Trout in aquaponics
- some experiences from Landvik

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

Siv Lene Gangenes Skar,
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 1\textsuperscript{st} 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 \textit{largest interdisciplinary} research institute in the agricultural and environmental sphere, and \textit{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
Water treatment: 10% of water volume
Fish tanks: 30% of water volume
Plant beds: 60% of water volume

University of Virgin Island

System Layout

Total water volume, 110 m³
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
Aquaponics is a natural, organic method of soilless plant production.

There are no harmful herbicides or pesticides used in 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.*

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
Can aquaponic systems be adapted to Norwegian aquaculture?

Helge Liltved1*, Morten Homme2, Siv Lene Gangnes Skar3, Ole-Kristian Hess-Erga1, Stein Uleberg4 and Asbjørn Drengstig5

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2 Feedback Aquaculture ANS, Kranveien 60 C, N-4950 Risør
3 Bioforsk Øst Landvik, Reddalsveien 215, N-4886 Grimstad
4 Aquaponics AS, Bjørø, 4735 Evje
5 Hobas Ltd., P.O.Box 391, N-4067 Stavanger

Aquaponics - en spennende kombinasjon av akvakultur og landbruk

Aquaponics kombinerer landbasert akvakultur med restirkulering av vann og planteproduksjon i vannkultur uten bruk av jord (hydroponic) i ett og samme system. Denne produksjonsformen får stadig mer oppmerksomhet...
THE AQUAPONICS FACILITY AT BIOFORSK LANDVIK MARCH 2015

‘Salanova’ LETTUCE

‘Crispy’ LETTUCE
Definition Temperatures

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

Our activity: 150 m² totally
RAS - Recirculated Aquaculture System

Fish → Particle filtration → Biofiltration

Sump → Environment pH, temp., O₂, CO₂, NH₃, NO₃, → Heating/Cooling Aeration

Water in → Water out → Water out

Discharge
RAS + Hydroponics = Aquaponics

Fish
Particle filtration
Biofiltration
Plants

Sump
Water in
Water out

Environmental
pH, temp., O₂,
CO₂, NH₃, NO₃,

Heating / Cooling
Aeration

Discharge
Wet composting

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)

<table>
<thead>
<tr>
<th>Elements</th>
<th>Parameter</th>
<th>Unit</th>
<th>Plants – water in</th>
<th>Plants – water out</th>
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<td>TDS</td>
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<td>Mo</td>
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<td>Na</td>
<td>mg/l</td>
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Aquaponic system with drip/irrigation

(Enduet et al, 2010)

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<thead>
<tr>
<th>HLR (m³/m² day)</th>
<th>Plant bed</th>
<th>BOD</th>
<th>TSS</th>
<th>TAN</th>
<th>NO₂-N</th>
<th>NO₃-N</th>
<th>TP</th>
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<td>78.3</td>
<td>89.5</td>
<td>42.3</td>
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Plant growth and nutrition

Photosynthesis: \[6 \text{H}_2\text{O} + 6 \text{CO}_2 \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2\]

<table>
<thead>
<tr>
<th>Elements</th>
<th>Proportion of dry weight</th>
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<td></td>
<td>ppm</td>
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<td>C</td>
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<tr>
<td>O</td>
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<tr>
<td>H</td>
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<tr>
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<td>Fe</td>
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<td>B</td>
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<tr>
<td>Zn</td>
<td>20</td>
</tr>
<tr>
<td>Cu</td>
<td>6</td>
</tr>
<tr>
<td>Mo</td>
<td>0,1</td>
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</table>

(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/m², +18 %)

Nedenfor vises ved 75 kg/m² 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
THE AQUAPONICS FACILITY AT BIOFORSK LANDVIK MARCH 2015

'Crispy' LETTUCE

'Salanova' LETTUCE
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

![Graph showing plant growth in Norwegian aquaponics]

7 weeks test
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, mitzuna, 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 mitzuna for our trials
Thank you for your attention!

Questions?

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