



# Fremtidens havbruk trenger bioteknologisk forskning.

Sett fra fiskefôrindustrien

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**EWOS**<sup>®</sup>



# Outline

- ▶ **Biotechnology is already in wide use in the feed supply chain**
  - Fermentation in processing feed ingredients
- ▶ **Biotechnology has become a major tool in feed research and development**
  - Examples from EWOS Innovation
- ▶ **Options for future wider use**
  - Can microalgae become a major and sustainable feed resource



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# Fermentation as manufacturing technology

## As ingredient

- ▶ Yeast
  - Feed yeast
  - Phaffia pigments
  - Yeast derivatives
    - Beta glucans
    - Nucleotides
    - Mannan oligo saccharides (MOS)
  - Organic bound minerals
- ▶ Bacteria
  - Bioprotein
  - Immunstimulants
- ▶ Algae
  - Protein
  - Lipids

## As manufacturing technology

- ▶ Vitamins
  - Vitamin B family
  - Vitamin K
- ▶ Aminoacids
  - Lysin
  - Treonin
  - Histidin
- ▶ Enzymes
  - Phytase
  - Carboxylases
  - Proteaser
  - Lipaser

# Enzymatic modification

- ▶ Fish silage
  - An important feed ingredient
  - Enzymatic degradation (autolysis) and conservation well suited for preservation and upgrading of fish by-products
  - Low cost makes the technology useful to preserve resources with
- ▶ Fish hydrolysates
  - Controlled modification of fish proteins
  - Aim to improve bioavailability and find new properties
- ▶ Animal by-products
  - Max 10000 dalton
  - Improve bioavailability, e.g. feathermeal



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# ▶ Biotechnology at EWOS Innovation (EI) **EWOS**<sup>®</sup>

- ▶ EI initiated a biotechnology program six years ago
- ▶ Aim: Develop biomarkers of feed composition and performance

**High Field NMR:** (EI Dirdal and Imperial College UK)

- fish meal and oil composition
- processed feed vs raw ingredients
- small fish as biosensor of ingredients
- salmon plasma metabolites

**Gene Expression:** (EI, NIFES Bergen and St Andrews UK)

- fast and slow growth models
- growth hormones, receptors, binding proteins

**Protein Expression:** (EI and St Andrews UK)

- protein antibodies for high throughput analysis

**Biology and Technology of Feed Trials**

- develop methodology for rapid feed trials of groups and individuals
- redesign trials to allow sampling for metabolic, gene and protein marker discovery and application

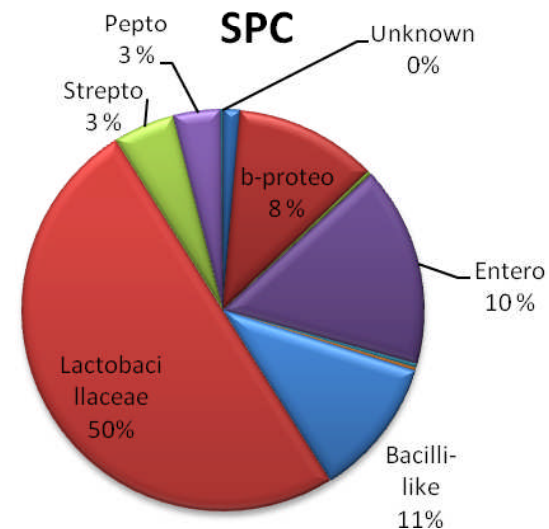
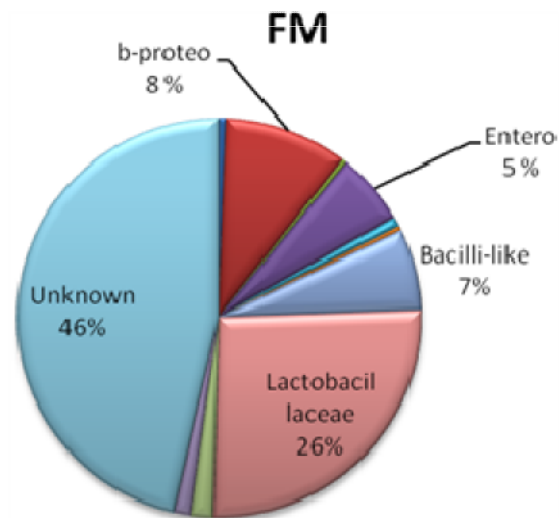
# Biotechnology use for quick answers

