GAIN
Green Aquaculture Intensification

SUMMER SCHOOL

FROM AUGUST 30TH TO SEPTEMBER 3RD

This project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 773330 (GAIN)

GAIN Green Aquaculture Intensification

SUMMER SCHOOL

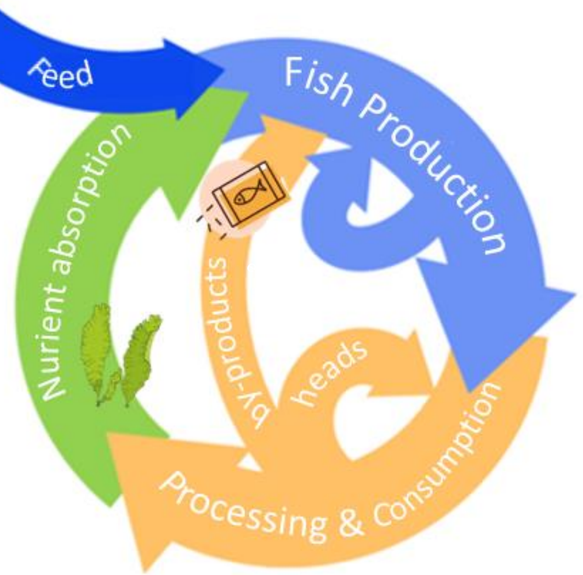
ASSESSING ECONOMIC SUSTAINABILITY OF INNOVATIONS: THE “TYPICAL FARM” APPROACH

SEPTEMBER 2ND

DR. CORNELIA KREISS et al.

This project receives funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 773330 (GAIN)

„SUSTAINABLE“ PRODUCTION PRACTICES - ECONOMIC SUSTAINABILITY?



picture sources: bp milling, BAF, CKreiss

„SUSTAINABLE“ PRODUCTION PRACTICES - ECONOMIC SUSTAINABILITY?

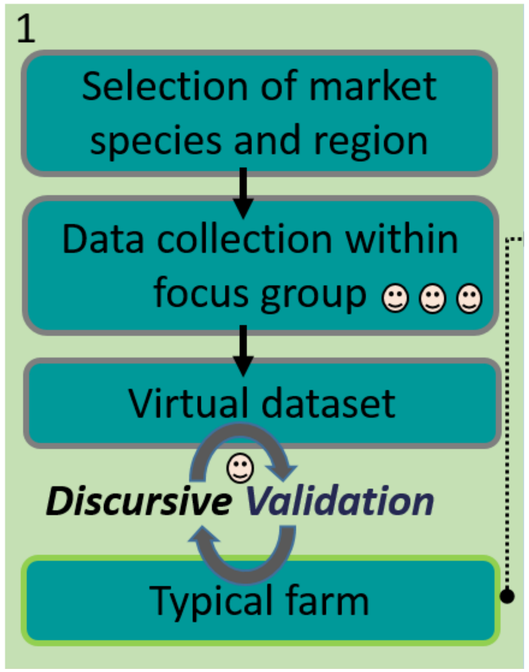
Changes in production practices and investment, such as feed composition or including an aquaponic unit within production may impact several productivity parameters:

- bioeconomic productivity indicators: growth, survival, and FCR
- capital investment
- labour input
- energy demand…

➔ eco-efficient production & valorisation of by-products may open up new value chains/marketing opportunities.

Economic costs-benefit analyses are crucial to assess if „sustainable production practices“ are also sustainable from an economic point of view

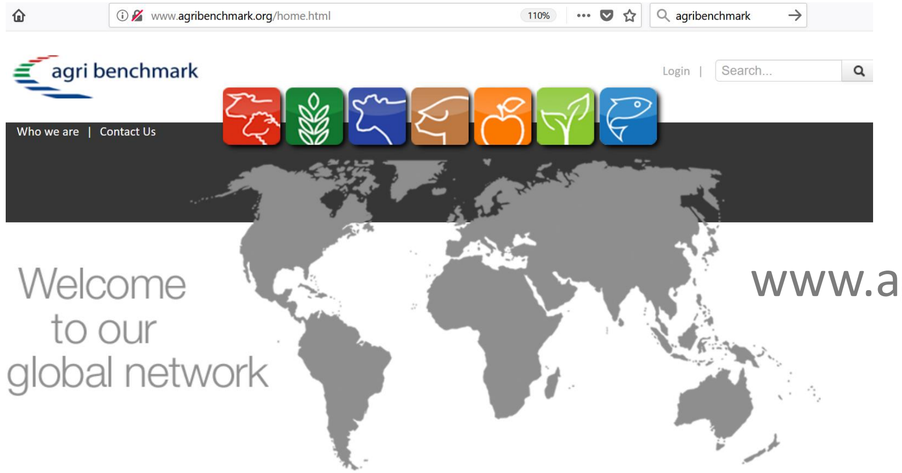
TYPICAL FARM APPROACH



- Standardized sampling & data collection strategy for farm economic datasets
- Originating in agricultural economics & applied by various institutions

➔ *agri benchmark*: Network of scientists, advisors & producers

Founded 2006; coordinated by Thünen-Institute
Comparison of agriculture and fish production systems



www.agribenchmark.org

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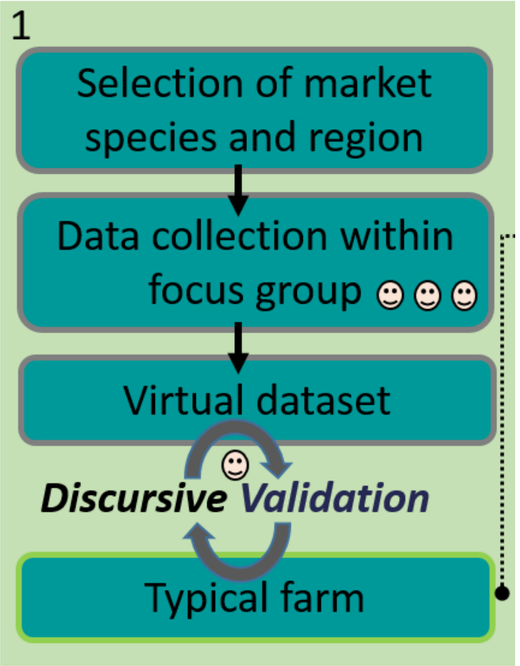
TYPICAL FARM APPROACH



A typical farm…

… is a virtual dataset, which is empirically grounded. It is based on information about real costs, techniques and other inputs;

… is located in a region regarded as typical for the specific fish production within the study country;

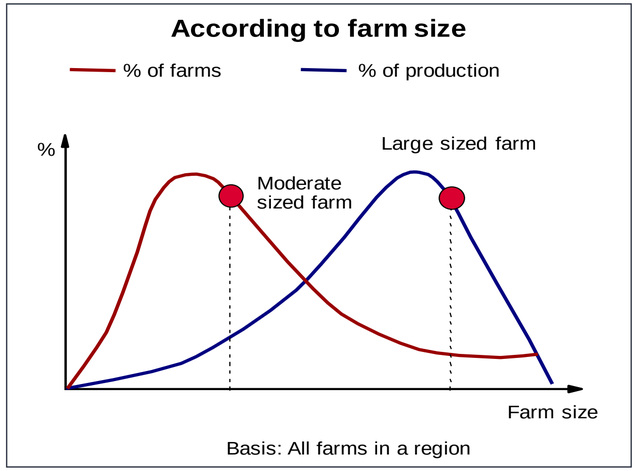
… combines operating resources, labour and capital in a way, which can be seen as good example for a typical fish production in this region;

… pictures a coherent image of the quantity structure of production processes and prices of an ideal type of a fish farm.

… reflects the prevailing production system with common technology, capital input, labour resources and typical production volume within a representative region

TYPICAL FARM – SOURCES OF DATA

STATISTICS



Tobias Lasner

- identify regions (NUTS)
- farm sizes and distribution
- pre-define cases

FOCUS GROUPS

- define cases
- define variables' values

INTERVIEWS/FARM VISITS

Pictures: Cornelia Kreiss

- review variables
- production system knowledge
- interpret data

TYPICAL IS NOT AVERAGE – HOW TO START

Production Capacity	Number of Farms
1-49	1512
50-99	84
100-249	307
250-499	132
500-999	274
>1000	9

Tobias Lasner

~~Average farm size (in tonnes/farm) = 159 t / farm~~

- Which class has the highest share in volume and/or represents the majority of farms? ✔
- Define model farms: ✔
  - good practice
  - best practice
  - niche system farm ✔

