PROJECT X

Welcome to the

KNOWLEDGE X CHANGE

Webinar

Building Resilient Supply Chains Through Alternative Feed Ingredients

29 September 2020

12.30-3.30 p.m. BST (9.30 pm Sydney)

Virtual

FEED X

#FEED-X2020
#KnowledgeXChange

Webinar Flow

KNOWLEDGE X CHANGE

PROJECT X

Webinar

12:30 Introduction FEED-X Programme

Session 1: Market Opportunities in the Feed Industry
12:35 Market Opportunities in Aquaculture Feed
Questions

Session 2: Feed Ingredient Opportunities – Alternative Oils, Proteins and Technology
12:50 Introducing the Innovators selected by FEED-X
12:55 8 Innovators present & questions
13:35 Panellist open the discussion: Exploring Future Opportunities

Session 3: Ecosystem Dependence and Post Covid trends
14:00 2 Innovators present & questions
14:10 Panelist open the discussion: Ecosystem dependence and Post Covid trends

FEED X

#FEED-X2020
#KnowledgeXChange

Session 1: Market Opportunities in the Feed Industry

PROJECT

#FEED-X2020
#KnowledgeXChange

KNOWLEDGE XCHANGE

Webinar

FEED X

Market Opportunities

Feed-X Webinar

29 September, 2020

Based on the Market Opportunities Report 2018

Project X' goal is to transform 10% of the global feed industry by adopting alternative feed ingredients

FEED-X

Target

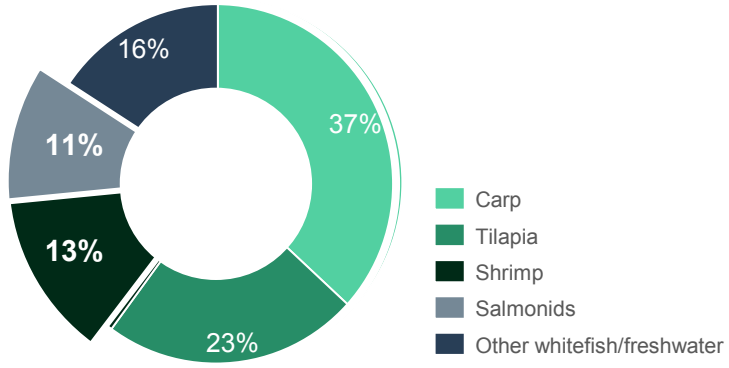
10% of the global feed industry to adopt alternative feed ingredients into value chains

Important to keep in mind that:

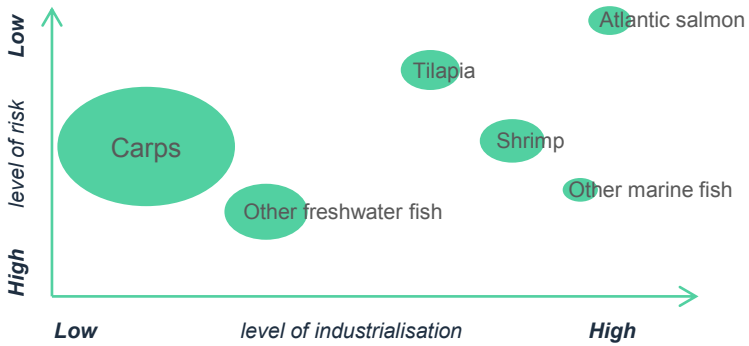
- The market opportunity report was made in 2018 (recent developments are not included in this presentation)
- Numbers from 2016, and only from publicly available sources (e.g. annual reports, sustainability reports, etc.)
- Only the most relevant slides will be shown today

We expect the largest transformation for shrimp and salmonid feed as farmed shrimp and salmon are highly valued, industrialised, and globally traded species

Global production of aqua feed in 2016 (39.9 million tonnes)



