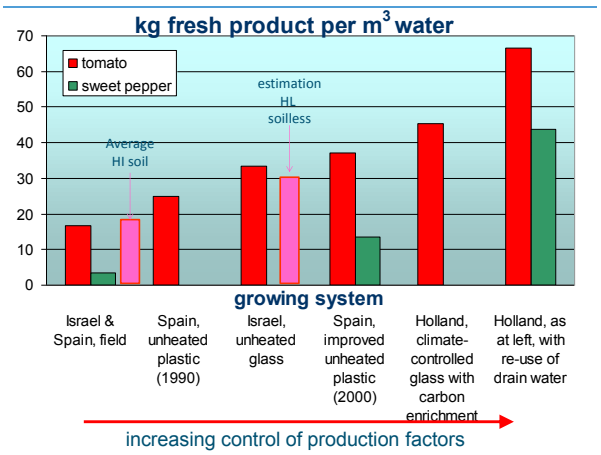
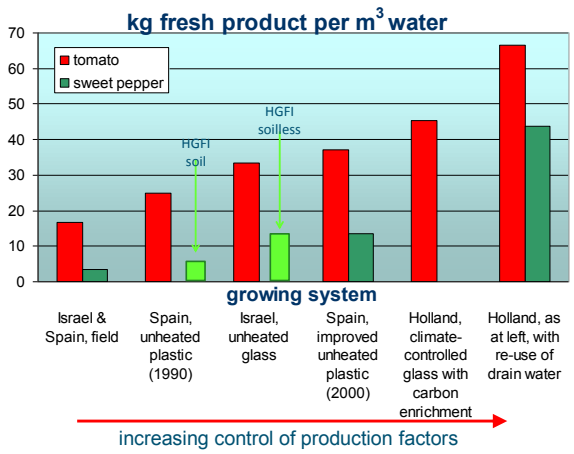
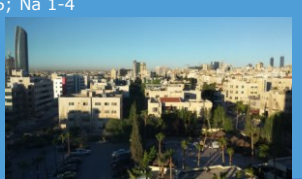






WATER SCARCITY

1. Agriculture use 50% water (750 M m3/yr)
2. Jordan treated waste water reuse is 300 M m3/yr
3. EC 1.5-2.5; Na 1-4



Soilless culture is a very good answer

1. Saves >50% water in hot climates
2. Saves >60% nutrients (cost)
3. Means no nutrient emission
4. Means no pesticide emission in water
5. Covering substrate in plastic saves 10-20% transpiration

Recirculation is a key technology for the next 30 years
Recirculation is for covered, shaded and open horticulture crops
WUR GH has the opportunity to go for all the above

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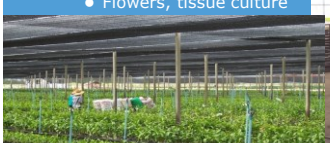
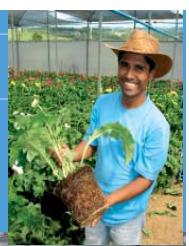
MARKET: ASIA

- Explosive growth in
  - Uzbekistan, Turk-menistan, Kazachstan
- Korea
  - High tech substrate
- China, Vietnam
  - Low tech but …
- Thailand, Indonesia, S.
  - Flowers, tissue culture



MARKET: S-AMERICA

- Brazil
  - Water based cultures
- Chili
  - Ban on methyl bromide
- Colombia, Peru
  - Flower production
- Argentinia
  - Soil contamination

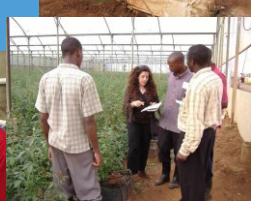


MARKET: N-AMERICA

- USA: Hydroponic product = cleaner = higher price
  - Organic: fear of human pathogens
  - Environment Chesapeake Bay act
  - Water is for civilians
- MEXICO AND CANADA
  - Food for the US
- CARAÍBIC
  - Tissue and spices