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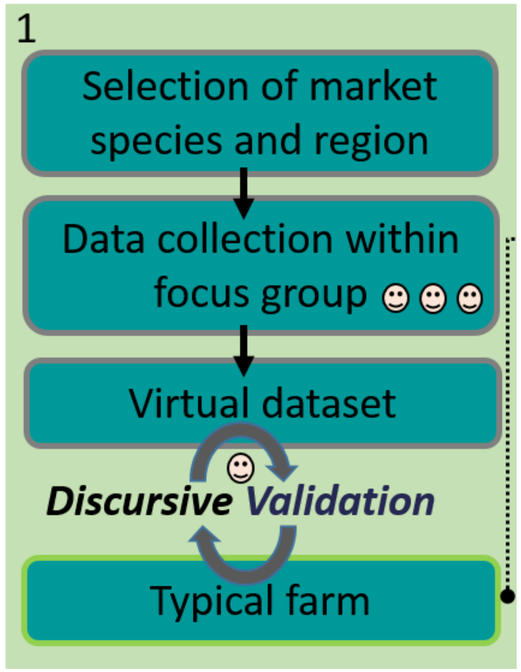
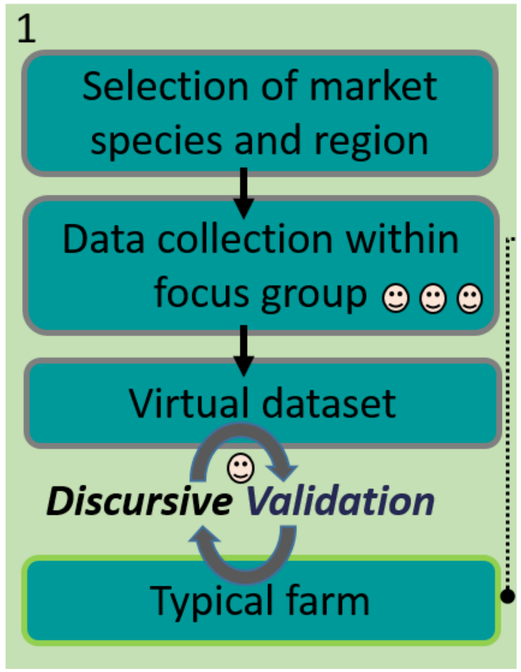
TYPICAL FARM – COST TYPES



1. Cash costs

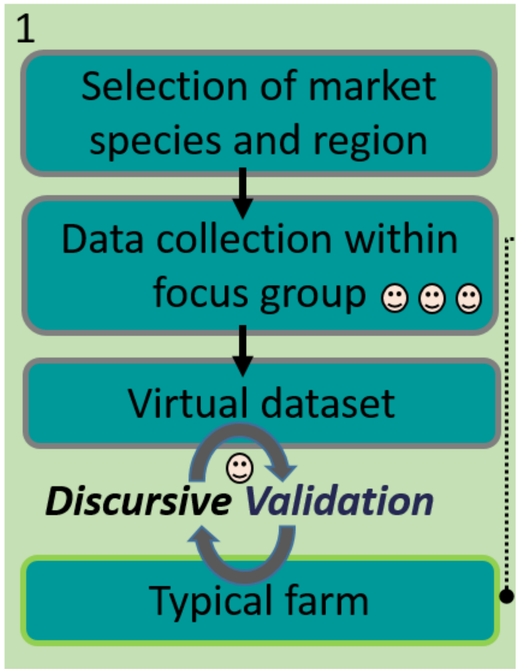
TYPICAL FARM – COST TYPES



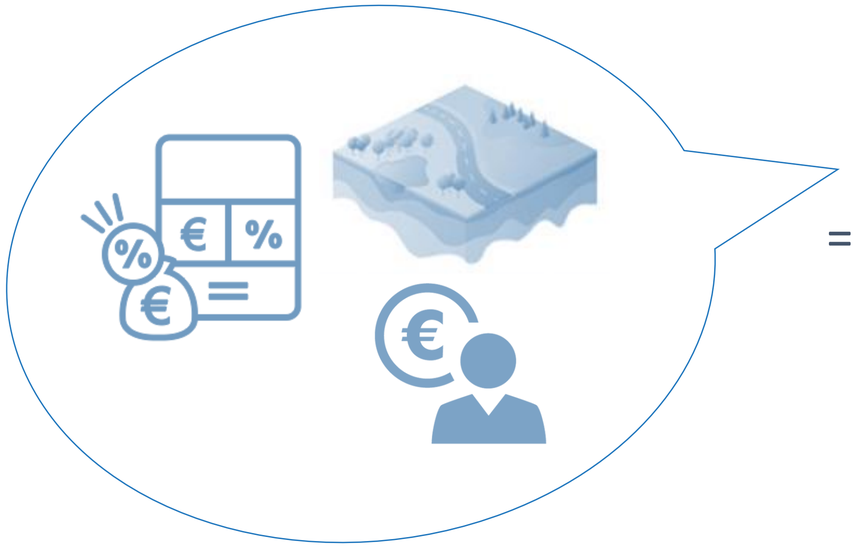
1. Cash costs
2. Depreciation (Buildings, Equipment, Farming systems)

$$\sum \frac{\text{Replacement value}}{\text{Economic lifetime}}$$

TYPICAL FARM – COST TYPES

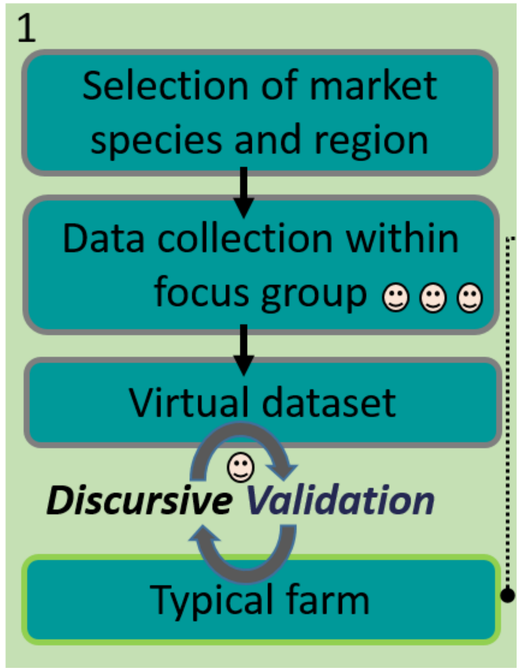


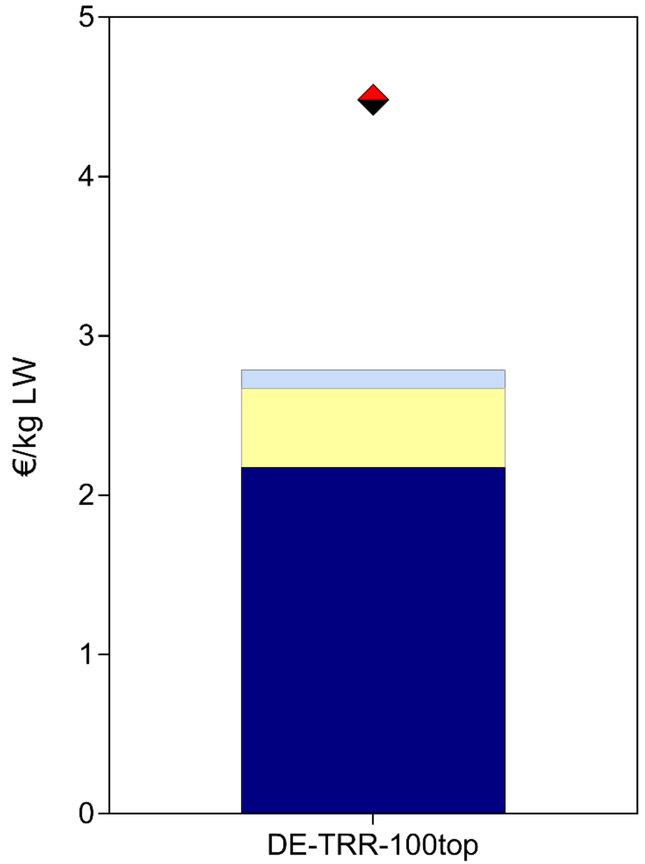
1. **Cash costs**
2. **Depreciation** (Buildings, Equipment, Farming systems)
3. **Opportunity costs** (labour, capital, property)



∑ own production factors
= wage, interest & rent approach

TYPICAL FARM – EXAMPLE





D) Market returns

C) Opportunity costs

B) Depreciation

A) Cash costs

Profit

Long-term = D – (A + B + C)

Mid-term = D – (A + B)

Short-term = D – A

ADVANTAGES AND TODAY'S APPLICATION

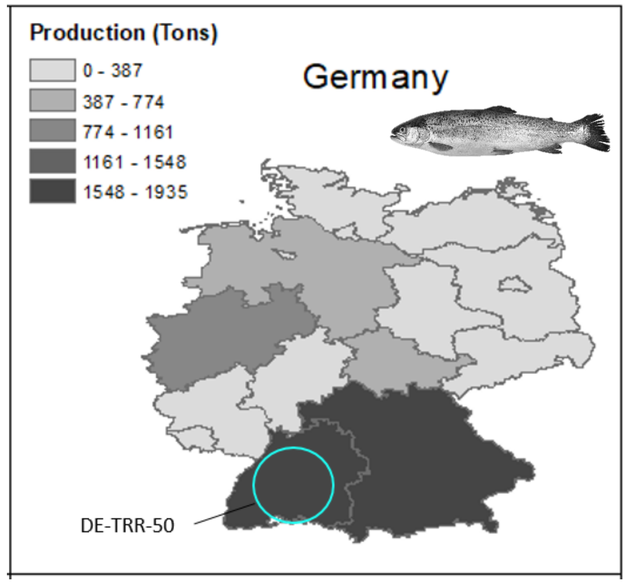
- Understand the economic drivers at farms and fisheries level
- Standard global operating procedure for data collection
- Exchange knowledge and datasets
- Join projects

Free membership "put one farm in… get the world back"