Level of risk and industrialisation of species



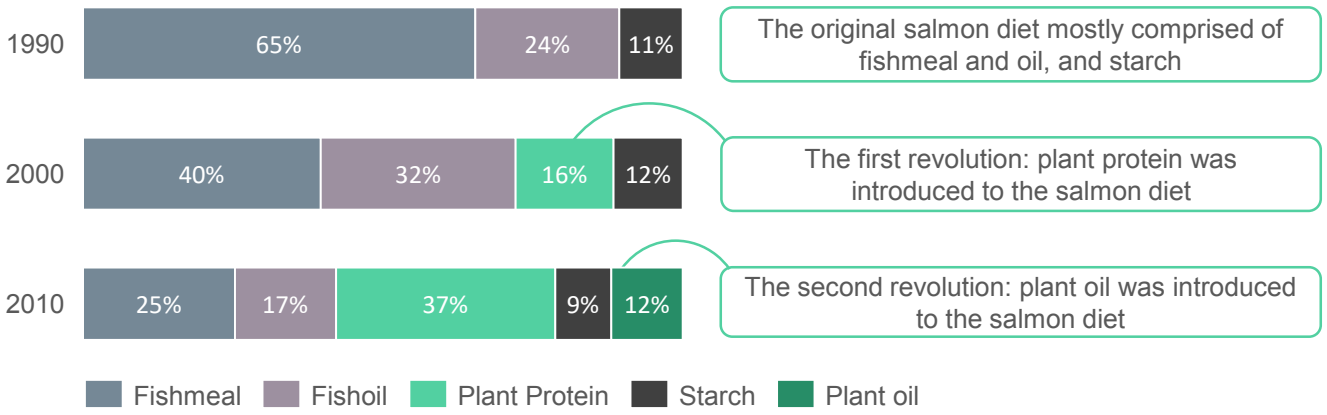
- In 2016, **39.9 million tonnes** of aqua feed was produced globally, whereas salmon feed represented ~**4.4 million tonnes**, and shrimp feed ~**5.2 million tonnes**.
- High-value species, **salmon and shrimp**, play a more significant role in **international trade.** Although salmon and shrimp are relatively small in volume compared to other species, they are very **visible products** in many markets due to a high level of **industrialisation** and **high R&D** and innovation activities.
- As salmon and shrimp are exposed to the fishmeal trap, and more highly-valued, industrialised, and internationally traded, and thereby more visible products, we expect the **largest transformation for salmonid and shrimp feed** in the short to medium-term.
- As global feed producers are diversifying into low-value species, and **technology transfer from salmon to other species** is likely to occur, we expect transformation for species like **carp** in the medium to long-term.

Notes: figures adapted from Marine Harvest Industry Handbook 2017

Sources: Fishbase,org, FAO, OECD, Marine Harvest Industry Handbook (2017), Naylor et al.. 2000, Skretting, Professor Frank Asche - Green Growth in Fisheries and Aquaculture Production and Trade

The feed industry is facing the challenge of substituting marine and agricultural ingredients with novel ones

