

Trout in aquaponics - some experiences from Landvik

Development of an integrated fish- and plant production for Nordic conditions.

norden
Nordic Innovation

Siv Lene Gangenes Skar,

Bioforsk

Lifelong Learning Programme


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 in Norway – regional structure**
- **Research areas:**
  - Arctic agriculture
  - Organic food and farming
  - Soil, Water and Environment
  - Horticulture, Urban Farming and Greening
  - Plant health and Plant protection

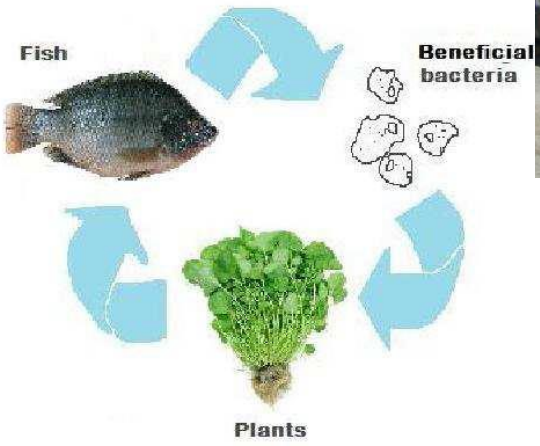
Norwegian Institute of Bioeconomy Research – NIBIO

- From 1st of July 2015
- Three agriculture institutes becomes one
- Gene resources (living gene bank), Agriculture and environmental research, economic analysis
- The Norwegian Institute of Bioeconomy Research (NIBIO) will be Norway's *largest interdisciplinary* research institute in the agricultural and environmental sphere, and *one of Norway's largest research institutes*.
- Appointed Director General: Alvhild Hedstein

Why aquaponics in Norway?

… once upon a time, there was
a fisherman and a tomato producer…

Utvikling av integrert fisk- og planteproduksjon (Aquaponic) for norske forhold



Aquaponics AS at Bjorå Gård at Evje

Norwegian cluster in Aust-Agder

The group working with Aquaponics at Landvik

- ✓ BIOFORSK (research institute – non profit)

  Siv Lene Gangenes Skar, Randi Seljåsen, Olav Langmyr, Atle Beisland, Erling Stubhaug

- ✓ NIVA (research institute - private)

  Rolf Høgberget, Ole-Kristian Hess-Erga

- ✓ AqVisor AS (private consulting company)

  Jan Morten Homme, Asbjørn Drengstig, Jan Erik Jenssen

- ✓ UiA (University of Agder)

  Helge Liltved

Contact in Canada – Dr Nick Savidov, AARD.

EU COST Action FA1305: Aquaponics HUB (Bioforsk, NIVA)

Activity and professional network

Funding partners:

- COST Action FA 1305 – The EU Aquaponcis HUB: Realising Sustainable Integrated Fish and Vegetable Production for the EU
- EU Life Learning program – Leonardo da Vinci Partnerships: IS, DK, ES, NO

- national projects

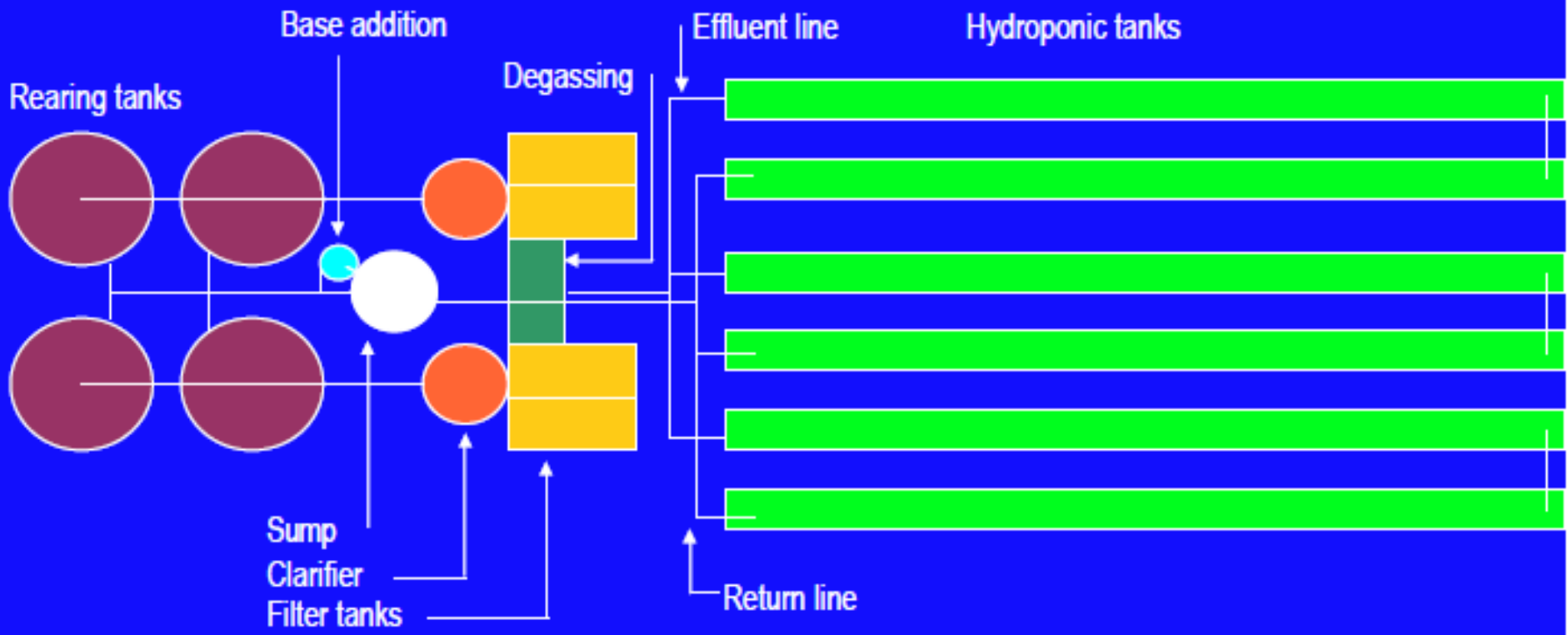
  (The THINK BOX, BioSys, etc.)