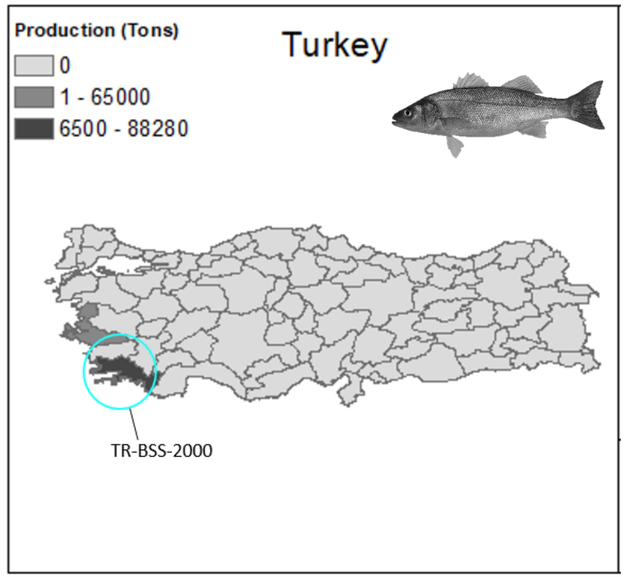
Horizon 2020
European Union Funding
for Research & Innovation

APPLICATION GAIN INNOVATIONS - FEED

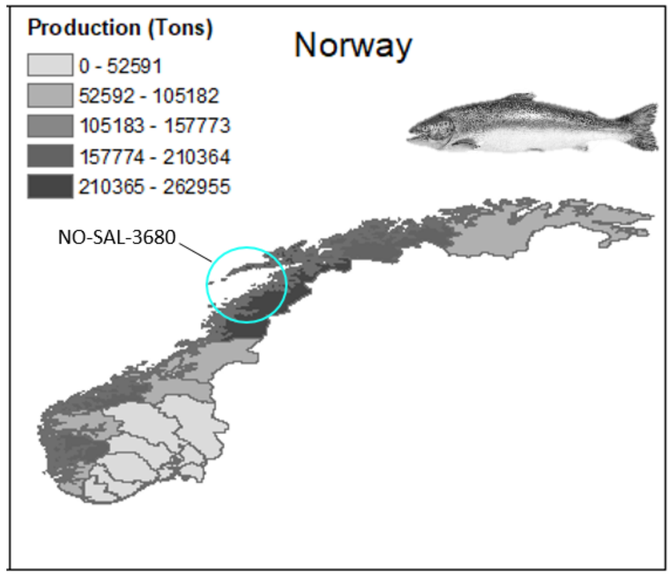
Enhancing circular economy while reducing pressure on fisheries and farm land resources and carbon footprint



50t trout raceway/pond farm
Region: Baden-Württemberg



1000t seabass/seabream netcage farm
Region: Muğla



3680t salmon netcage farm
Region: Nordland

Maps: CERES project, modified

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APPLICATION GAIN INNOVATIONS - FEED

Enhancing circular economy while reducing pressure on fisheries and farm land resources and carbon footprint

GAIN SUMMER SCHOOL

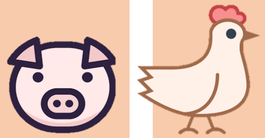
CONTROL FEED

Current standard feed including fishmeal (FM), e.g. soy products, wheat

APPLICATION GAIN INNOVATIONS - FEED

Enhancing circular economy while reducing pressure on fisheries and farm land resources and carbon footprint

CONTROL FEED	NOVEL FEED I	NOVEL FEED II	NOVEL FEED III	NOVEL FEED IV
Current standard feed including fishmeal (FM), e.g. soy products, wheat	Byproducts from livestock production No fishmeal	Byproducts from livestock production No fishmeal	Focus on greens No fishmeal	Focus on greens includes fishmeal



APPLICATION GAIN INNOVATIONS - FEED

Enhancing circular economy while reducing pressure on fisheries and farm land resources and carbon footprint

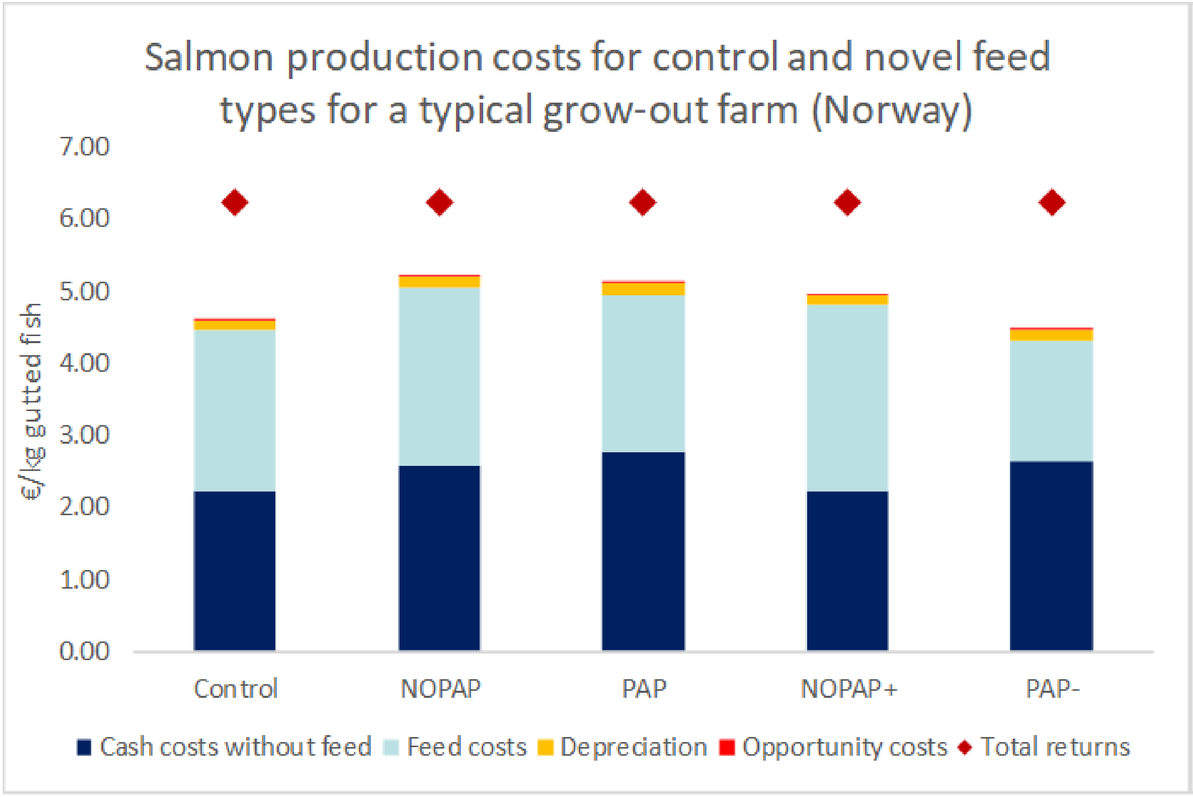
GAIN SUMMER SCHOOL

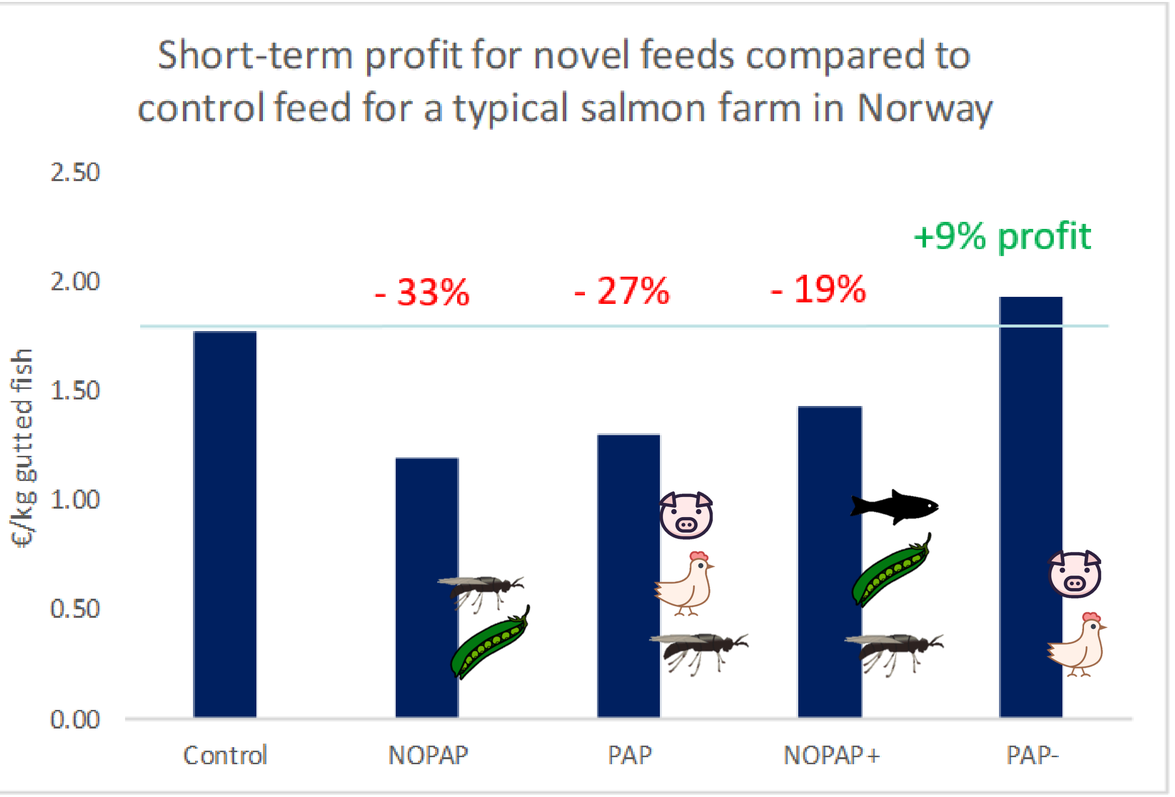
CONTROL FEED	NOVEL FEED I	NOVEL FEED II	NOVEL FEED III	NOVEL FEED IV
Current standard feed including fishmeal (FM), e.g. soy products, wheat	Byproducts from livestock production No fishmeal	Byproducts from livestock production No fishmeal	Focus on greens No fishmeal	Focus on greens includes fishmeal