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- ▶ Test raw materials
- ▶ Rapid analytical methods on molecular level
- ▶ Diagnostics
- ▶ Differentiate between bacterias in the gut
- ▶ Sea lice *in vitro* screening
- ▶ Method development



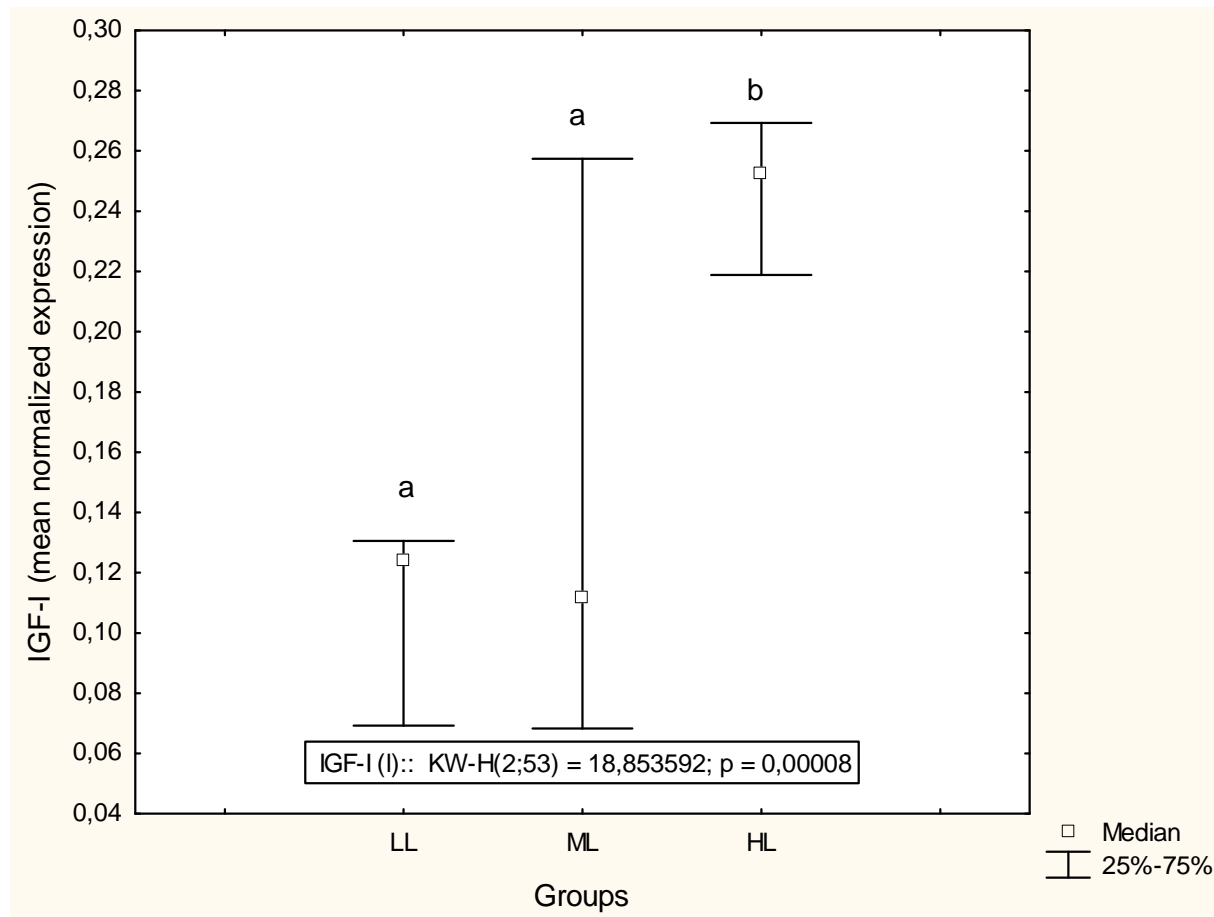
Salmon intestine bacterial species are measured by gene expression. A fishmeal (FM) enriched diet has distinct gut microflora from soy (SPC) diet