- **Aquaponics NOMA – Nordic Marin**

THE CONCEPT
- where did we begin

University of Virgin Island
System Layout

Water treatment: 10% of water volume
Fish tanks: 30% of water volume
Plant beds: 60% of water volume



Total water volume, 110 m^3

Land area - 0.05 ha

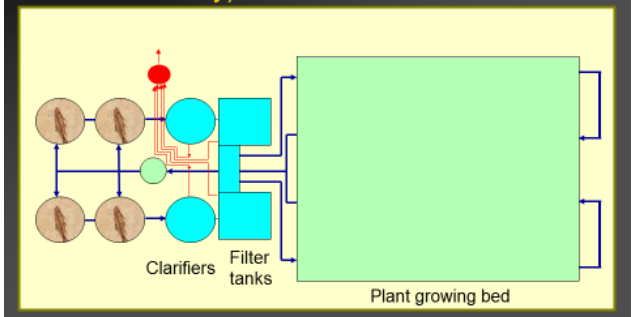
Dr James Rakocy

Visited Canada and Dr. Nick Savidov, Brooks, Alberta

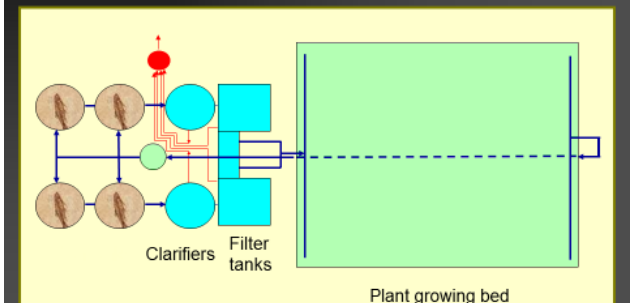
Objectives in Canadian aquaponics research

- To improve water use efficiency
- To increase greenhouse space usage
- To minimize labor requirements
- To achieve close to 100% Nutrient Use Efficiency, NUE

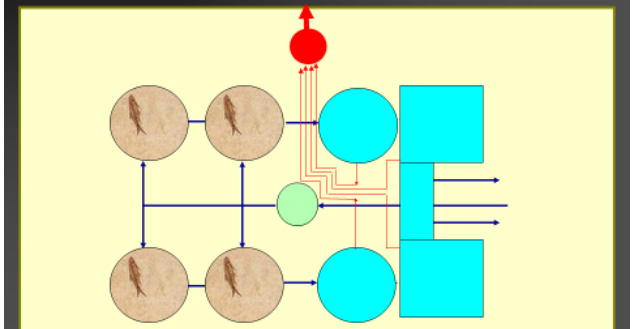
Brooks Aquaponics Facility, BAF, is based on the University of Virgin Island Model (Dr. James Rakocy)



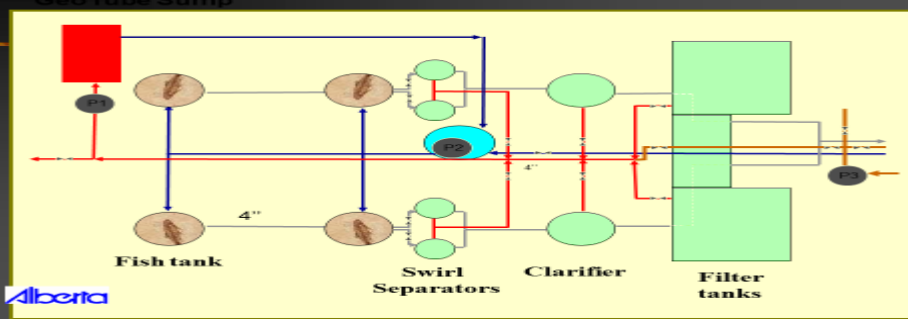
Brooks Aquaponics Facility, BAF, is based on the University of Virgin Island Model (Dr. James Rakocy)



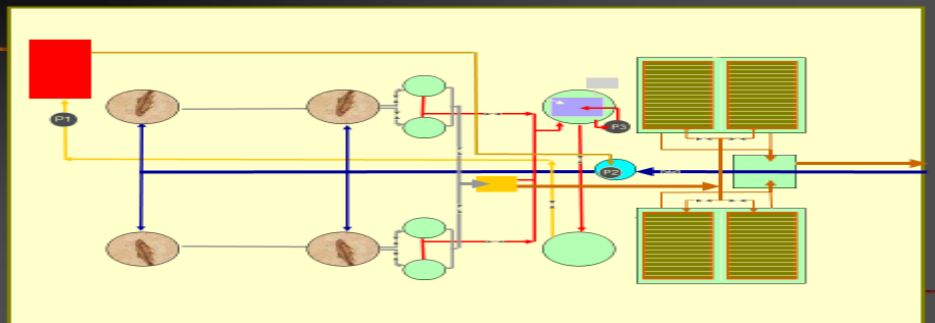
Brooks Aquaponics Facility, BAF, is based on the University of Virgin Island Model (Dr. James Rakocy)



Generation 2



Generation 3



BENEFITS OF TROUT AQUAPONICS

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

There are **no harmful herbicides or pesticids** used in aquaponics.

BENEFITS OF TROUT AQUAPONICS

Fish do **not carry** the same pathogens, such as **E. coli and salmonella**, that warm-blooded animals do.