EMERGING INGREDIENTS
Insect meal - microbial biomasses

INGREDIENTS ORIGINATING FROM CIRCULAR ECONOMY PRINCIPLES & EU RESOURCES
FPH - microalgae - macroalgae - vegetable protein concentrates of European origin

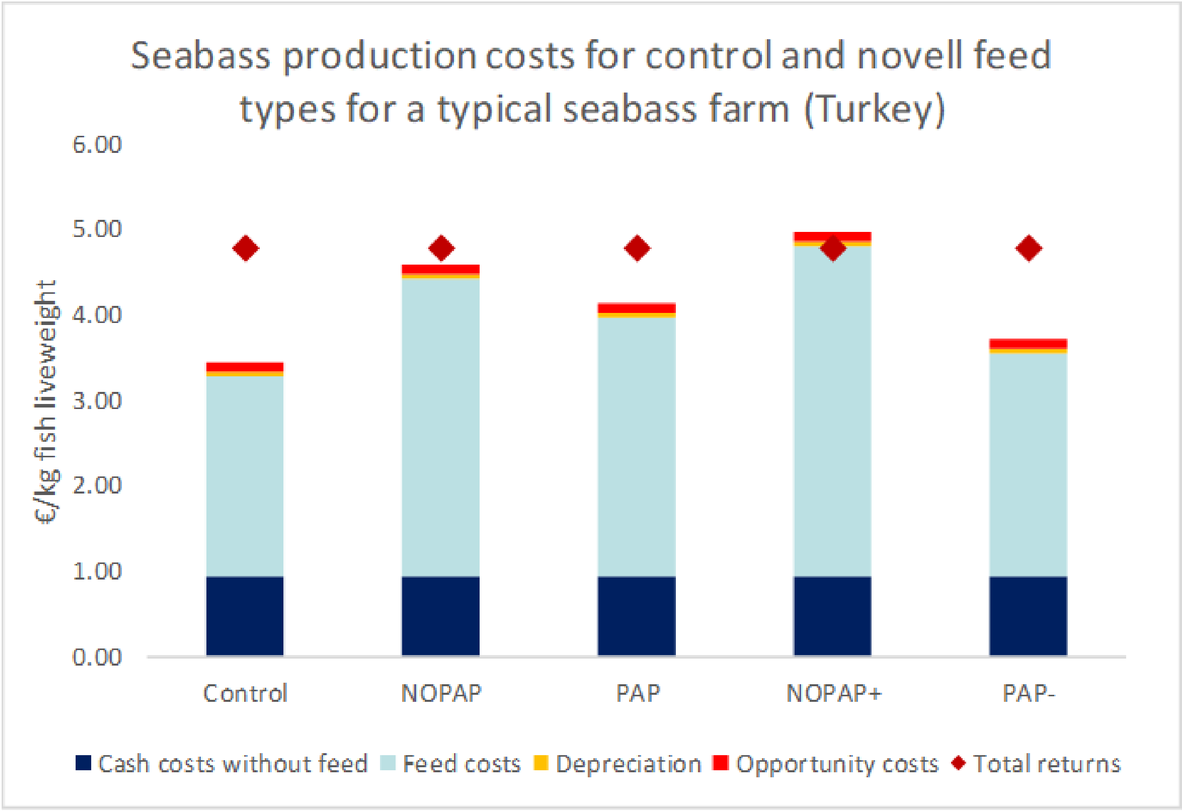
APPLICATION GAIN INNOVATIONS - FEED

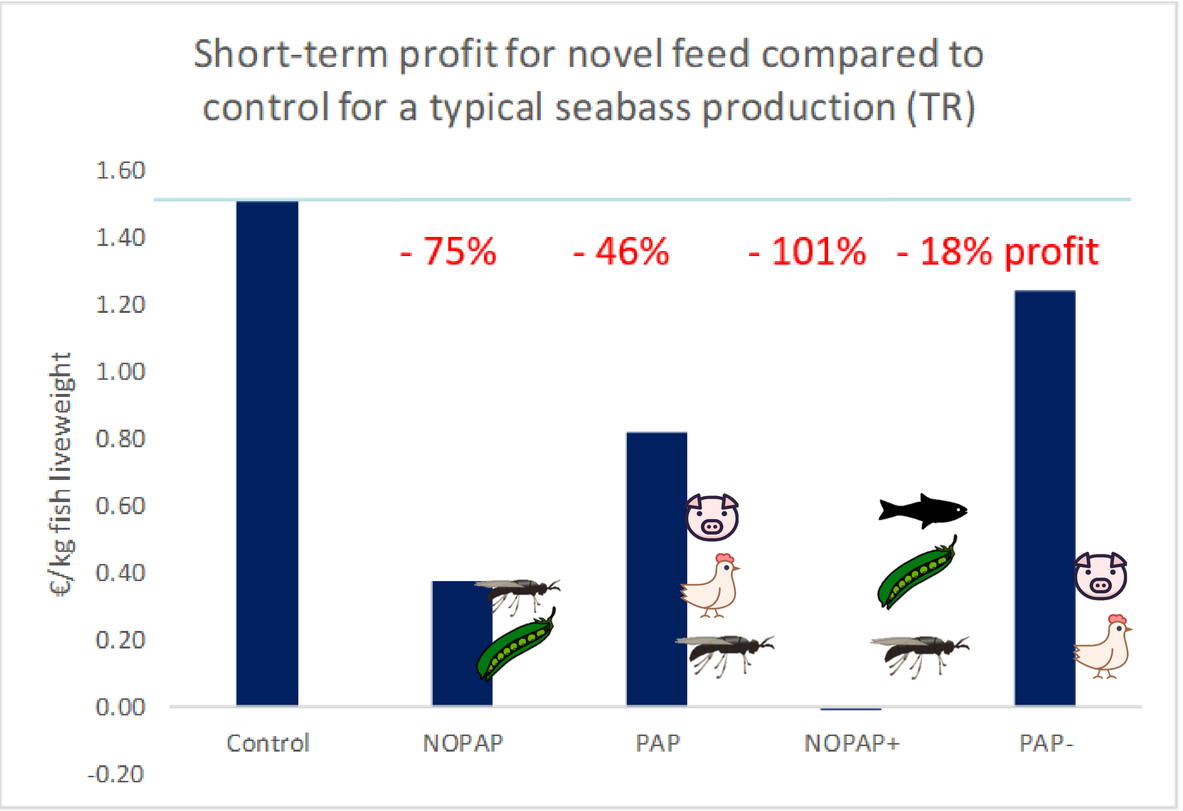


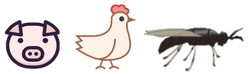


SALMON				
WEIGHT GAIN	▼	▼		▼
FCR	▲	▲		▲
PRICE	$$$	$$	$$$$	$

APPLICATION GAIN INNOVATIONS - FEED



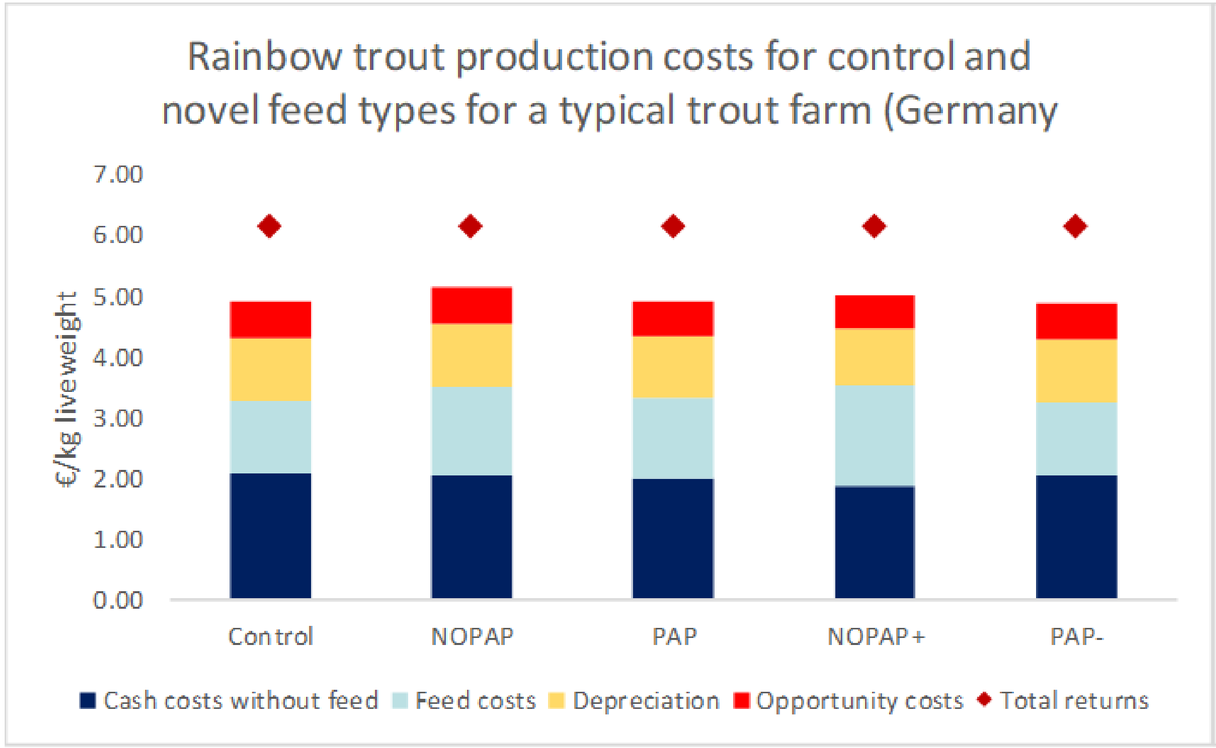


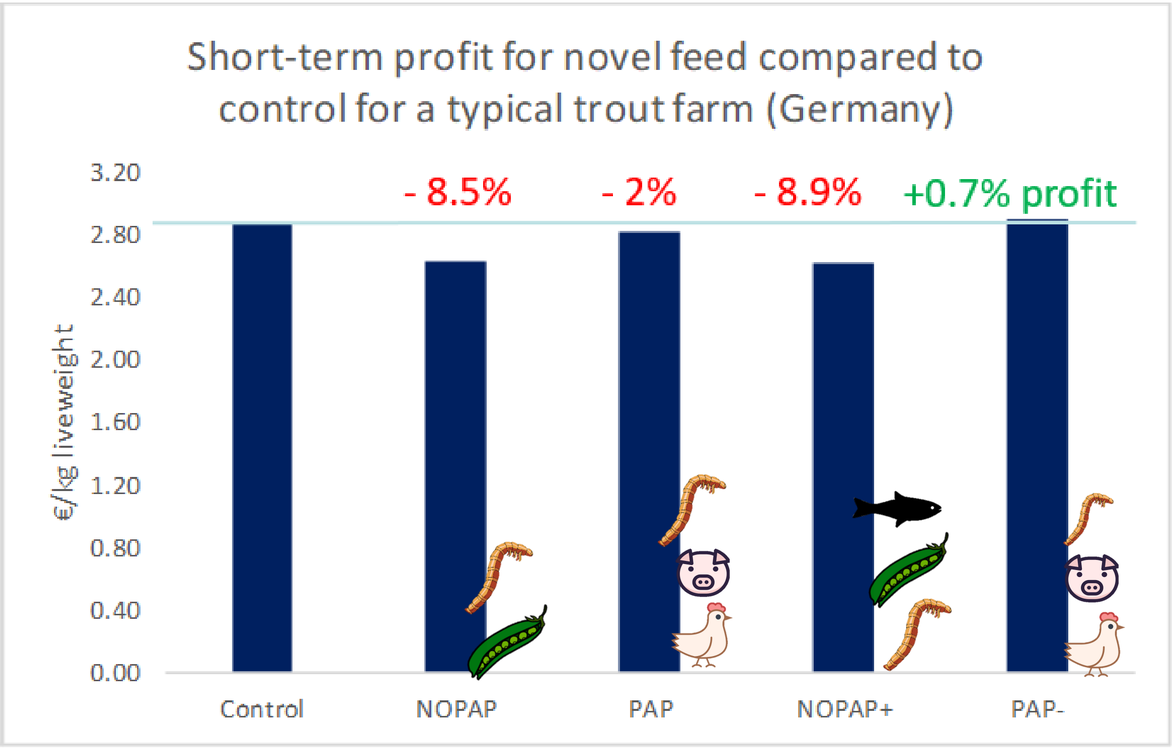
SEABASS				
WEIGHT GAIN				
FCR				
PRICE	$$$	$$	$$$$	$

THÜNEN

APPLICATION GAIN INNOVATIONS - FEED

GAIN SUMMER SCHOOL





TROUT				
WEIGHT GAIN		▲	▲	
FCR			▼	▲
PRICE	$$$	$$	$$$$	$

THÜNEN

APPLICATION GAIN INNOVATIONS - FEED

CONCLUSIONS