# “Speedometer – 1”



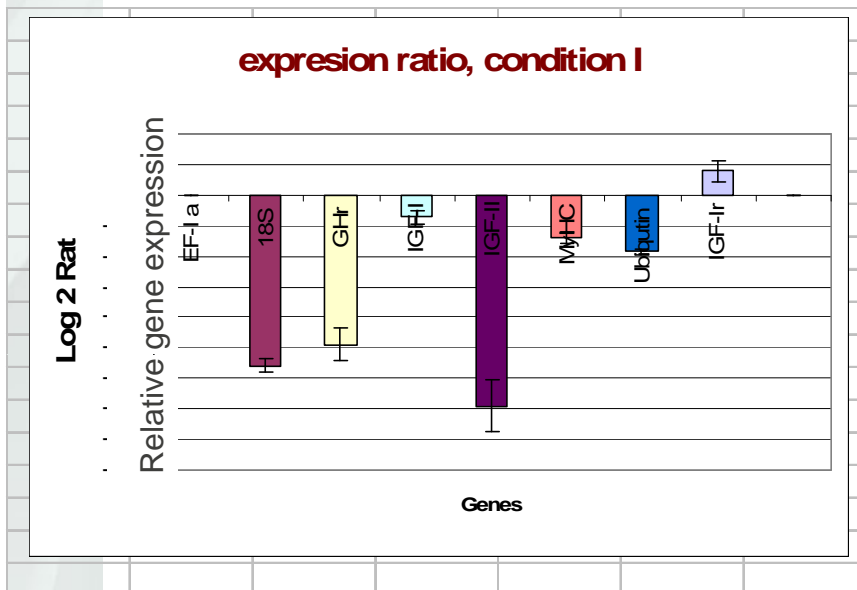
## Gene expression in hepatic tissue of salmon fed lysine above and below requirement



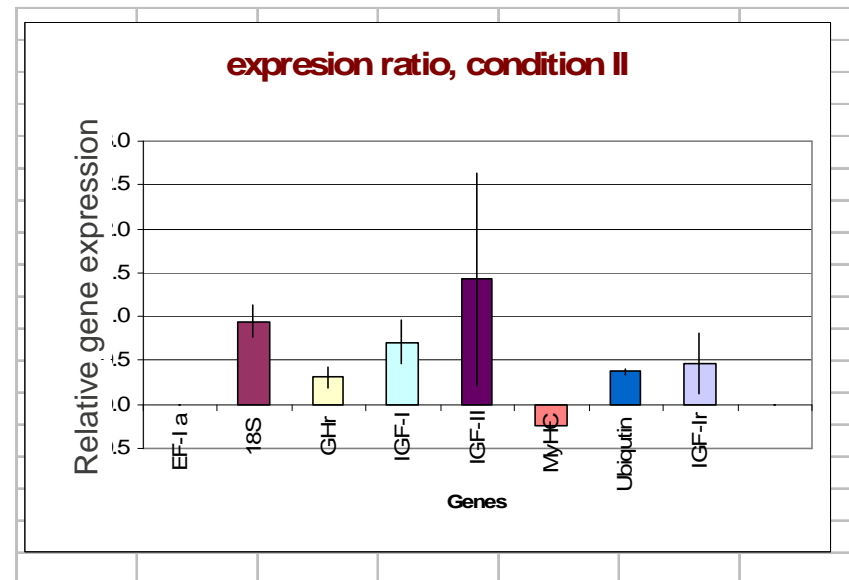
IGF-I was significantly up regulated by 2.2 fold in salmon fed high lysine (HL) vs. required lysine level.