BENEFITS OF TROUT AQUAPONICS

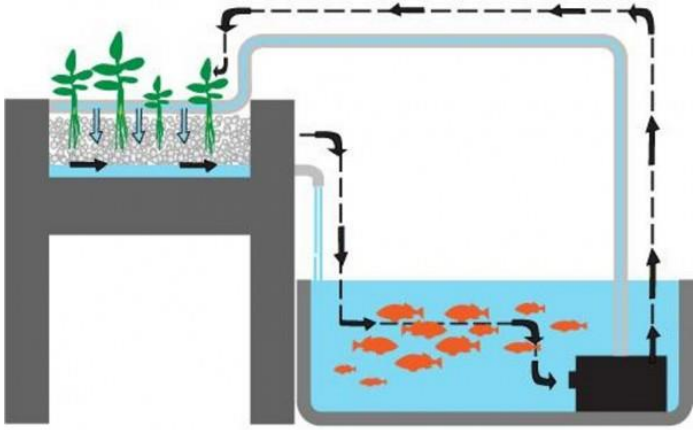
WHEN YOU **ELIMINATE THE SOIL**,

YOU **ELIMINATE SOILBORN DISEASE**.

BENEFITS OF TROUT AQUAPONICS

An aquaponic greenhouse can be **located near a marketplace**, reducing transportation costs.

No requirements to the place.



aquaponic system

In a **controlled environment**, aquaponics can be done year around and close to the marketplace.

Gives newly harvested, safe and fresh products to the local market.

BROODSTOCK
– brown trout at Syrtveit Hatchery, NO

Brown trout at Bioforsk Landvik

Rainbow trout Tau Hatchery, NO

(picture from rainbow trout at Bioforsk Landvik)

Legislation, water quality, fish welfare

- Bottlenecks
- Certifications needed
- Knowledge and innovation,
- Marked and products

Stor interesse fra publikum og media

FISKEHELSE juni 2012

Can aquaponic systems be adapted to Norwegian aquaculture?

Helge Liltved[1*], Morten Homme[2], Siv Lene Gangnes Skar[3], Ole-Kristian Hess-Erga[1], Stein Uleberg[4] and Asbjørn Drengstig[5]

[1] Norsk institutt for vannforskning, Gaustadalleen 21, N-0349 Oslo

[2] Feedback Aquaculture ANS, Kranveien 60 C, N-4950 Risør

[3] Bioforsk Øst Landvik, Reddalsveien 215, N-4886 Grimstad

[4] Aquaponics AS, Bjorå, 4735 Evje

[5] Hobas Ltd., P.O.Box 391, N-4067 Stavanger

10 | NYHETER ONSDAG 26. SEPTEMBER 2012 Fiskeribladet

Dyrkar jordbær i fiskemøkk

På Bjørå gartneri veks plantane i vatn frå kummar fulle av innlandsfisk. Planterevolusjonen skal gje 20 tonn ekstra tomater i året og redusere energibruken med ein kvart million.

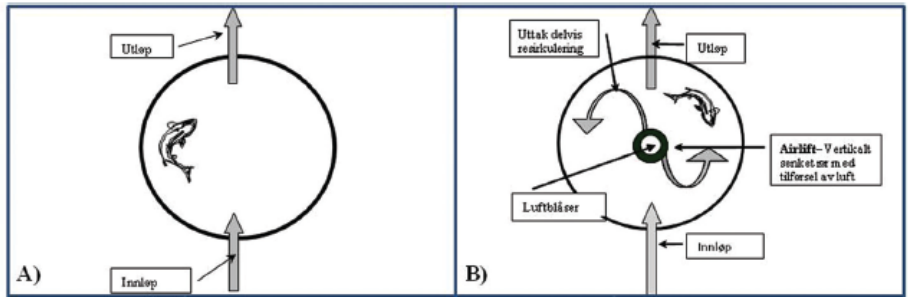
Lettare å drive oppdrett

Den nye teknikken som blir testa ut på Bjørå, vil gjere det lettare å drive med oppdrett av innlandsfisk, sidan alt vatnet blir resirkulert.

AKTUELT

Aquaponics - en spennende kombinasjon av akvakultur og landbruk

Aquaponics kombinerer landbasert akvakultur med resirkulering av vann og planteproduksjon i vannkultur uten bruk av jord (hydroponic) i ett og samme system. Denne produksjonsformen får stadig mer oppmerksomhet