MARKET: AFRICA

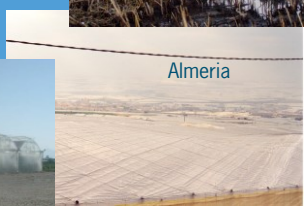
- Nigeria (West)
  - Intensive low tech horticulture
- Sahel
  - Obesitas by unbalance
- Ethiopia, Kenia, Uganda
  - Flower production
  - Water scarcity/contamination
- South Africa, Uganda
  - Dutch propagators



MARKET: EUROPE

- NORTH
  - Niche producers
  - Health; Se, Zn, Iodine
- Mediterranean
  - Bulk
  - Water: civilians get priority
- Turkey
  - Emerging potential

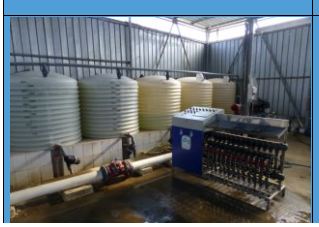




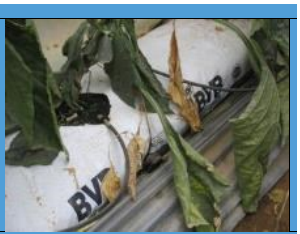

Middle East / Mediterranean experience

Country	Greenhouse	Crop	Yield level kg/m²/yr	Additional
Abu Dhabi	Plastic tunnel	Tomato	30	Pad &fan, top
Abu Dhabi	Old plastic tunnel	Tomato	15	Pad &fan, common
Algeria	Plastic tunnel	Tomato	25	
Saudi Arabia	Plastic tunnel	Tomato	20	Pad &fan, common
Egypt	Plastic house	Pepper	15	Pad & fan, heating
Egypt	Screen house	Pepper	3.5	Light screen
Holland	Venlo Glasshouse	Tomato	75	
Holland	Venlo Glasshouse	Cucumber	100	High wire!
Holland	Venlo Glasshouse	Pepper	40	
Spain	Square plastic house	Tomato	30	Air heating















1. People matter over techniques.
2. Tranining and education are neeeded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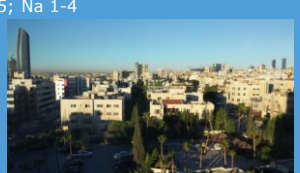


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The People

Recirculation

Potential advantages Jordan

1. Yield +10%, diseased soil +30-50%
2. Horticulture saves 20 Mio water m3/yr: hydroponics
3. Agriculture saves 500 water Mio m3/yr: sensors
4. Fertiliser emission saving hort. 20 Mio kg/yr
5. Fertiliser emission saving agric. 50 Mio kg/yr
6. Emission of crop protection agents -80%
7. Potential decentralized RO policy;
8. Potential rain harvest 8 Mio m3/yr

Some support measures

1. Dedicated analysis laboratory
2. Supporting research in Jordan
    1. Funding fundamental R&D (25%)
    2. Funding applied R&D (75%)
3. Education of growers and managers in Jordan
4. Dissemination to growers of outcomes by
    1. Universities
    2. Applied research

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System components

- Water Quality
- Water Storage
- Filters
- Fertilisers (purer)
- Fertiliser Recipe
- Fertiliser mixing (pH)
- Pumps
- Generator
- Irrigation distribution
- Irrigation Schedule
- Drippers
- Rooting media
- Pots and containers
- Drain collection
- Drain storage
- Disinfection
- Measuring

Supply water: quality and price

	Salts	Price
Rainwater	++	++
Tap water	– –	– –
Surface water	– –	++
Bore hole water	– /++	– /++
Reverse osmosis water	++	– –
Condensation water	++	++

➔ Rainwater + RO or bore hole water
➔ Analyse quality before start

++ low salts -- -- high salts

++ low price -- -- high price

Storage (and rainwater collection?)