- Results confirm the importance of economic cost-benefit analysis

➔ Growth performance under feed most promising, but not economically feasible
➔ Growth performance under feed least promising, but economically most promising

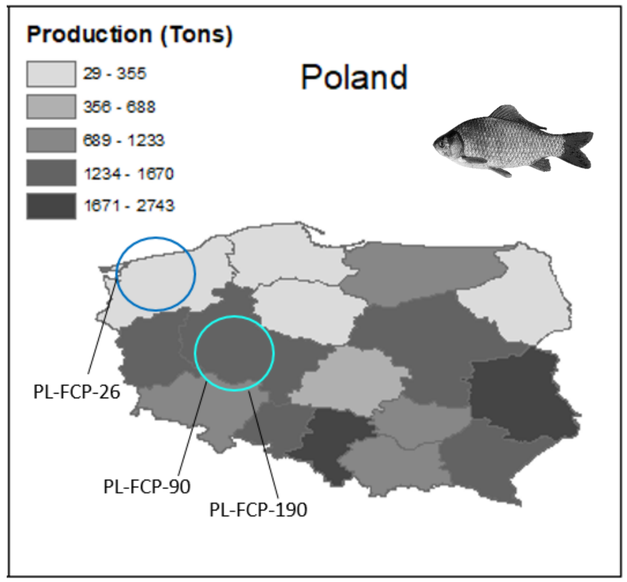
- Differences between species:

CTRL feed cost/kg fish:

Price of novel feeds:

➔ Salmon: highest additional profit for feed (lowest novel feed price + medium feed cost/kg fish)
➔ Trout: most promising over all novel feed types (medium novel feed price + lowest feed costs/kg fish)

APPLICATION GAIN INNOVATIONS - RAS



Map: CERES project, modified

Example Polish carp farm defined for region of Western Pommerania producing 26 tons within 33 months

➔Not a typical farm as main production takes places further south
➔Good example farm to analyses costs/benefits of pilot RAS farm