‘Salanova’ LETTUCE

THE AQUAPONICS FACILITY AT BIOFORSK LANDVIK MARCH 2015

‘Crispy’ LETTUCE

Bioforsk Landvik

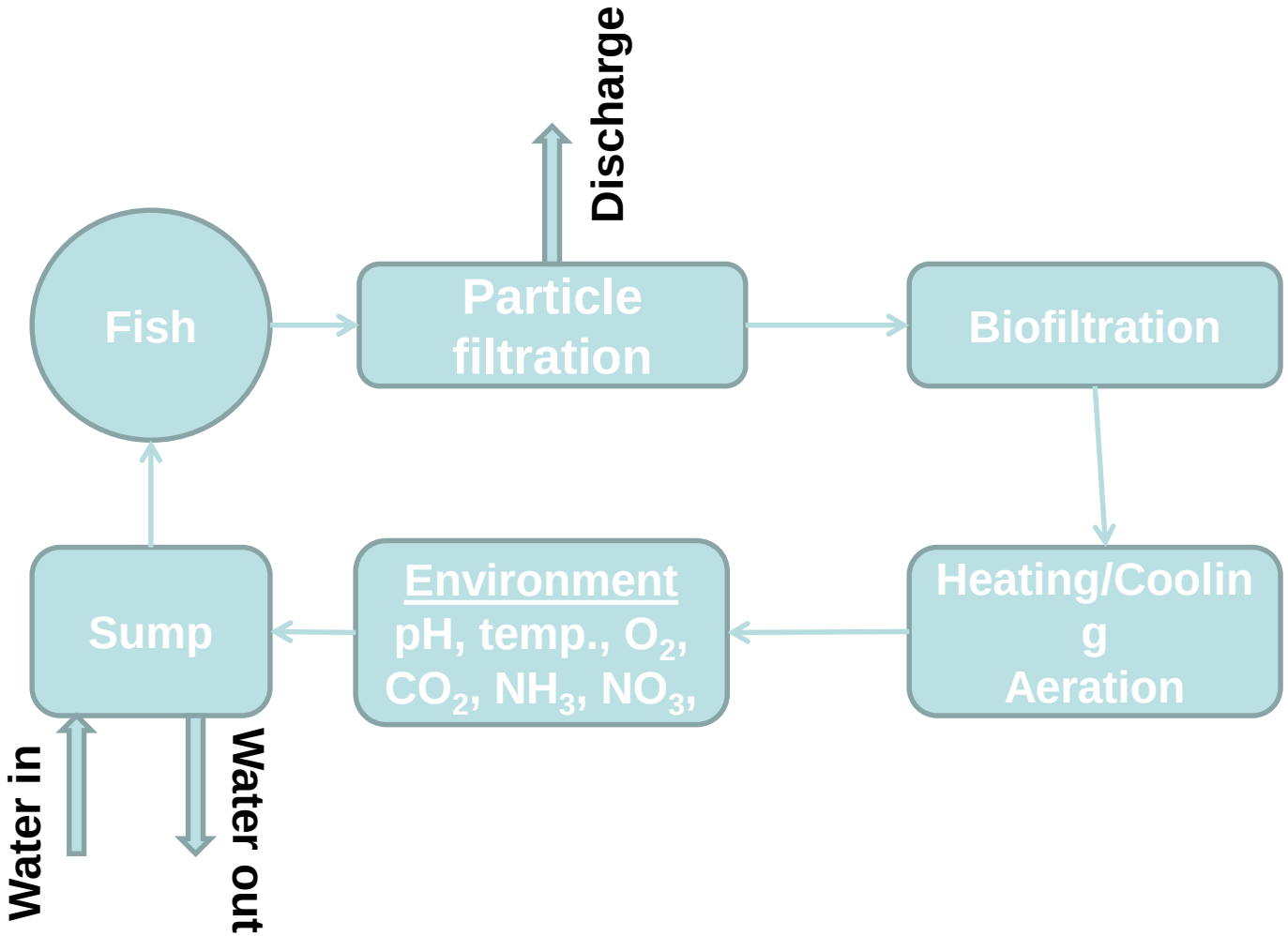
Avd. forskning innen aquaponics

Lokalitet 34317, Landvik

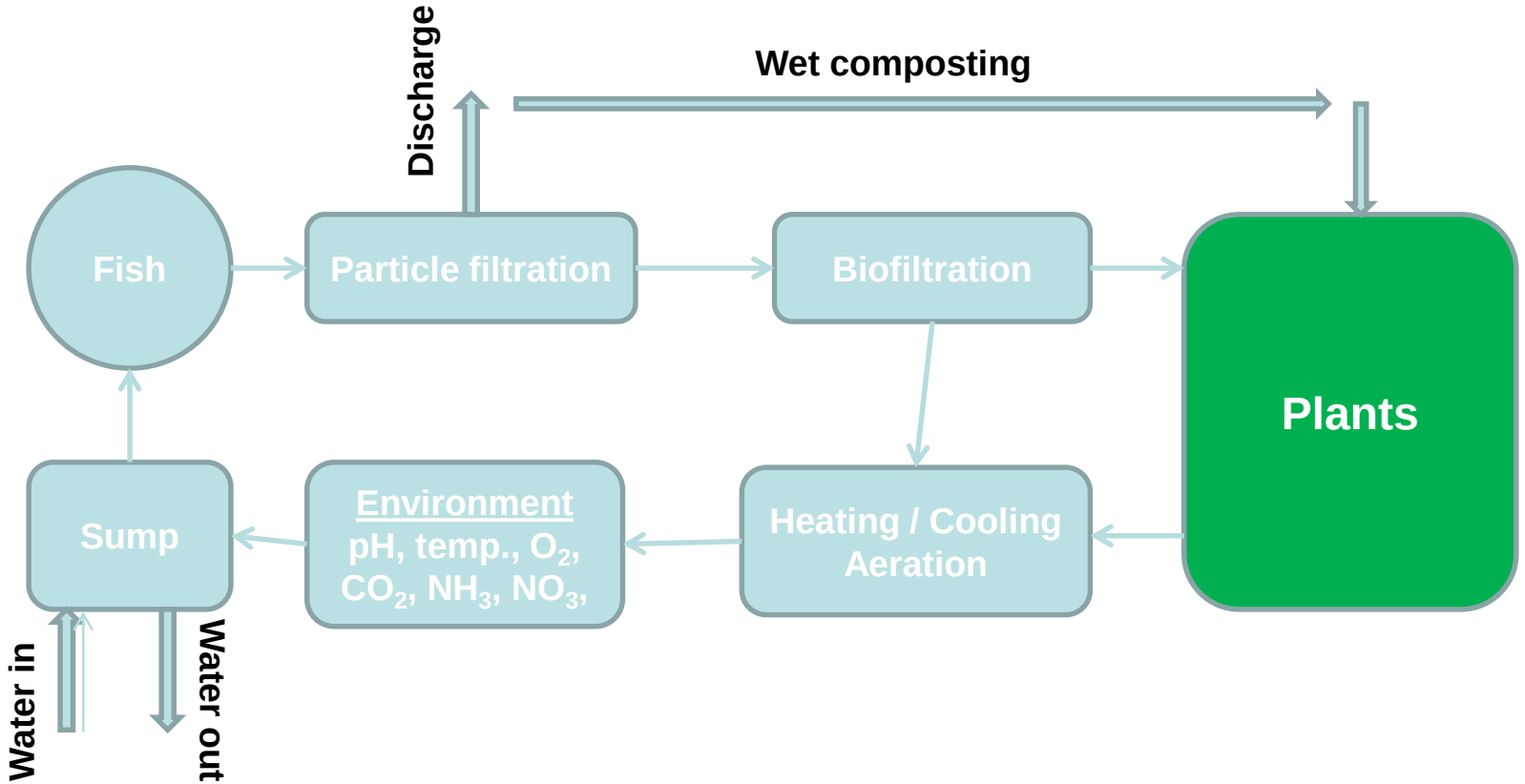
Definition Temperatures

- Three Classifications
  - cold-water species below 15°C