Fertilisers

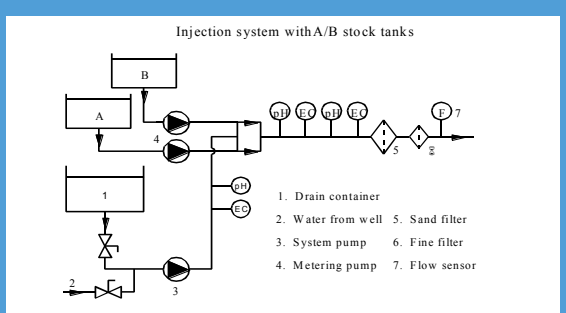
- No sodium chloride
- Low sulphates
- Compound (easier)
- Single fertilisers (cheaper)
- Single trace elements
- Low urea/ammonium

Recipes: Composition nutrient solution for tomato

Standard nutrient recipe for Tomato (except micro elements)

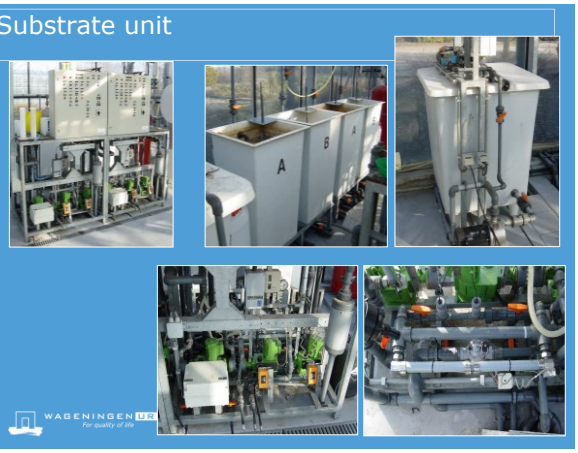
mmol/L	pH	EC	NH4	K	Ca	Mg	NO_3	SO_4	H_2PO_4
In Substrate	5.5	3.7	<0.5	8.0	10.0	4.5	23.0	6.8	1.0
Free drainage		2.6	1.2	9.5	5.4	2.4	16.0	4.4	1.5
Recirculation		1.6	1.0	6.5	2.75	1.0	10.75	1.5	1.25

Nutrient application (A + B)



Filters and Generator

Substrate unit



Distribution, Drippers and Irrigation Schedule

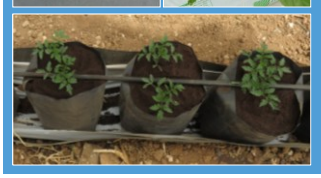
- Start time (depends on substrate)
- Stop time (depends on substrate)
- Irrigation frequency (>10)
- Irrigation rate (<120 ml/3 min i.e. 2L/h)
- Quantity (based on solar radiation)
- Plant position from dripper (homogeneity)

Technical lay-out

Rooting Media

- Organic; peat, coir, wood, compost, sphagnum
- Inorganic; rockwool, perlite, pouzolane, vermiculite
- Synthetic; oasis (phenol; poly uretane; polyacrylate; poly lactic acid).

Plant size



Support system and drain collection

Light cover needed!

Disinfection and drain storage: Effect and costs

	EFFECT	COSTS
Heat treatment	++	--
UV lighting	++	--
Membrane filtration	++	-- --
Slow sand filtration	+	+
Ozone	++	-- --
Anodic oxidation (ECA)	--	+
Hydrogen peroxide	--	+
Sodium hypochlorite	-- --	++
Chlorine dioxide	--	++
Copper Silver ionisation	--	-- --
No disinfection	--- --- ---	+++ ➔ **High risks!**

-- -- bad performance
++ good performance

-- -- high costs
++ low costs

Measurements

Feedback on:
1. Drain
2. Supply
3. Input water
4. pH/EC

General:
The concept of feedback has to be fully implemented
Only then recirculation will be safe

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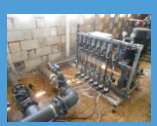
Some problems with recirculation

Water retention



CO_2 / pH slip

Temperature.

