

11:50-12:10 Val á plöntum fyrir köld kerfi

Selections of plants in a cold system

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# BIOFORSK - Norwegian Institute for Agricultural and Environmental Research

- **Bioforsk is a national R&D institute under the Norwegian Ministry of Agriculture and Food, with about 500 employees.**
- **7 places all over Norway**
- **Research areas such as:**
  - Arctic agriculture
  - Organic food and farming
  - Soil, Water and Environment
  - Horticulture and Greening
  - Plant health and Plant protection



# BENEFITS OF AQUAPONICS

Aquaponics is a natural, organic method of soilless plant production.

There are no harmful herbicides or pesticides used in aquaponics.



# Aquaponics...



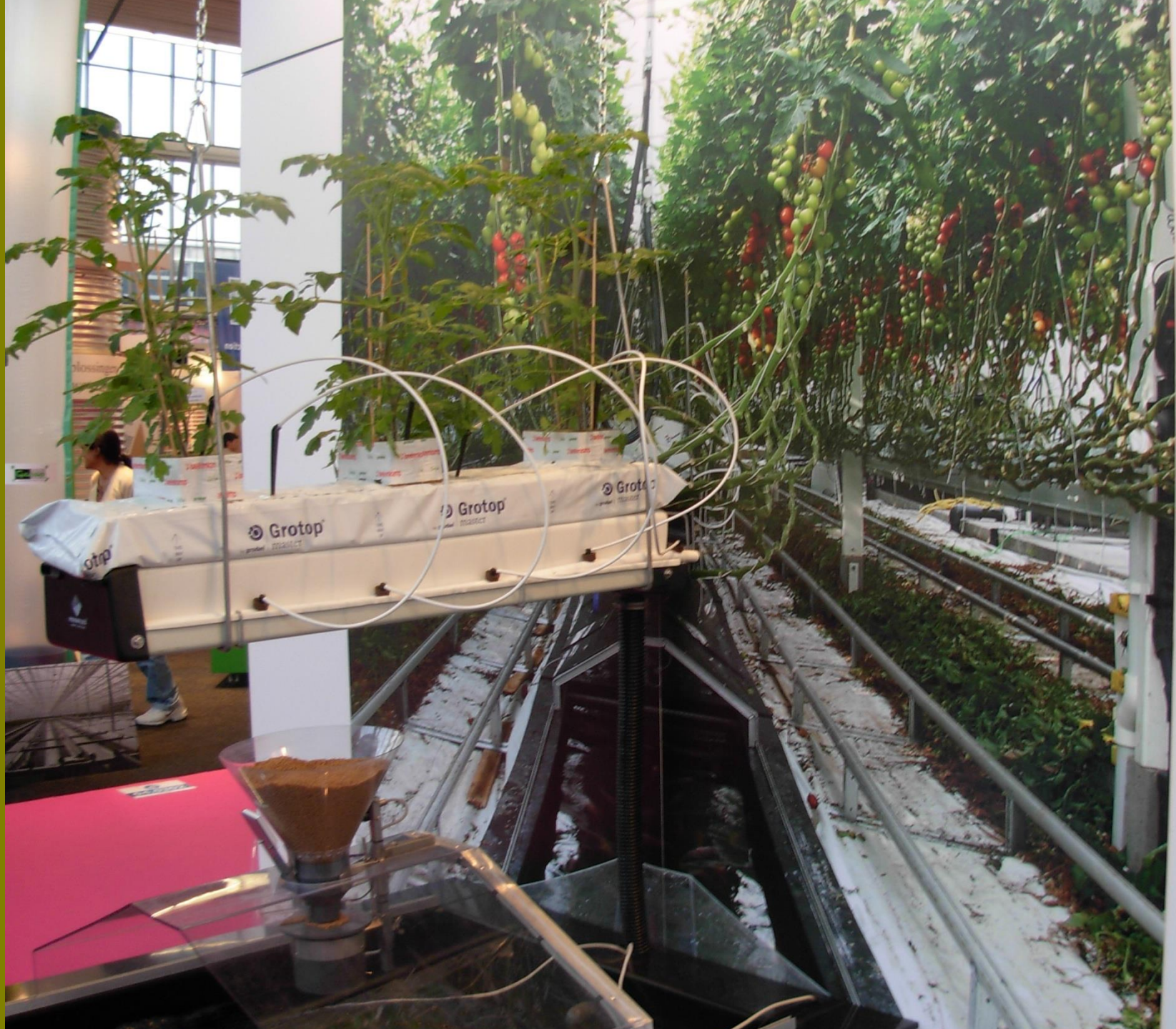
**AQUAPONIC =  
ORGANIC / BIOLOGIC WATERCULTURE**

# BENEFITS OF AQUAPONICS



WHEN YOU  
ELIMINATE THE  
SOIL,  
YOU ELIMINATE  
SOILBORN DISEASE.