Change in aquaculture diet composition by weight in Norwegian aquaculture



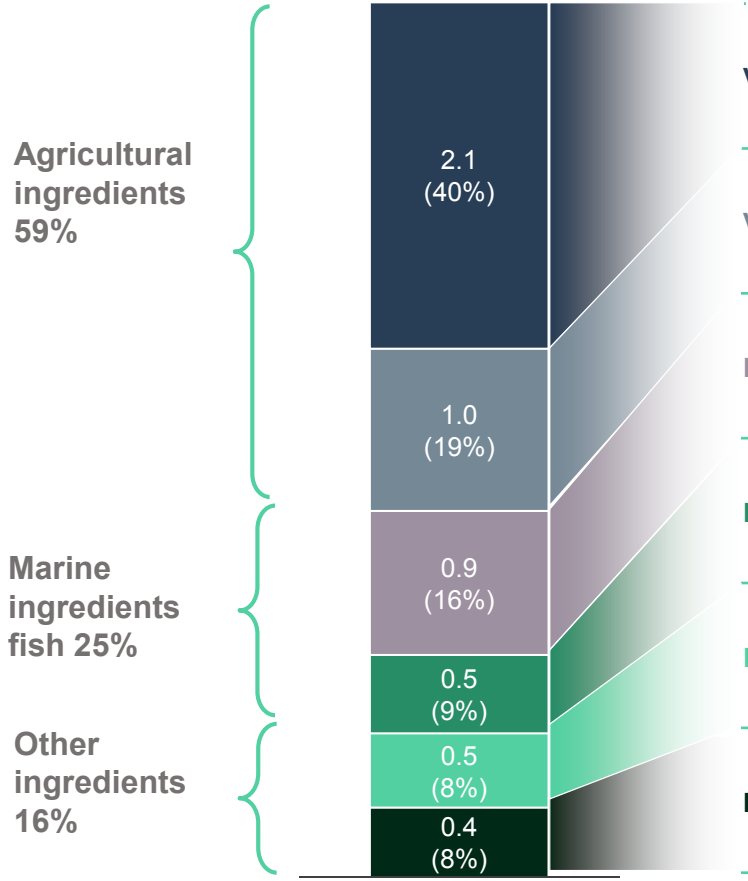
The third revolution: the introduction of novel ingredients like algae and bacteria

- There have been **three revolutions** within fish feed. First, the introduction of **plant protein**. Second, the introduction of **plant oil**, and today, **micro algae and bacteria,** among others, to meet the need for marine omega-3 without being dependent on fisheries.
- **Marine ingredient** content has been **reduced over time**. Its role is now strategic rather than to provide bulk protein or oil. Due to fishmeal and oil's critical components, like functionality and mix of amino acids, they are now at a level that is very **hard to reduce further** (without novel ingredients).
- Depending on the alternatives used, their substitution by other ingredients may **affect the health of farmed fish.** Vegetable ingredient-based diets can affect the intestinal flora and immune defenses and overall health status of the fish. Too little omega-3 can make salmon less robust and more prone to develop viral diseases.
- To offset their rising prices, as feed tonnages increase, feed companies will continue to stretch available quantities of fishmeal and fish oil further by **substituting them with other ingredients.** Those novel ingredient are **not yet scalable.**

Photo: Skretting
Sources: NOFIMA, SEA at Risk, FAO 2016 SOFIA report, Seafish (2016), IntraFish (2017, 2018)

Agricultural ingredients represent 59%, and marine ingredients 25%, of the big four feed companies' feed

Big four feed companies' ingredients in 2016 combined, in million tonnes and weighted average in %



Challenges for the whole industry

The increased usage of agricultural ingredients to offset dependence on fishmeal is problematic due to the **clearing of land for production** of soy and rapeseed. The heavy use of chemicals has led to soil degradation and water contamination. **The rainforest has been destroyed for soy plantations.**

The use of fishmeal and fish oil from wild catch is a challenge as they have a **static supply and only 14% of fish caught for all uses were MSC-certified in 2017.**

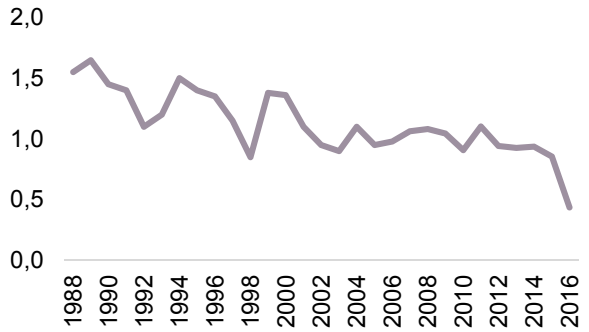
Notes: Weighted average percentage. See appendix for calculations.
Sources: Skretting Sustainability Report 2017, Cargill Aqua Nutrition Sustainability Report 2016, Biomar Sustainability Report 2016, Marine Harvest Annual Report 2016, Nofima (2011)

The big four consume 60% of available fish oil, and unless they change production strategy they will demand close to 100% in 2030