# “Speedometer -2”

## Gene Expression and Muscle Growth



slow growth



fast growth

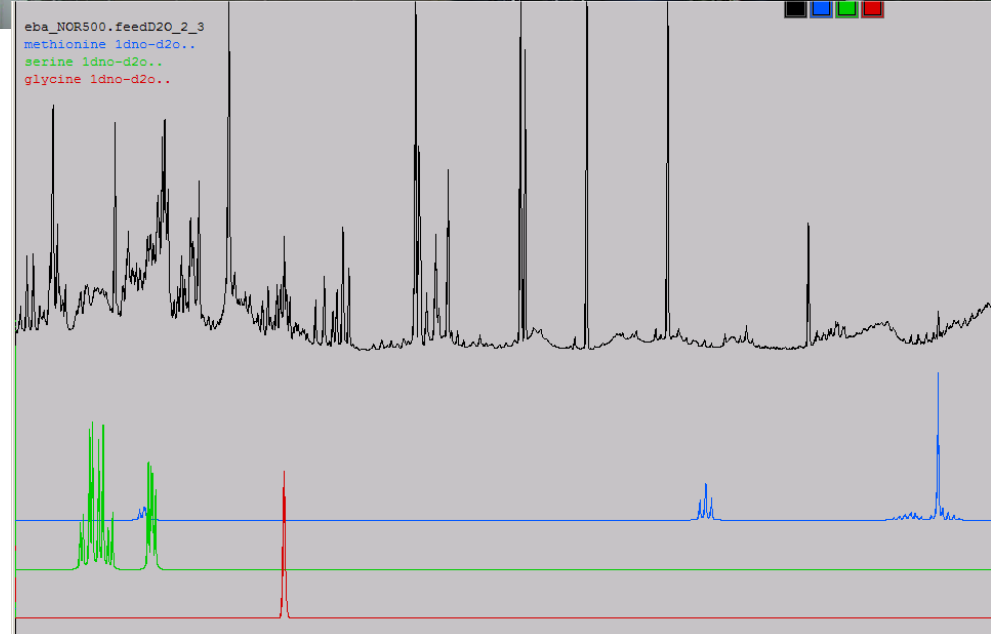
PCR shows tendency for decrease of GH-receptor, IGF-II, and ubiquitin in slow vs normal growth. Tendency for increased IGF-I, IGF-II, IGF-receptor with fast growth. (16S and EF-1 are standards)

# Metabolomics: Raw material profiling

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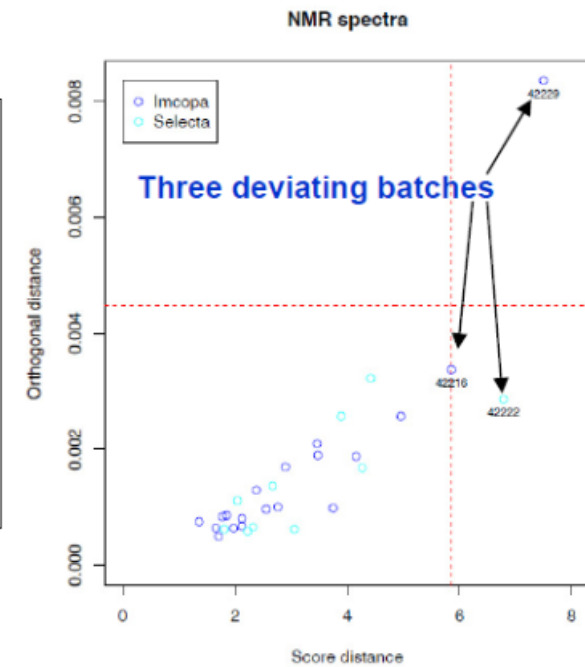
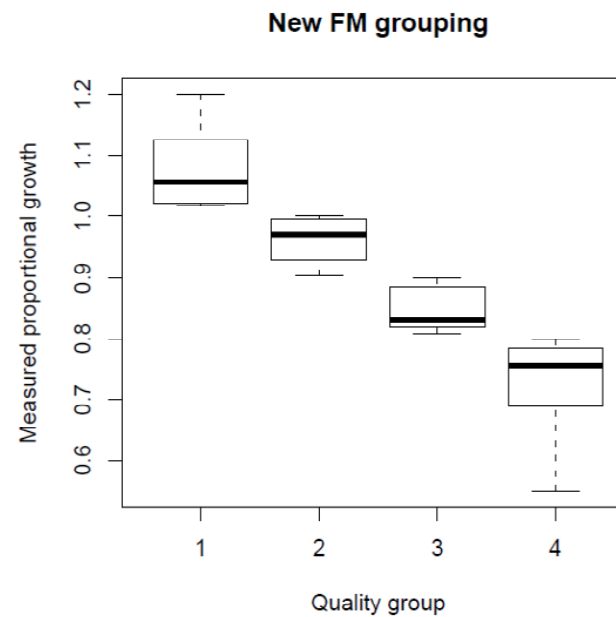
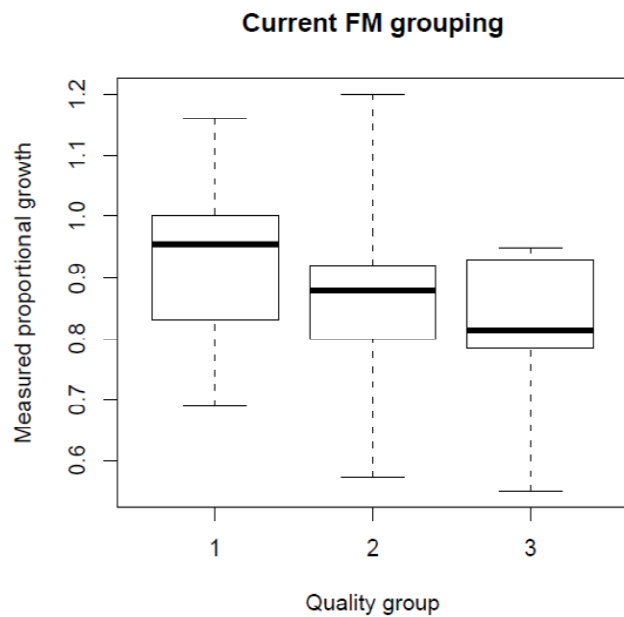
***HF-NMR  
metabolic  
profiling of raw  
materials.***