# Aquaponics can also be potentially useful for school education



Aquaponics Trial in Rosemary High School

# BROODSTOCK - wild brown trout

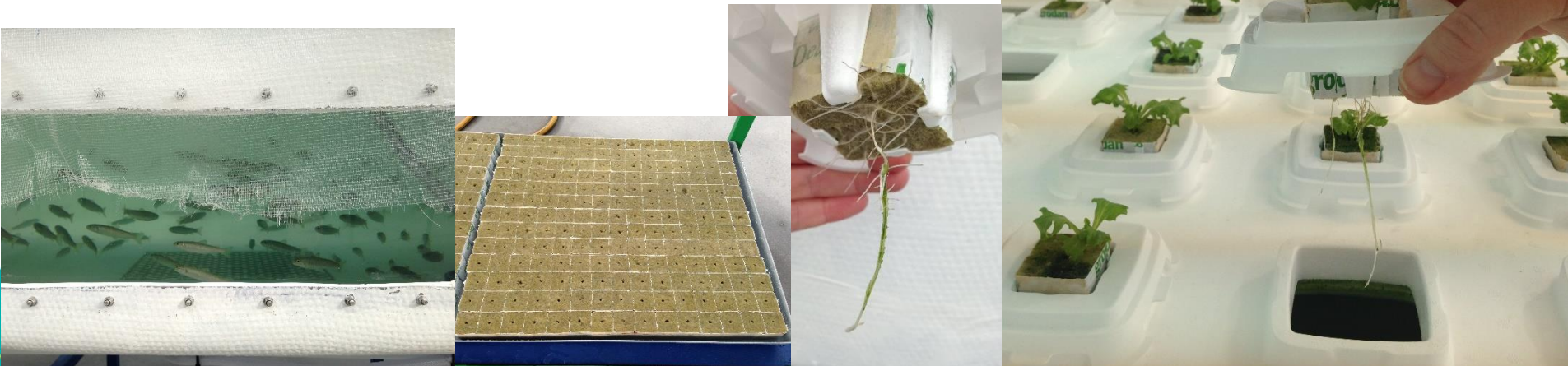




# The system for Nordic conditions



- *The Nordic Aquaponics Design* for production system is based on deep rafts with floating plants - stable system
- The plants need
  - steady floating board
  - an easy and effective way of handling the boards
  - easy to clean and re-use
  - non-soil system gives rockwool cubes for growing media