Pictures: ZUT: Remigiusz Panicz, Piotr Eljasik and Jacek Sadowski

APPLICATION GAIN INNOVATIONS - RAS

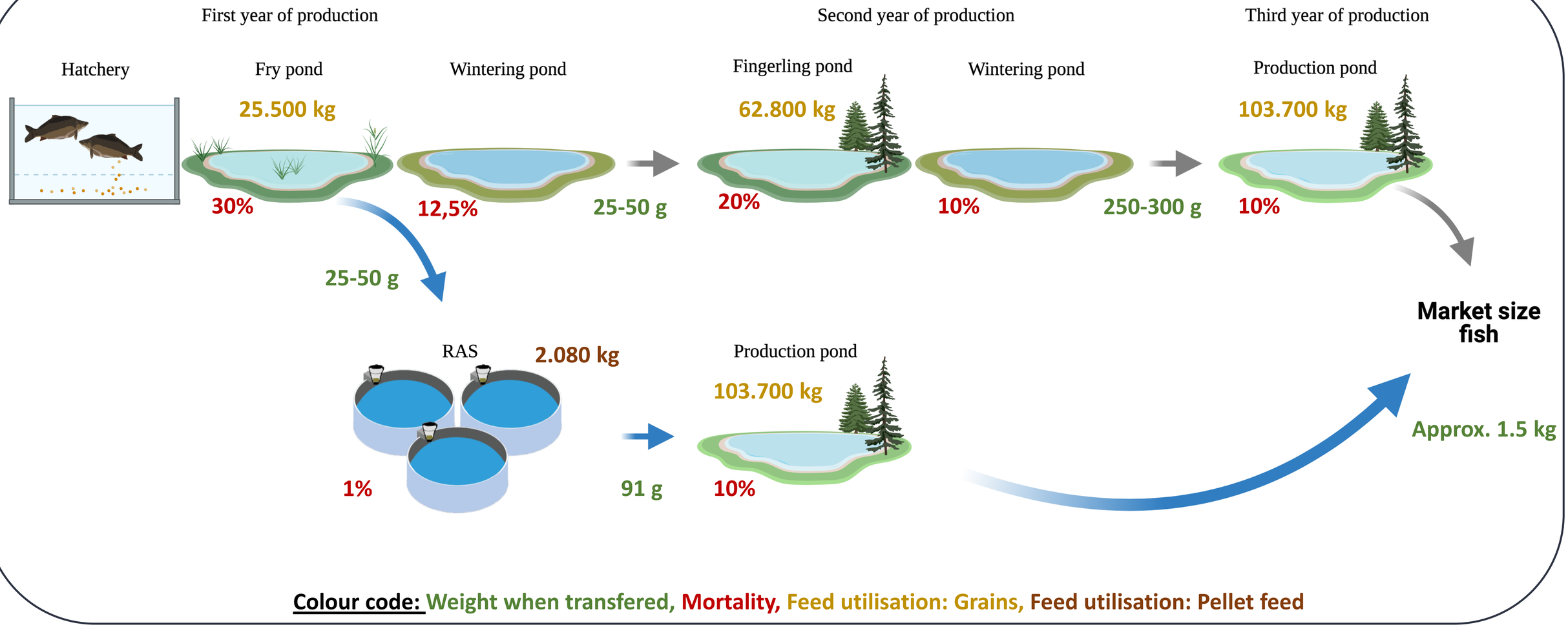


Figure & data: ZUT: Remigiusz Panicz, Piotr Eljasik and Jacek Sadowski

APPLICATION GAIN INNOVATIONS - RAS

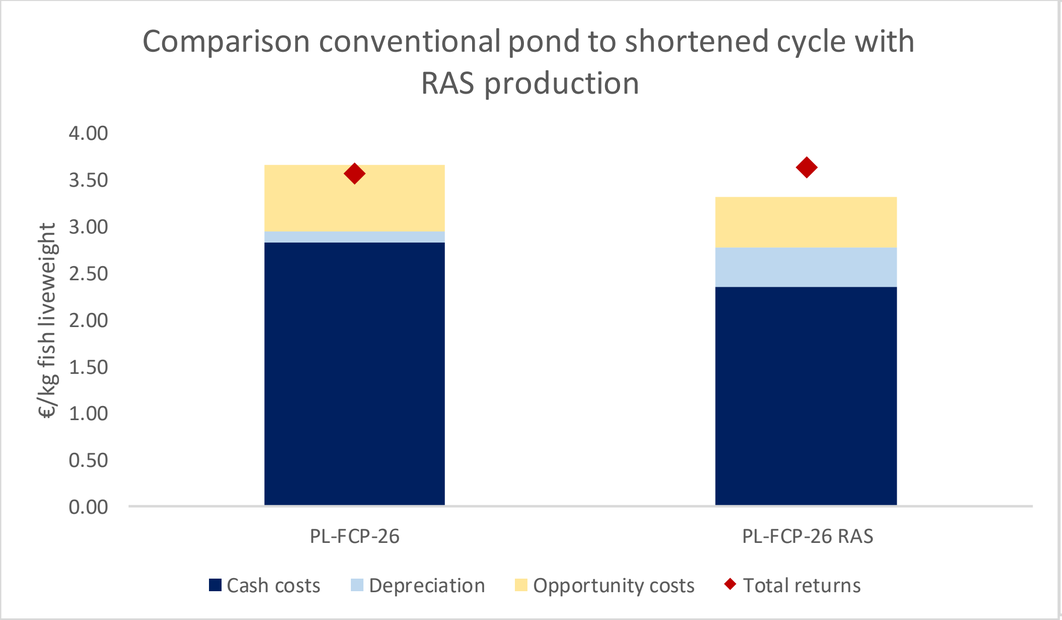
- Less area needed
- Shortening production cycle – lower labour costs
- Slightly higher returns
- Lower mortality = less fingerlings to be stocked

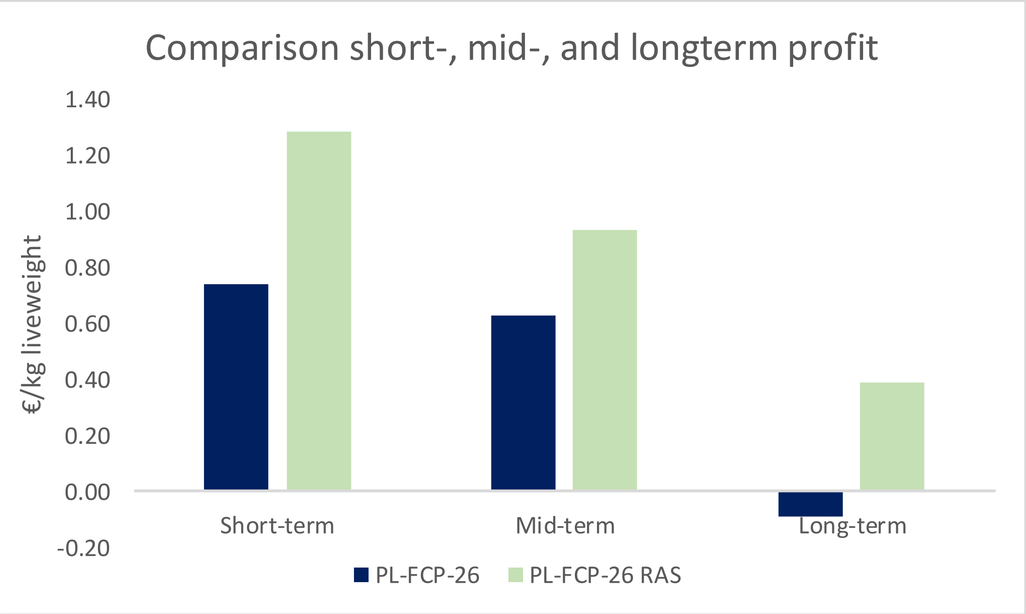
- Additional investment for RAS equipment + maintenance
- Additional labour for watercress maintenance
- Higher electricity demand
- Higher water demand
- Higher feed costs (additional pellet feed)

Additional investment for a 26t-Carp-RAS plant, Poland

	Device	Prim use	Replacement value	Liftime(years)
Aeration	6 high blower + 48 air diffuser	5	22,608 PLN	20
Feeding	Feeders	5	29,769 PLN	20
Water analysis	Oxyguard	5	25,000 PLN	20
Water treatment	Polygeyser (mechanical filtration) + Biological filter, sedimentation tank and sparus pump	5	42,192 PLN	15
Minor equipment	Electro tools, buckets and nets	5	1,600 PLN	5
Buildings	Tent for RAS	5	150,000 PLN	20

APPLICATION GAIN INNOVATIONS - RAS





- Shortening of production cycle is very promising: 73% higher profit on short term scale (55 cents/kg)
- >5 times higher profit on long-term scale (48 cents/kg)

➔ Ensures long-term profitability of small carp farm

APPLICATION GAIN INNOVATIONS - RAS

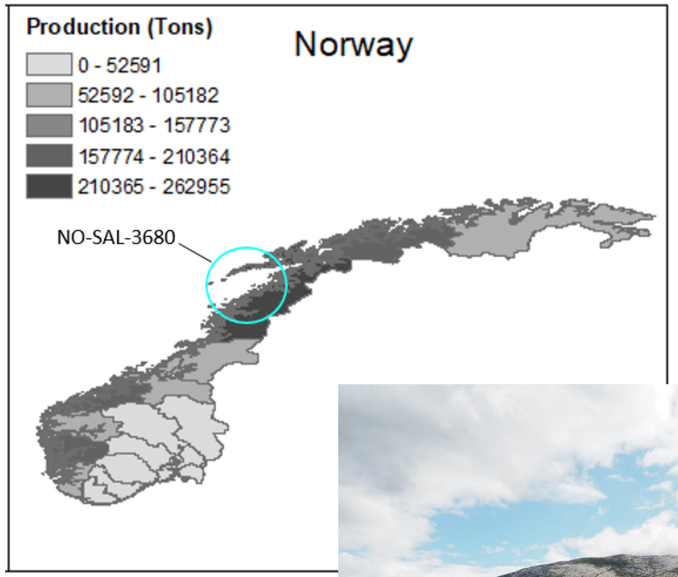
CONCLUSIONS

- Including RAS unit to replace wintering ponds is very promising

➔ Shortening of production cycle/reduction of required area essential for increasing profit
➔ Water cress is a side product (2.4 % of total returns), but self sustainable
➔ Marketing effort for plant product has to be taken into account
➔ Other plant species than water cress might be cultured as well, also during remaining production cycle

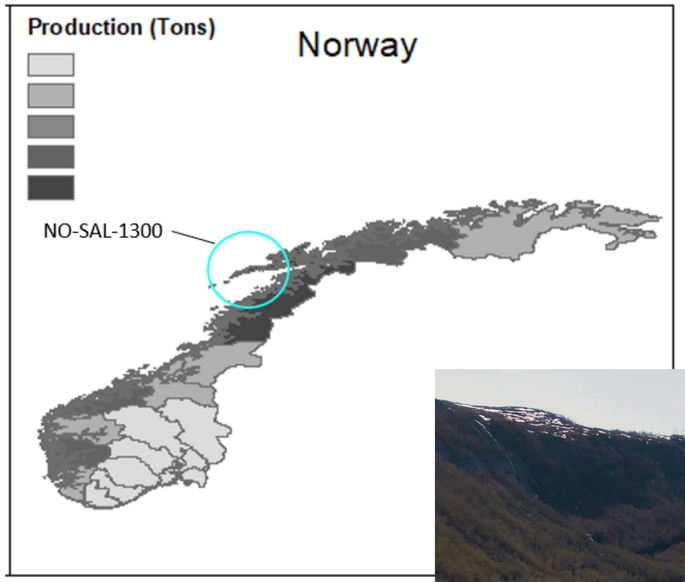
- Next step could be transfer to a typical (larger) farm