***Advanced  
visualization and  
analysis of  
spectroscopic  
data with  
applications to  
all types of  
samples.***



# Fish meal quality is predicted from regression models using chemical spectra

## Fm Tool



# Diagnostic tools

## ▶ RT – PCR Lab

- Fish Pathogen Diagnostics PCR analysis for 5 fish pathogen (ISAv, BKD, SRS, PD, IPNv).
- Capacity of 4500 PCR / month.
- Capacity of 1200 fish / month.



## ▶ Sea Lice Lab

- Anti attachment compounds
- *In vitro* DFB efficacy monitoring

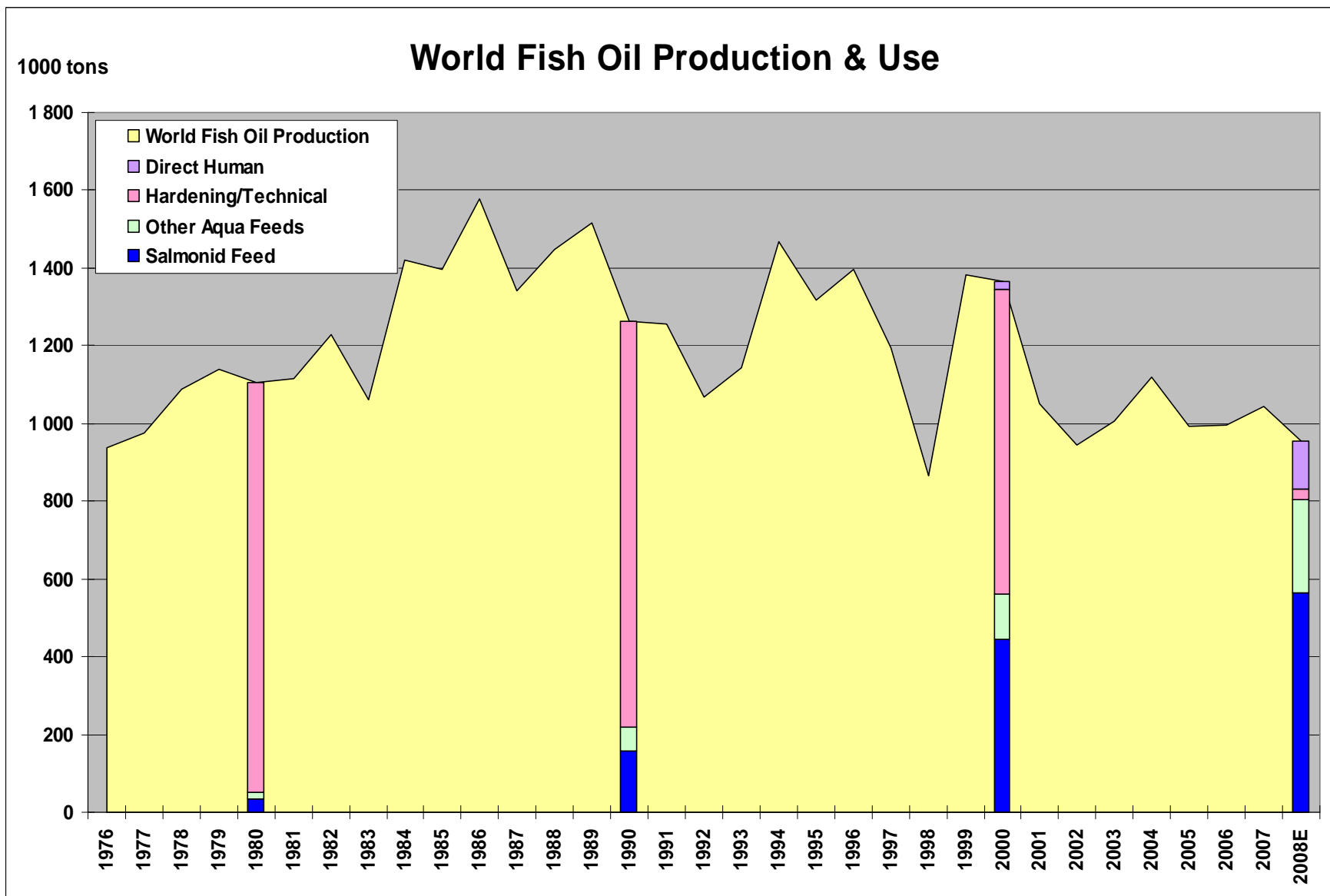




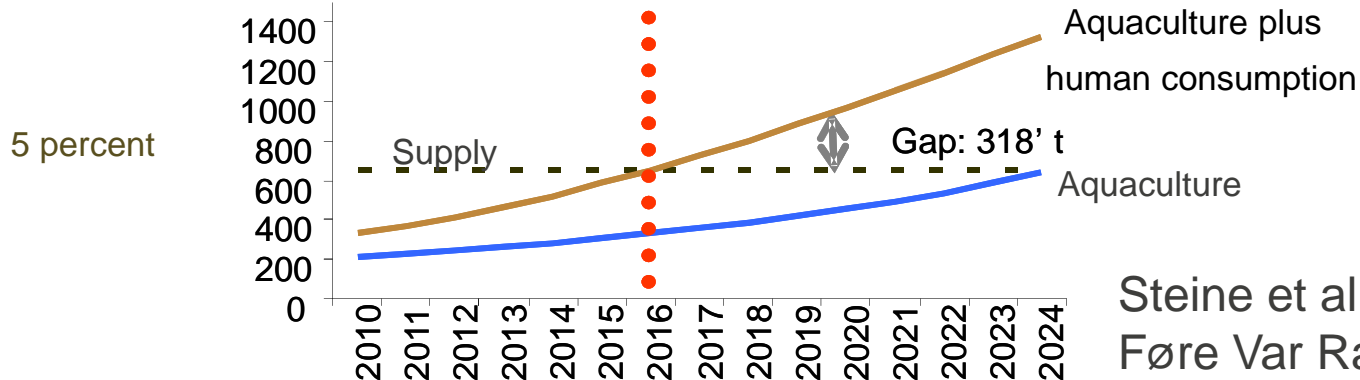
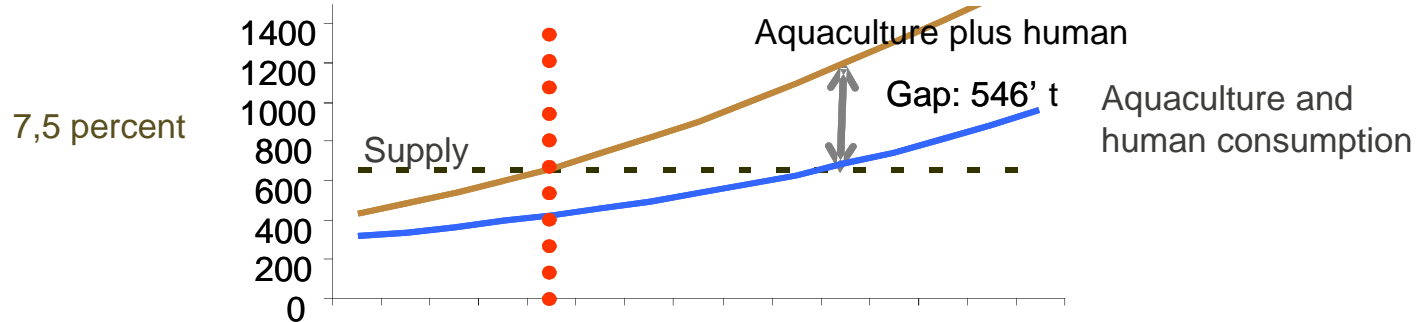
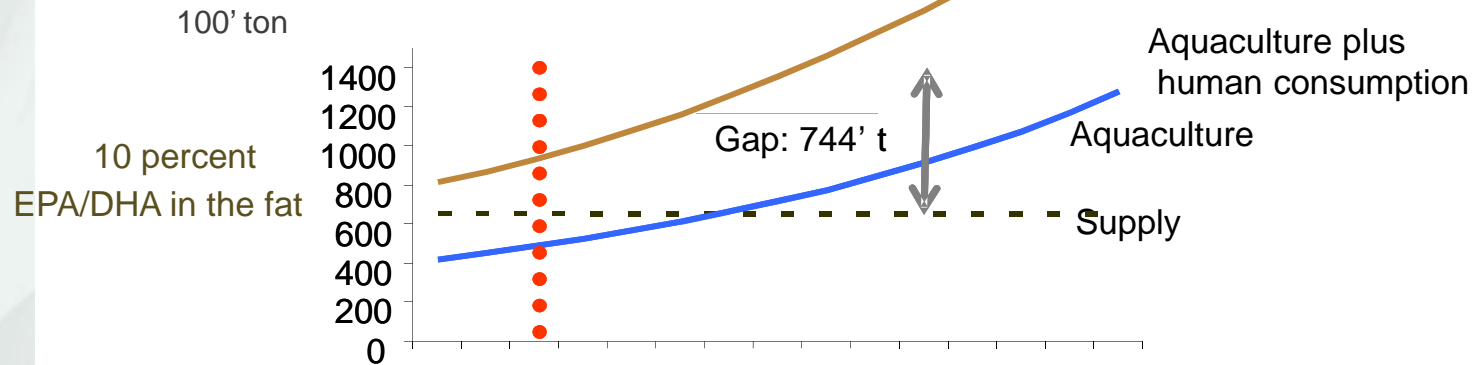
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Sources:  
 Production: FAO  
 Usage: Holtermann