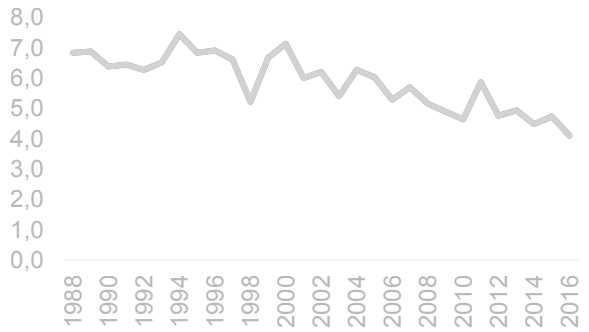
Available supply 2015	Big four usage 2016*	Expected big four usage 2030*
Fish oil 0.8m tonnes	**~0.5m tonnes** Equalling 60% of available fish oil, assuming static supply of 0.8m tonnes	**~0.8m tonnes** Equalling 98% of available fish oil, assuming static supply of 0.8m tonnes
Fishmeal 4.7m tonnes	**~0.9m tonnes** Equalling 19% of available fishmeal, assuming static supply of 4.7m tonnes	**~1.5m tonnes** Equalling 31% of available fishmeal, assuming static supply of 4.7m tonnes

Historical development of fish oil and fishmeal supply 1988-2016

Global fish oil production (million tonnes)



Global fishmeal production (million tones)



Fish oil is a scare resource with **decreasing supply.** We expect static supply in the future as total allowable catch highly depends on quotas and environmental phenomena like El Niño.

In 2016, the big four feed companies used **60% of global available fish oil**, equalling 0.5 million tonnes of total global fish oil used in the aquaculture industry.

Assuming an annual feed growth rate of 3.6% and a constant share of fish oil in feed, the total use of fish oil by Skretting, Cargill Aqua Nutrition, Biomar and Marine Harvest Feed will be **98% of available resources in 2030.**

Fishmeal has **decreasing supply,** but is **not as scarce as fish oil** as there are more volumes available. However, availability depends on the same external factors as fish oil as fish oil is a by-product of fishmeal.

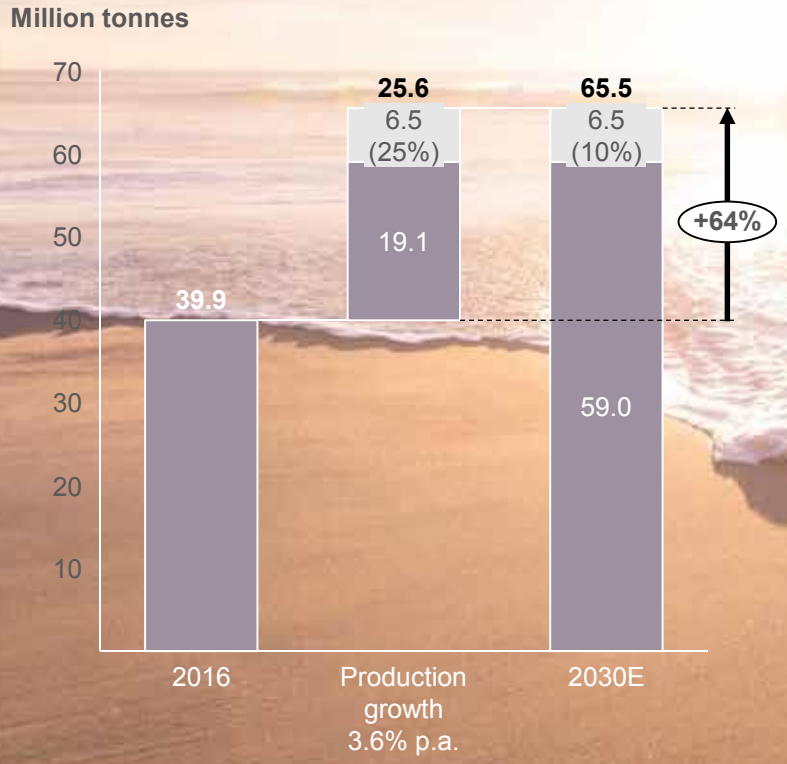
Today, the big four feed companies consume **19% of global available fishmeal**. With a growth rate of 3.6% per year, consumption will only account for 31% of total supply in 2030.