  - cool-water species between 15°- 20°C
  - warm-water species above 20°C

RAS - Recirculated Aquaculture System

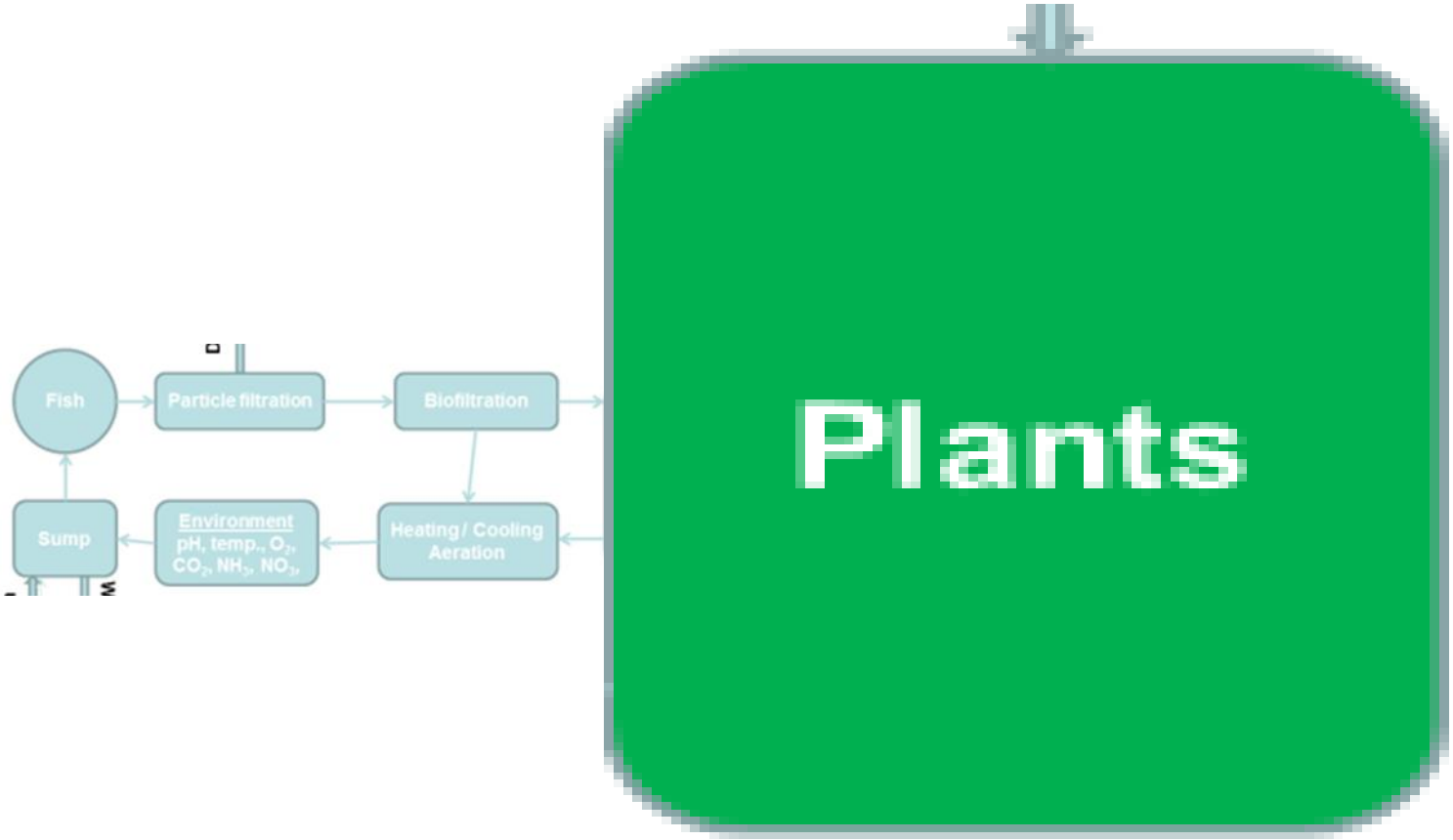


RAS + Hydroponics = Aquaponics



GOAL = ZERO DISCHARGE

The dominans of plants



Hydroponic Systems

A) Nutrient Film Technology (NFT)

B) Floating Raft (Deep Water System)

C) Media Bed (Gravel, Leca, pumic, etc.)