# Undercoverage and severe increase in EWOS<sup>®</sup> substitution can arise quickly



Steine et al., 2011, NILF;  
Føre Var Rapport



## Alternative EPA+DHA sources to fish oil

- ▶ EPA/DHA GM plant oil:
  - Potentially available in 5-10 years. GM currently not accepted in EU.
  
- ▶ Microbes:
  - GM yeast production through fermentation suggests relatively high price.
  
- ▶ Krill, new fish species, other marine organisms:
  - Large biomass but costly to catch.
  - Precautionary management policies will not allow heavy volumes
  
- ▶ Algae:
  - Currently low volumes and high prices.

## Algae as EPA/DHA source in feeds

- ▶ Algae needs to be price competitive with fish oil on EPA+DHA per weight of product basis to get into feed formulation.
  - Scarcity may drive prices in the future
  -
- ▶ In order to penetrate fishfeed market, we need large volumes
  - Ambitions must be in the area of producing minimum 100 000 tons of fish oils equivalents
- ▶ EPA/DHA may need to be extracted as oil from algae for coating pellet which adds extra cost. Potential reasons below:
  - High fat algae exceeds maximum fat level in dry mix for proper pellet expansion in extruder.
  - High carbohydrate/ indigestible takes up too much space in formulation.
  - Negative effects of algae components on growth or health



# Summary

- ▶ **Biotechnology is already in wide use in the feed supply chain**
  - **Examples are shown on well established applied biotechnology**
- ▶ **Biotechnology has become a major tool in feed research and development**
  - **EWOS Innovation use biotech as tool for beter and quicker product development**
- ▶ **Options for future wider use**
  - **Can microalgae fill the gap on supply of omega-3 fatty acids**

An aerial photograph of a lush green landscape, possibly a forest or agricultural field, with a bright sun flare in the center. The sun is positioned in the upper middle of the frame, creating a strong lens flare effect that radiates across the scene. The ground below is a mix of dark and light green, suggesting different vegetation or terrain. The overall mood is bright and natural.

Thank you for your attention

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