*Notes: *Assuming growth rate of 3.6% p.a., and constant market share for Skretting, Cargill Aqua Nutrition, Marine Harvest Feed and Biomar and constant share of fish oil and fishmeal in production*

Source: PwC Analysis, Strategy& 2017 – Global fismeal and oil market outlook

In 2030, 6.5m tonnes of the global aqua feed production must be transformed in order to reach the 10% goal

Global aqua feed production in 2016 and estimated production in 2030 (million tonnes)



In 2030, the global, estimated production of aqua feed will increase to **65.5 million tonnes**, following the aquaculture growth rate of 3.6% p.a. This equals a **total growth of 64%.**

In order to transform 10% of the aqua feed value chain, **6.5 million tonnes** must be sustainably produced in 2030.

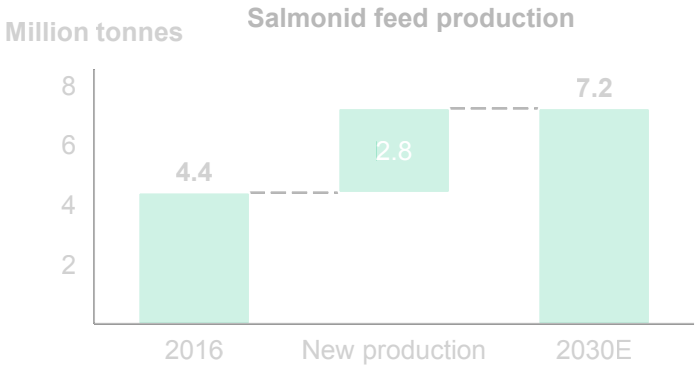
For the transformation to only be covered by production growth, **25% of new production** (6.5m tonnes) must be covered by sustainable ingredients or technology.

Notes: E = estimate

Sources: PwC Analysis, PwC Strategy& (2017) Global fishmeal and oil market

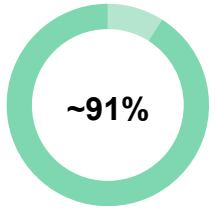
If salmon and shrimp feed drive transformation change, 41% of their combined production in 2030 will cover the goal of 6.5 million tonnes

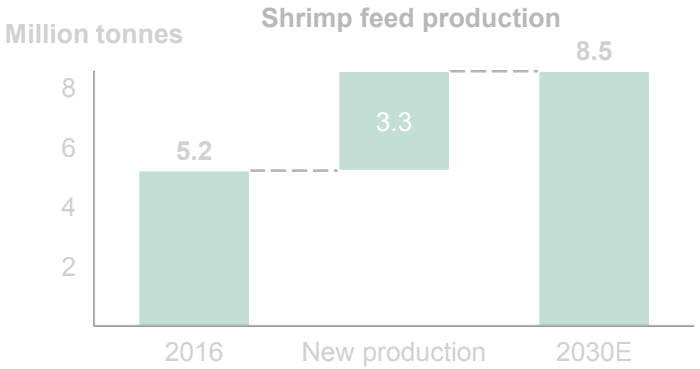
We expect feed for salmon and shrimp to be the main contributors to the value chain transformation. Assuming the annual growth rate to be 3.6% p.a. and the share of feed for salmonids and shrimp to be constant at **11% and 13% respectively**, we expect the global production of salmon and shrimp feed in 2030 to be **15.7 million tonnes in total.**



Salmonid feed, 2030

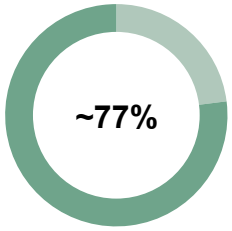
For the salmonid feed value chain to cover the transformation goal of 6.5m tonnes, **91% of the total value chain of 7.2m tonnes** needs to be produced sustainably in 2030.