Also - Drip Systems

Aquaponics Deep Water System

Production experiment with Okra (Rakocy et al, 2004)

Elements	Parameter	Unit	Plants – water in	Plants – water out
Total nutrition	EC	mS/cm	0,5	0,5
	TDS	mg/l	236	236
Macro Nutrients	NO_3-N	mg/l	26,3	27,5
	TP	mg/l	16,4	15,9
	Ortophosphorus	mg/l	15,0	15,2
	K	mg/l	63,5	64,6
	Ca	mg/l	24,2	24,3
	Mg	mg/l	6,0	6,0
	SO_4	mg/l	18,3	18,8
Micro Nutrients	Cl	mg/l	11,5	11,5
	Fe	mg/l	1,3	1,3
	Mn	mg/l	0,06	0,05
	Zn	mg/l	0,34	0,34
	Cu	mg/l	0,03	0,03
	B	mg/l	0,09	0,09
	Mo	mg/l	0,01	0,01
Others	Na	mg/l	13,7	13,7

Aquaponic system with drip/irrigation

(Enduet et al, 2010)

HLR (m^3/m^2 day)	Plant bed	BOD	TSS	TAN	NO_2-N	NO_3-N	TP
0,64	In (mg/l)	6,7	74,6	12,02	0,58	19,8	17,0
	Out (mg/l)	1,7	23,0	2,68	0,19	5,8	6,7
	Removed (%)	**47,3**	**67,0**	**64,1**	**67,2**	**62,4**	**50,0**
1,28	In (mg/l)	6,7	74,4	12,04	0,56	20,0	17,1
	Out (mg/l)	1,3	21,1	2,23	0,14	5,4	6,3
	Removed (%)	**54,5**	**69,5**	**68,4**	**75,0**	**64,9**	**52,8**
1,92	In (mg/l)	6,8	74,8	12,01	0,56	19,9	16,9
	Out (mg/l)	1,3	19,2	1,94	0,11	6,2	7,0
	Removed (%)	**55,4**	**72,3**	**71,0**	**80,4**	**60,4**	**47,8**
2,56	In (mg/l)	6,9	74,4	11,99	0,57	20,0	17,0
	Out (mg/l)	1,0	14,2	1,68	0,09	6,6	7,1
	Removed (%)	**61,4**	**79,0**	**73,3**	**84,2**	**58,5**	**47,5**
3,20	In (mg/l)	6,7	73,9	11,98	0,57	20,1	17,1
	Out (mg/l)	0,7	11,2	1,14	0,06	9,7	7,9
	Removed (%)	**65,5**	**82,9**	**78,3**	**89,5**	**42,3**	**42,8**

Plant growth and nutrition

Photosynthesis: $6\ H_2O + 6\ CO_2 \xrightarrow{\text{Light}} C_6H_{12}O_6 + 6\ O_2$

Elements	Proportion of dry weight	
	ppm	%
C	450 000	45
O	450 000	45
H	60 000	6
N	15 000	**1,5**
K	10 000	1,0
Ca	5 000	0,5
Mg	2 000	0,2
P	2 000	0,2
S	1 000	0,1
Cl	100	0,01
Fe	100	0,01
Mn	50	0,005
B	20	0,002
Zn	20	0,002
Cu	6	0,0006
Mo	0,1	0,00001

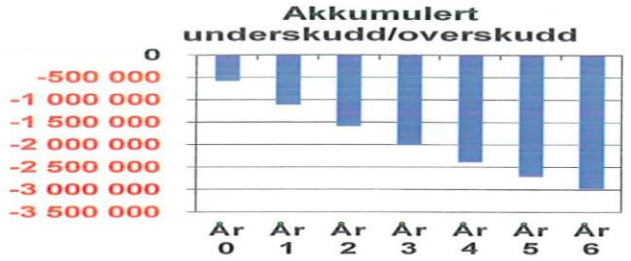
(Benton Jones, 2005)

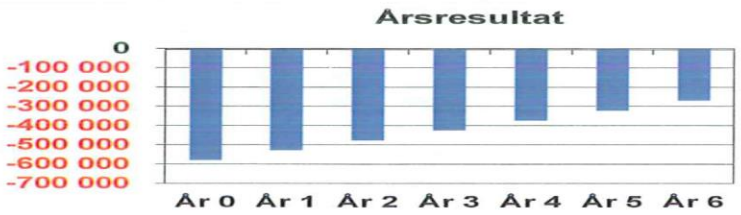
How much is it possible to increase plant production relative to fish production?

- It is important to be good in plant production and aquaculture at the same time, to get the most out of the potential of the products for sale
- Literature says that you *can* have approximately 7-10 kg plant biomass for 1 kg fish feed
- The good producers often gets between 4:1 to 8:1 in practise
- Healthy economy – fixed costs

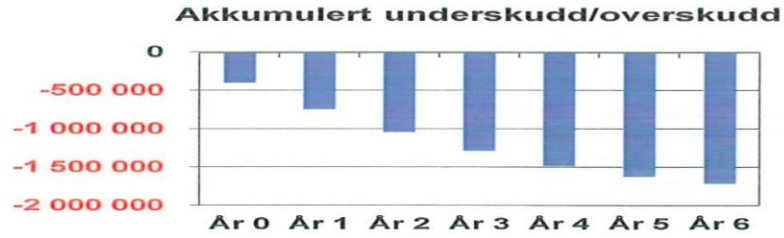
Economy TOMATO – estimated
(60 kg/m^2, -3%), (65 kg/m^2, 5%), (70 kg/m^2, 12%)

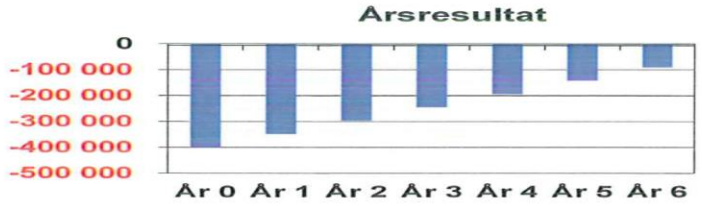
Settes produksjonen til 60 kg/m^2 i det samme oppsettet, blir resultatgraden -3 %.