APPLICATION GAIN INNOVATIONS - SIDESTREAM VALORISATION



C.Kreiss

3680t salmon netcage farm
Region: Nordland



SHP

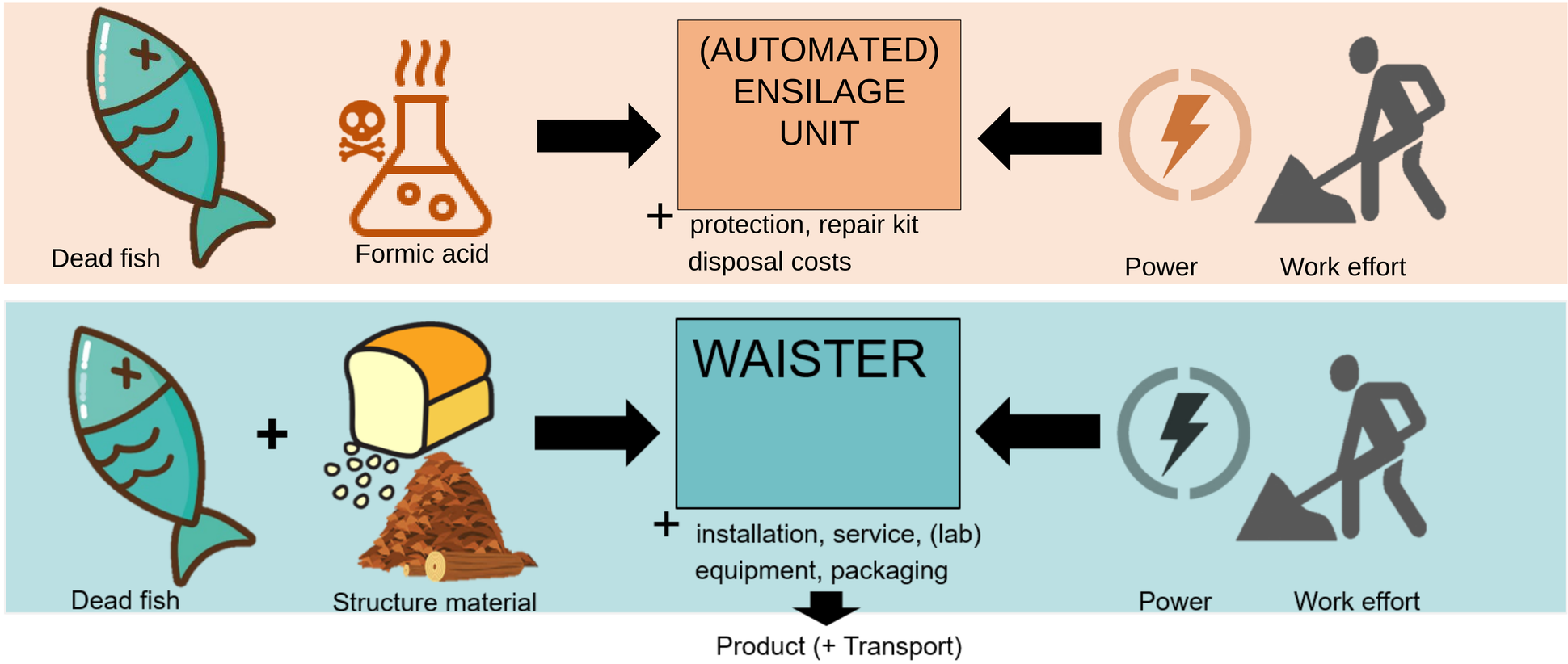
1300t smolt RAS farm
Region: Nordland

Maps: CERES project, modified

APPLICATION GAIN INNOVATIONS - SIDESTREAM VALORISATION

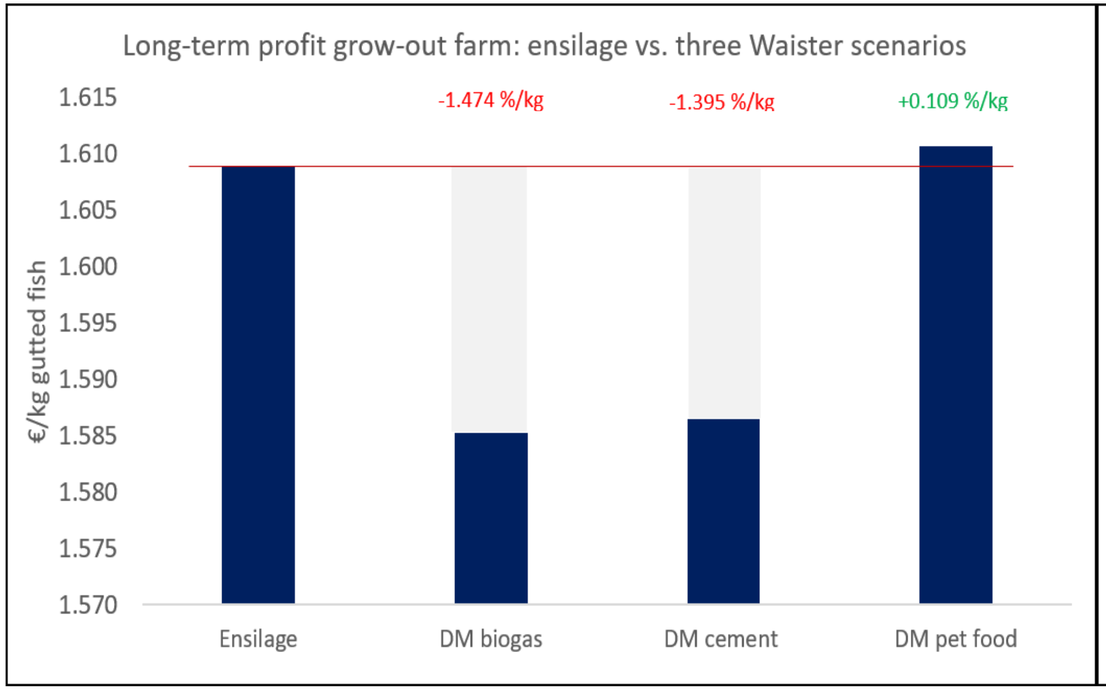
GAIN SUMMER SCHOOL

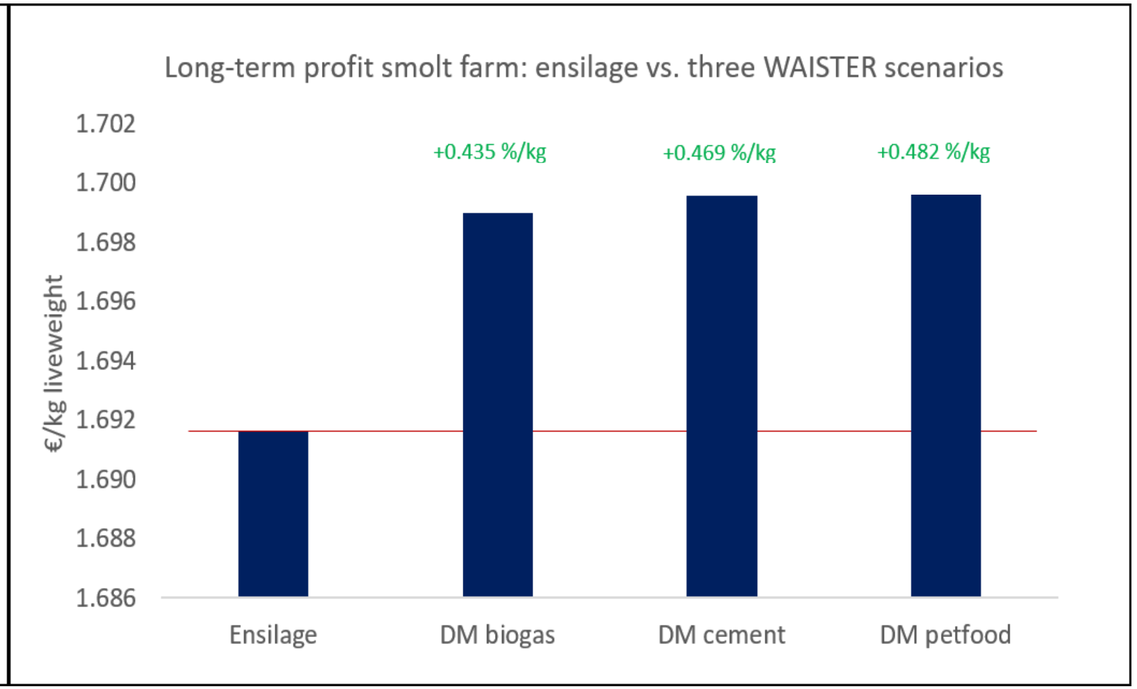
replacing ensilage by drying of dead fish and turning into a product



APPLICATION GAIN INNOVATIONS - SIDESTREAM VALORISATION

Control scenario **1)** Ensilage
Three marketing scenarios: **2)** DM sold to biogas plant - transport costs 50 €/ton; no returns
3) DM sold to cement industry - return deducted by transport costs: 15 €/ton
4) DM sold to pet food industry – return deducted by transport costs 1315€/ton





Grow-out: 47 tons dried material (morts & structure material) – pet food industry promising (+0.1% profit/kg)
Smolt: 11 tons dried material – all scenarios promising (+0.5% profit/kg)

APPLICATION GAIN INNOVATIONS - SIDESTREAM VALORISATION

CONCLUSIONS

- Interesting product with the potential to achieve increased returns

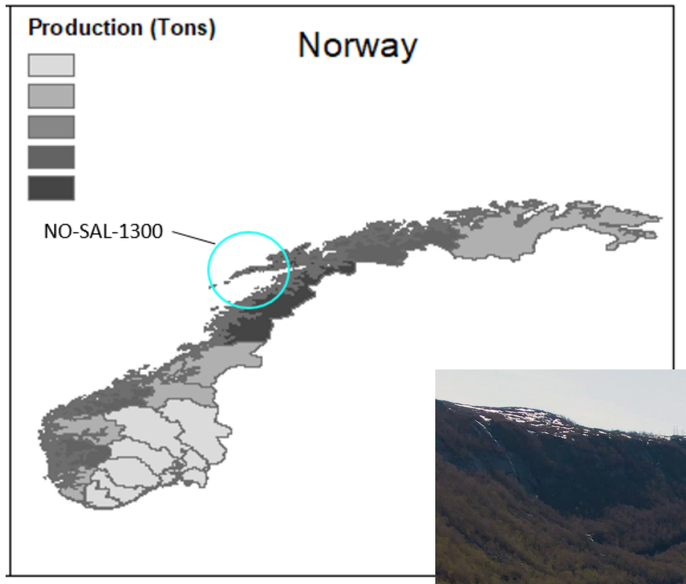
➔ Grow-out farm is already equipped with automated ensilage unit, labour saving less significant compared to smolt farm that still uses labour-intensive ensilage process

➔ No/low returns for the product: transport distance might have a significant impact on the final costs/return opportunities

➔ Commercial agreements will most likely be arranged on individual basis

➔ For the cement industry sector potential opportunity to achieve higher returns than assumed when taking into account that CO_2 taxes might be levied on other substrates.