Shrimp feed, 2030

Similarly, **77% of the total shrimp feed value chain of 8.5m tonnes** needs to be produced sustainably in 2030 in order to reach the transition goal of 6.5m tonnes.

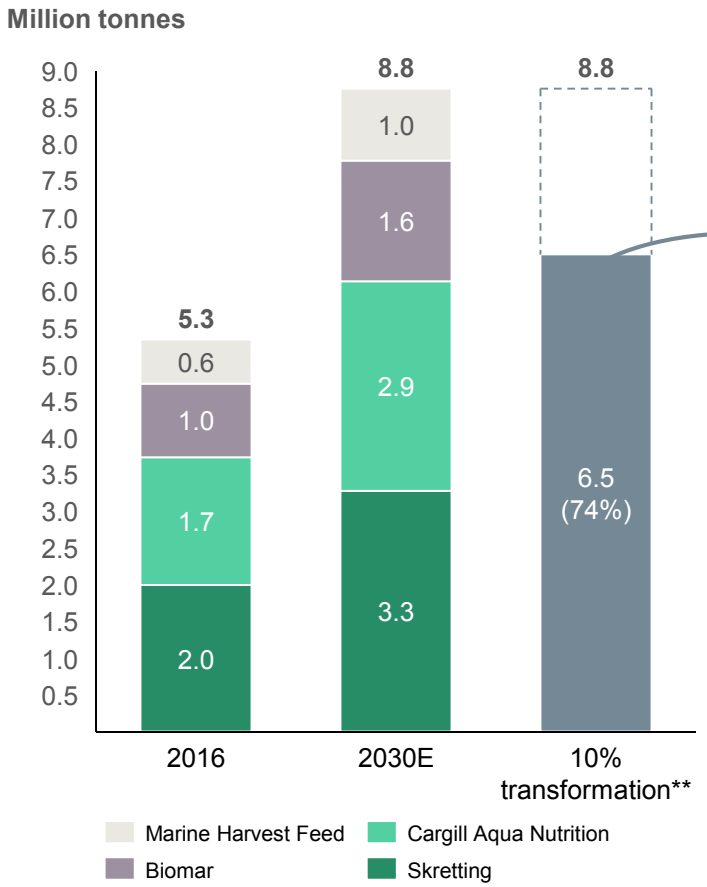


Notes: E = estimate

Sources: Marine Harvest Industry Handbook 2017, Kontali, FAO, PwC Analysis

If the big four feed companies take responsibility for the 10% transformation of global aqua feed, they must transform 74% of their feed by 2030

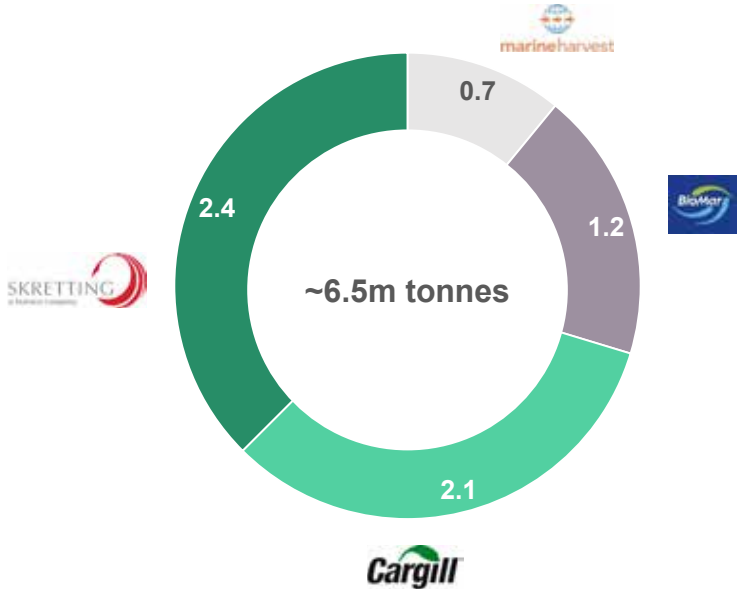
Total feed production Skretting, Cargill Aqua Nutrition, Biomar and Marine Harvest Feed in 2016 and 2030E (million tonnes)