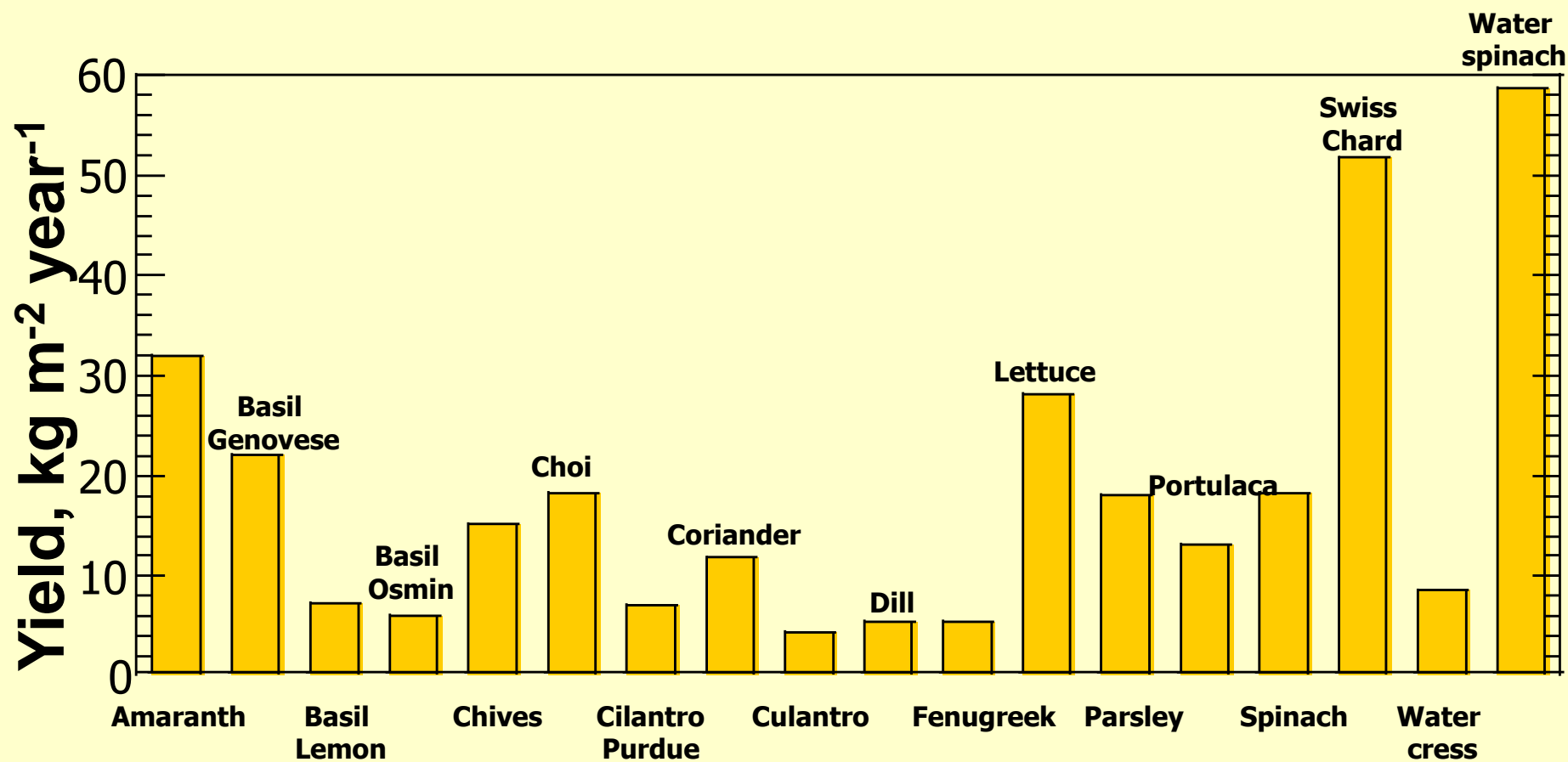
# The Cultivation Systems B.V., The Hague, The Netherlands



- Several parts for lettuce and herbs - dry hydroponics
    - start and finished floats, float inserts and plant holders
- Start floaters - 24 plants    Finished floats - 12 plants



# Annual production of herbs in aquaponics



# Rosemary roots

Hydroponics

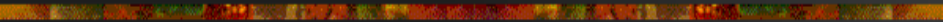


Aquaponics

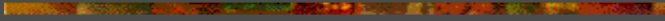


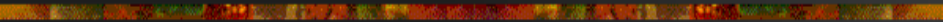
# Comparison of plant growth in hydroponic and aquaponic nutrient solutions

Crop Plant	Hydroponic			Aquaponic		
	Height (cm)	Shoot (g)	Root (g)	Height (cm)	Shoot (g)	Root (g)
Basil	30	226	68	35	301	111
Rosemary	31	141	119	35	226	290
Cucumber	138	1180	219	156	1580	274
Tomato	110	1616	198	114	1841	279

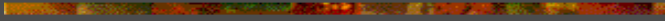


This study indicates that there is a factor stimulating nutrient uptake and assimilation by plants grown in aquaponic solutions where nutrients and many organic compounds are derived from fish feed.