APPLICATION GAIN INNOVATIONS - SIDESTREAM VALORISATION



SHP

1300t smolt RAS farm
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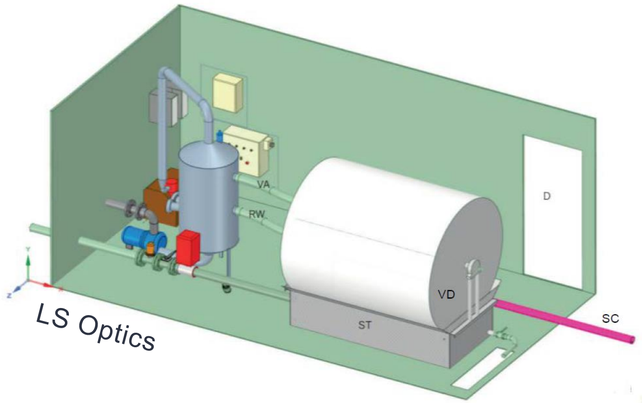
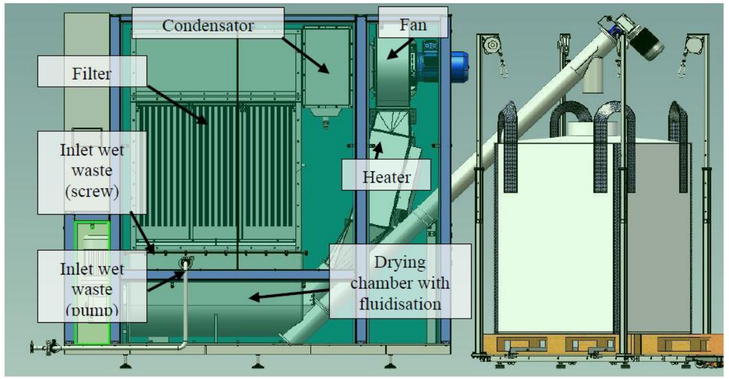


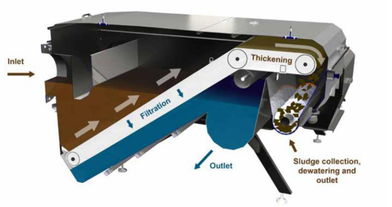


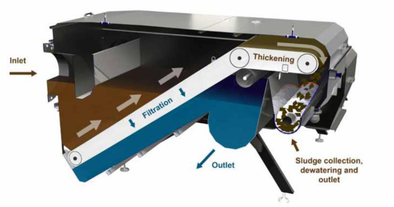
Waister

APPLICATION GAIN INNOVATIONS - SIDESTREAM VALORISATION

	Conventional filter system	Conventional filter system + Waister drying unit	S3/S4 filter system with infrared drying unit
Dry matter of sludge	**20%**	**90-95%**	**>90%**
Work effort 1st/2nd year		+0.3 % (ca. 41 000 NOK)	+0.6-0.8% (76 000-100000 NOK)
Variable costs (minor equipment, electricity, waste disposal)		-1.9 % (ca. 1.34 mio NOK)	-2.1 % (ca. 1.5 mio NOK)
Fixed costs first year (installation, service, maintenance machinery, control costs)		+0.5% (47 000 NOK)	+2.6 % (ca. 233 000 NOK)
Fixed costs from 2nd year onwards (service, maintenance machinery, control costs)		+0.3% (27 000 NOK)	+1.7 % (ca. 153 000 NOK)
Depreciation of equipment		+10% (180 000 NOK)	-20 % (360 000 NOK)
Opportunity costs		-	-

cash costs





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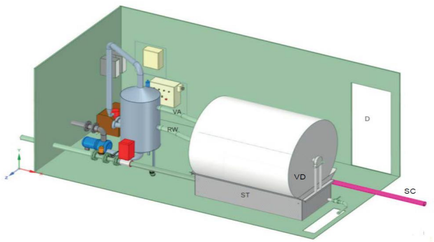
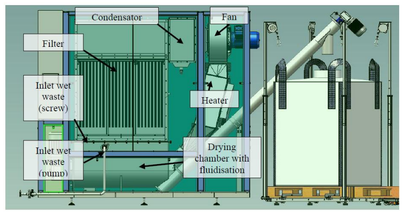
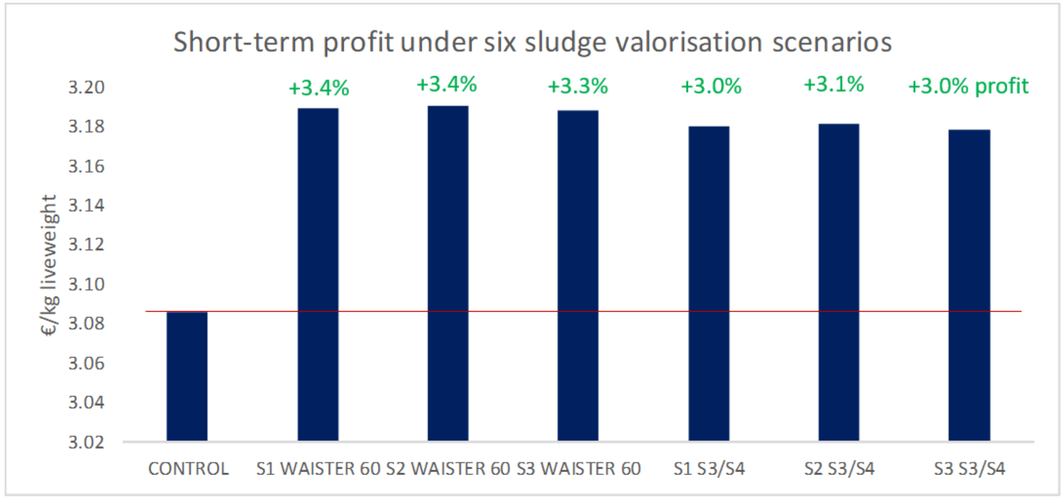


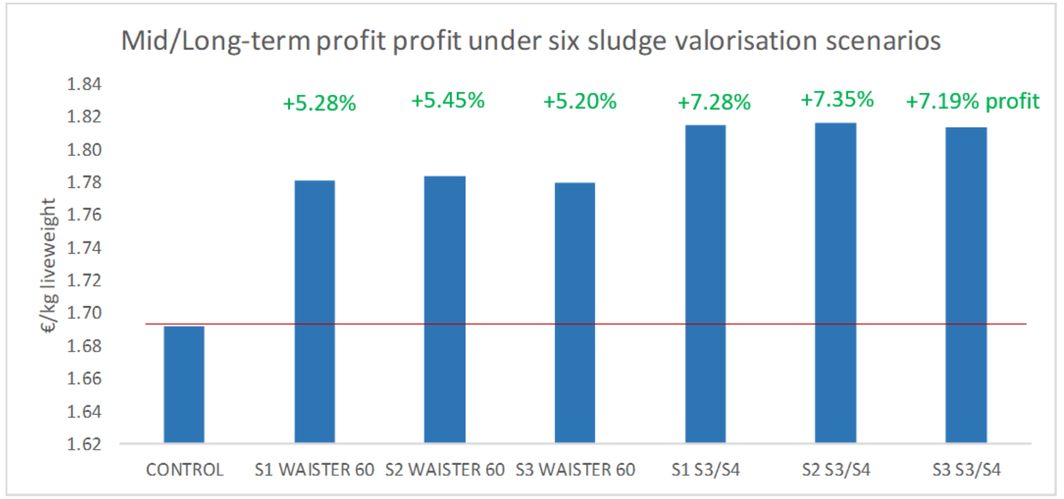
Scenario 1: Biofertiliser plant, free collection; no returns
Scenario 2: Cement factory: 12 €/ton transport, 27 €/t returns
Scenario 3: Biogas plant: 17 €/t transport, no returns



GAIN SUMMER SCHOOL

APPLICATION GAIN INNOVATIONS - SIDESTREAM VALORISATION





- Similar short-term profit increase for both systems under all scenarios about 3% (9-10 cent/kg)
- Mid- and long-term scale Waister: proportional increase of profit to 5 % (similar in absolute numbers)
- Mid- and long-term scale S3/S4 unit: increase of profit to 7% due to less depreciation (12 cent/kg)

GENERAL CONCLUSIONS

• Results confirm the importance of economic cost-benefit analysis on short to long-term scale

• Products deriving from circular economy principles might be more costly than conventional products
➔It is important to include economic cost-benefit analyses in studies on innovative methods (in AQ)

• Consumer willingness to pay for sustainable products might be a precondition for sustained profitability
➔ Market knowledge and providing adequate information to the consumer will be crucial (especially feed)

➔ Pre-condition is environmental sustainability of innovations - LCA talks 10:35 & 11:40am
➔ Social acceptability – Social acceptability talk 12:30 pm

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