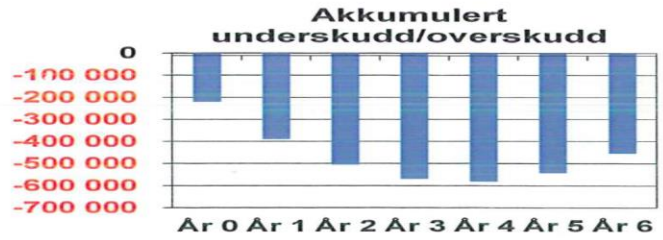


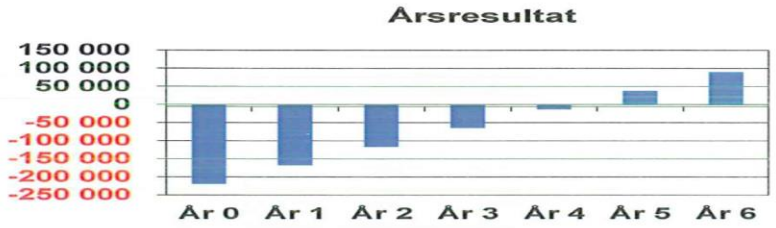
Nedenfor vises ved 65 kg/m^2 ved samme kostnader, og med en resultatgrad på 5 %.





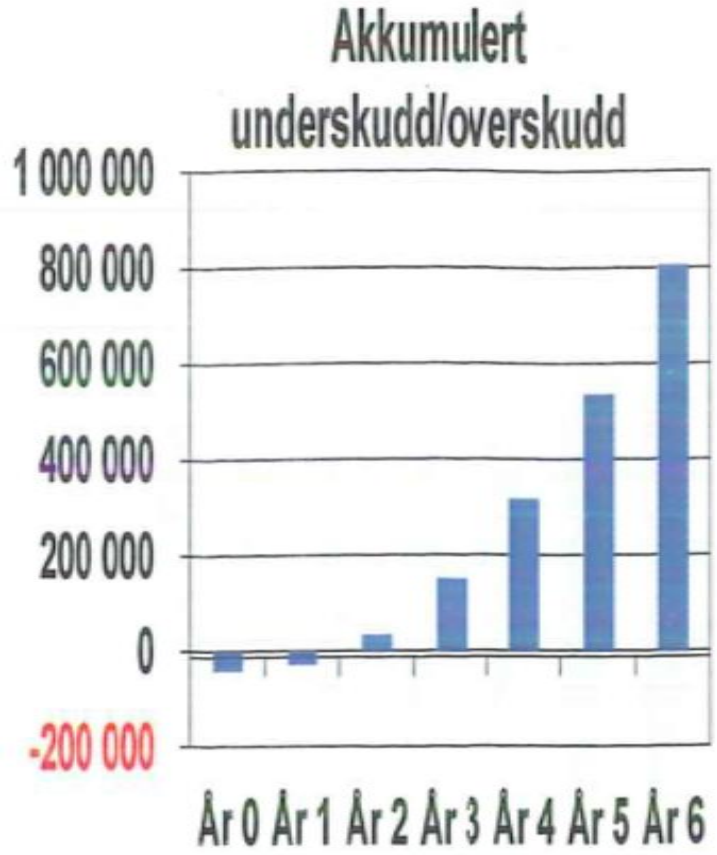
Nedenfor vises ved 70 kg/m^2 ved samme kostnader, og med en resultatgrad på 12 %.

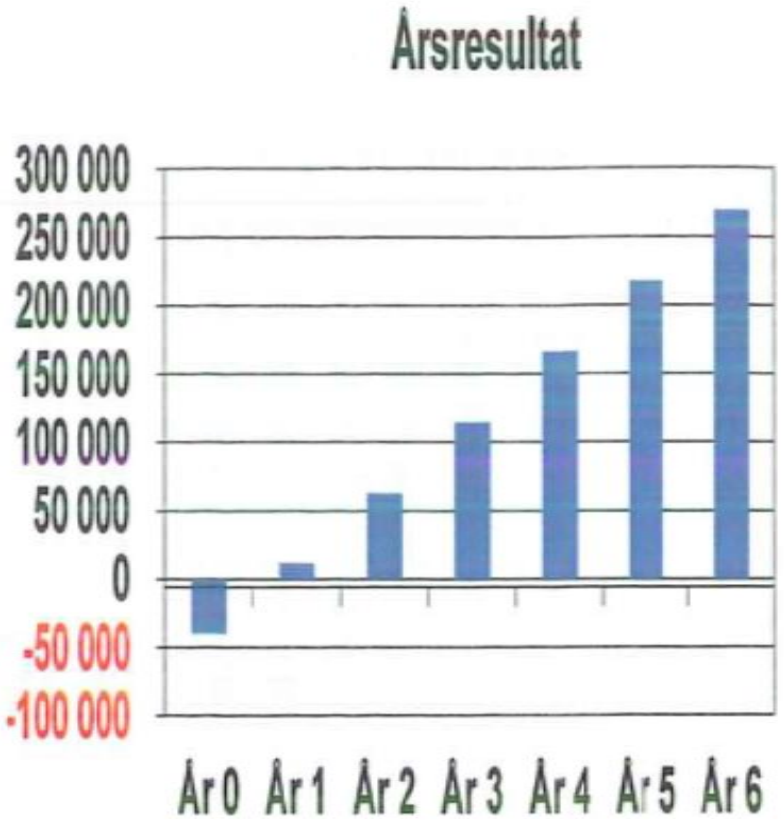




Economy TOMATO – estimated (75 kg/m^2, +18 %)

Nedenfor vises ved 75 kg/m^2 ved samme kostnader, og med en resultatgrad på 18 %.