Aquaponics represents a self-regulated, sustainable food production system utilizing mechanisms similar to the mechanisms existing in natural ecosystems



# Plants we choose for our system and why



- The plants need to
  - “like” cold water on their roots
  - grow fast in given conditions
  - grow with the nutrients they get from the fish
  - be strong to water born pathogens like phytium, phytophthora,...
  - Marked strategy - what will our costumers have
- Good vegetables choice for Nordic countries can be different varieties in lettuce, basil, mizuna, arugula, spring onion, salanova, red mustard, spinach, mint, watercress, chives, pac choi and other Asian greens. Strawberry, stevia, rosenroot...
- **ALSO - we wanted to see known numbers for plants, so we choose lettuce, basils and mizuna for our trials**





# Leafy lettuce - a lot of varieties



# Asian greens and edible flowers

- Mitzuna
- Pac choi
- Shungiku
- Mangold



- Eatable flowers - Borage (agurkurt), Calendula / marigold (blomkarse), Carnations / dianthus (nellik), Chervile (kjørvel), ...



Lettuce - 20-24 plants per m<sup>2</sup> ... x 6-9 times per year (120-216 plants/m<sup>2</sup>/year)



# Elicitors and abiotic stress mechanisms



Elicitors:

**DEF = An elicitor in biology is a compound that when introduced into a living organism it signal the activation or synthesis of another compound (e.g. trigger the plants production of phytochemicals).**

ethylene (defense responses, affect plant ageing and ripening of fruits)

jasmonate (inducing plant defense responses)

chitosan (spraying on plant leaves induce plant defense system)

gas composition in growing environment (CO<sub>2</sub> and O<sub>2</sub>)

UV radiation (affect synthesis of phenolic compounds, antioxidants)

Abiotic stress:

**DEF = Non-living environmental stress factors that can have a negative impact on a plants ability to grow in a given environment.**

temperature stress (low or high)

physical stress (wind or air flow in circulating water)

mechanical wounds (may accrue during trimming or handling)

antagonistic organisms in nutrient solution (microbes, pathogens)

oxygen stress (low oxygen level in nutrient solution)

# Plant growth and development

- Non destructive measurements during growth period:
  - weight the entire plant weekly during the production (biomass)
  - measure the root development (WinRhizo method)
  - Number of leafs/internodes/flowers/etc.
  - Number of days to sales product (day degrees)
- Destructive measurements at harvest
  - Biomass of roots and leaves separately
  - Scanning of roots (WinRhizo method)
  - Chemical analyses of harvested plant material
    - N (Total nitrogen and nitrate) accumulation in the plant
    - P, K accumulation
    - Micronutrient
    - Secondary metabolites (antioxidants)



# Healthy plant roots can increase plant growth by taking in more nutrients when water is unlimited

## Concentration of essentials in higher plants (Benton Jons, 2005)

Nutrients	Symbol	Part of dry weight of plants	
		ppm	%
<b>Macro nutrients</b>			
Carbon	C	450 000	45
Oxygen	O	450 000	45
Hydrogen	H	60 000	6
Nitrogen	N	15 000	1,5
Potassium	K	10 000	1,0
Calsium	Ca	5 000	0,5
Magnesium	Mg	2 000	0,2
Phosphorus	P	2 000	0,2
Sulphur	S	1 000	0,1
<b>Micro nutrients</b>			
Chlorine	Cl	100	0,01
Iron	Fe	100	0,01
Manganese	Mn	50	0,005
Boron	B	20	0,002
Zink	Zn	20	0,002
Cupper	Cu	6	0,0006
Molybdenum	Mo	0,1	0,00001



**Guideline: About 57 g fish feed per day per square meter plant production...**

## Oxygen Content in Fresh Water related to water temperature

Tempe rature		Oxygen Content, mg/L (ppm)
F°	C°	
32	0	14,6
41	5	12,8
50	10	11,3
59	15	10,1
68	20	9,1
77	25	8,2
86	30	7,5
95	35	6,9

Source: Nichols, M. 2002, *The Growing Edge* 13(5):30-35

# New research ideas for the future



- ❖ Define differences and similarity between water-based bioindustry - plant growth in greenhouse, aquaculture, micro algae production, ... evaluate the potential for technology transferring between the productions...
- ❖ Plant physiology studies...
- ❖ Aquaponics and Food Safety...
- ❖ Organic certification rules in Europe





# THANK YOU FOR YOUR ATTENTION!

LOOKING FORWARD TO  
COLLABORATE WITH YOU AND TO  
SHARE KNOWLEDGE, EXPERIENCE  
AND GUTS TO REACHED NEW GOALS!

THANK YOU FOR THE INVITATION!