Zinc release

Boron slip

Zinc level

Safety measures

Feedback on:
1. drain (accumulation, "ratio shift", depletion)
2. supply (fertiliser quality & dosing accuracy)
3. input water (input water quality, RO quality)
4. pH other than dosing moment
5. irrigation quantity (homogeneity)
6. drain quantity (plant use, wetness)

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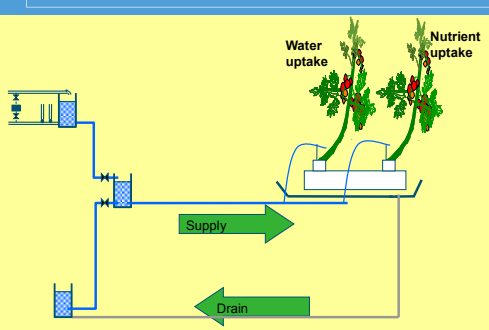
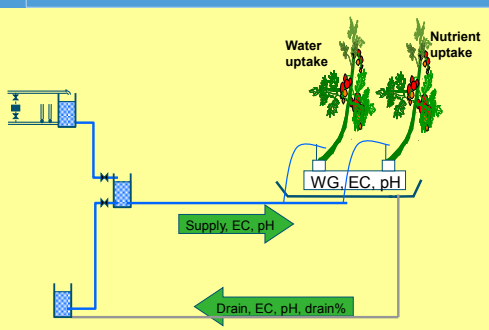
Basic compartmented construction

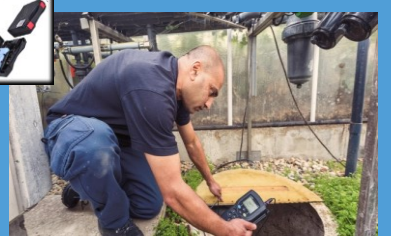


EC, pH and drain%

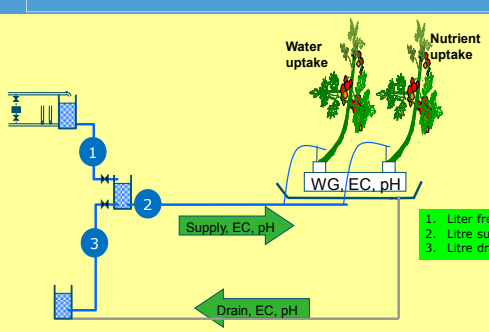


Already effective in Jordan

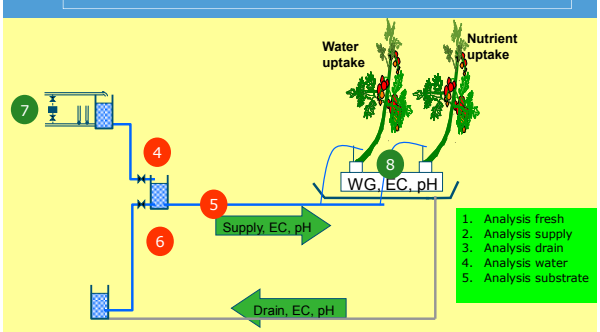
EC- pH-meters



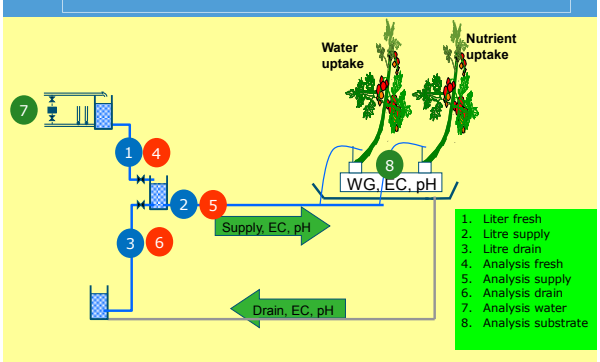
Check on input and output



Basic nutrient analyses



Basic compartmented construction



Frequency measurements (including registration data)

Amount (liter)	Fresh water	daily
	Supply water	daily
	Drain water	daily
pH / EC	Fresh water	1-2 /week
	Supply water	1-2 / week
	Drain water	1-2 / week
Nutritional analyses	Fresh water	1x / 2 months
	Supply water	1x / month
	Drain water	1x / month
Nutritional analyses	Water	Start, 1x/2months
	Substrate	Start

Conclusions

1. 50% water saving with Hydroponics over soil
2. Hydroponic components adapted to local situation
3. Training and education of:
   - Growers
   - Greenhouse staff
   - Supplier technicians
4. More applied research
5. Better dissemination & demonstration to growers

End

Thank you for your attention!