Pilot aquaponic system at Bioforsk

tv.nrk.no/serie/dagsrevyen-21

Some experience due to plant growth

- Monitoring important parameters for fish/plants
  - Internal logger program stores data, communicate with modem and calls alarm phone
- Mass balance
  - fish feed/plant species/growth rates
- Growth rate
  - optimizing growth parameters
- Further plant selection for trout aquaponics
  - test plant has been lettuce
- Wet composting
  - Need more research
- Energy
  - monitoring energy use

‘Salanova’ LETTUCE

THE AQUAPONICS FACILITY AT BIOFORSK LANDVIK MARCH 2015

‘Crispy’ LETTUCE

Bioforsk Landvik

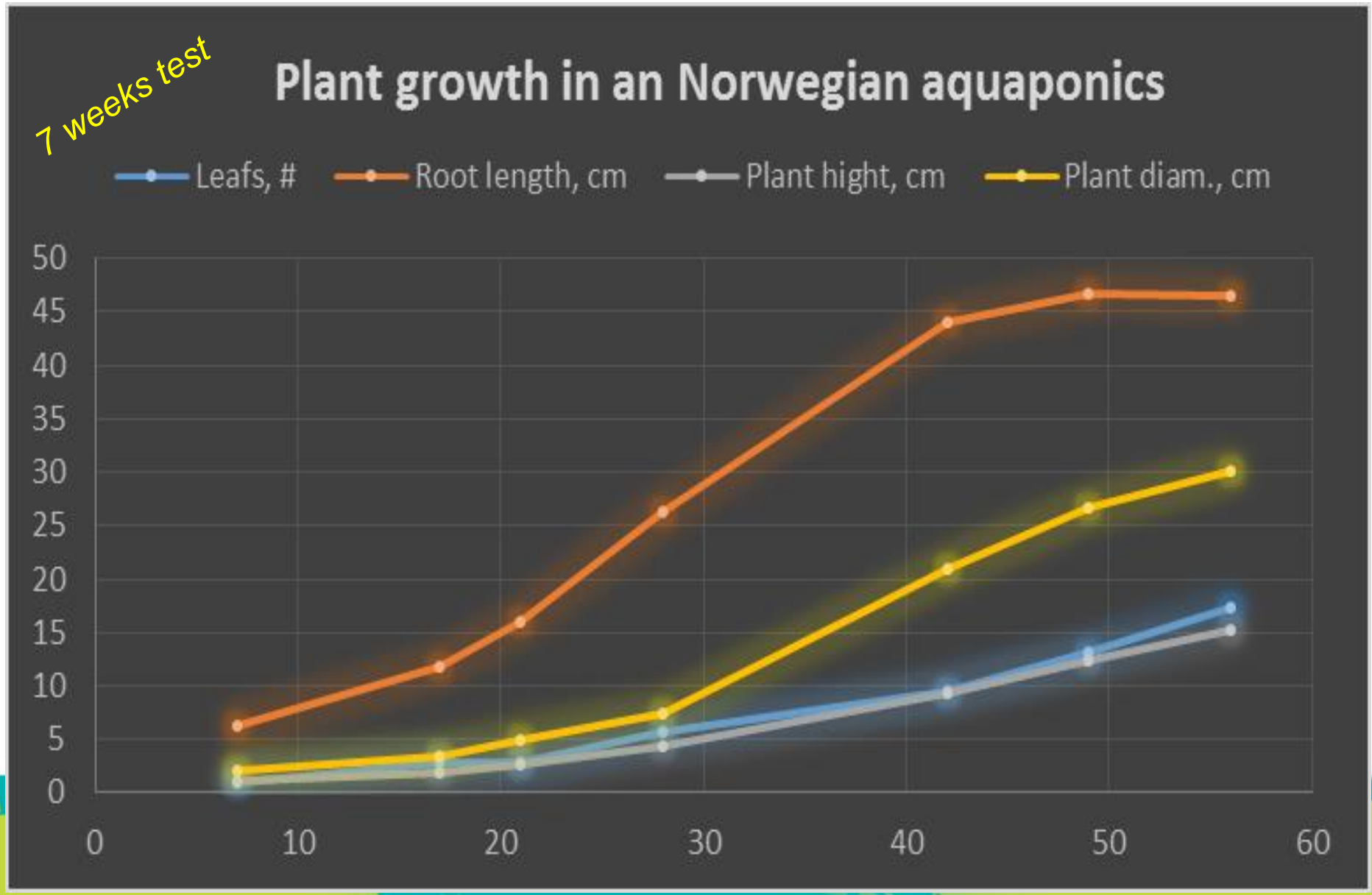
Avd. forskning innen aquaponics

Lokalitet 34317, Landvik

Nutrient content in trout aquaponics water and plants

- Stable system over the 7 weeks we tested it
- We found the balance in our system with trout and lettuce
- We don’t add anything than fish feed
- Plants were looking healthy all the period
- Water samples and samples from the plants were sent in for analysis for N, P, K, Mg, Ca, S, Mn, Fe, Na, Cu, Mo, Zn, B, Al, Si.
- We saw that Ca, Na, S and N accumulated a little over time in water
- The plants consumed more of Ca and Mn the latest 4 weeks in the system test, but less of Fe, Al and K

Plant growth in an trout aquaponics



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, phytophora,…
  - Marked strategy – what will our costumers have
- Good vegetables choice for Nordic countries can be different varieties in lettuce, basil, mitzuna, arugula, spring onion, salanova, red mustard, spinch, mint, watercress, chives, pac choi and other Asian greens. Strawberry, stevia, rosenroot…
- **ALSO – we wanted to see known numbers for plants, so we choose <u>lettuce, basils and mitzuna</u> for our trials**

Thank you for your attention!

Questions?

Contact: siv.skar@bioforsk.no
Skype: lookin4slgs