Today, the big four feed companies produce 5.3m tonnes in total. Assuming constant market shares and an annual growth rate of 3.6%, the four producers will have a total production of **8.8m tonnes** in 2030.

For the transformation of **6.5 million tonnes to be covered by the big four feed companies**, Skretting, Cargill Aqua Nutrition, Biomar and Marine Harvest Feed, **74%** of their combined production needs to be transformed.

For each player, transforming 74% of the production equals (in million tonnes):



**Assuming 3.6% growth p.a. and constant market share, E = estimate, **10% transformation (6.5m tonnes) of global aqua feed equals 74% of the big four' feed production in 2030*

Sources: Skretting Sustainability Report 2016, Cargill Aqua Nutrition Sustainability Report 2016, Biomar Sustainability Report 2016, Marine Harvest Annual Report 2016, IntraFish

Algae oil could potentially replace fish oil due to its high omega-3 content

Potential substitutes to fish oil

	Description	Category	Pros & Cons	Sustainability and other concerns
Fish oil **Can be substituted by:**	Oils derived from the tissues of oily fish.	1	✓ High Omega-3 oil content ✓ Significant volume available ✗ Expensive	✓ Consumers might be willing to pay more for seafood with high levels of omega-3 ✓ Most fish oil producers are MSC-certified or in Fisheries Improvement Plans (FIP), with the exception of Southeast Asia ✗ A scare resource, bycatch, illegal fishing and related social issues
Palm oil	Oils derived from palm trees.	2	✗ No DHA/EPA content ✓ Significant volume available ✓ Cheap	✓ Positive for feed utilisation and as a pellet binder ✓ Produces more oil per hectare than many other oil crops ✗ Concerns related to deforestation and GHG - not accepted by consumers ✗ Higher risk, negative impact on biodiversity even if RSPO-certified (Indonesia)
Hydrogenated vegetable oil	Oils derived from various oily vegetables to which hydrogen is added to improve the solidity (soy, rapeseed).	3	✗ No Omega-3 oil content ✓ Significant volume available ✓ Cheap	✓ Rapeseed contains about the same crude protein level as fishmeal ✗ Concerns related to deforestation and destruction of habitat ✗ Produce more greenhouse gas emissions than fossil fuels once emissions from indirect land use change are taken into account (differences between regions)
Krill oil	Oils derived from small sea crustacean widely dispersed across the world's oceans.	4	✓ High Omega-3 oil content ✗ Insignificant volume harvested ✗ Very expensive	✓ Willingness to pay if sourced sustainably. ~30% more expensive than fishmeal. ✗ Criticised for operating close to penguin colonies and whale feeding grounds ✗ About 1% of krill biomass is harvested. Aker Biomarine supplies ~60% (~158,000 tonnes) of harvested krill, and has an exclusivity agreement with Biomar.
Algae based oils	Oils extracted from macro and micro-algae.	5	✓ High Omega-3 oil content ✗ Insignificant volume available ✗ Very expensive	✓ Considered by the industry to be the most viable novel alternative to fish oil ✓ Algae oil is three times as concentrated as fish oil - 1% can replace 3% of fish oil ✗ The challenge is to get buy-in from farmers to scale up production ✗ Care must be taken regarding nutrient concentration and digestibility - may contain toxins. Not all species are suitable in feed.
GM-canola and camelina oil	Omega-3 camelina oil and canola and oil extracted from rape plants that have been genetically modified to produce the key fatty acid DHA.	6	✓ High Omega-3 oil content ✓ Will be available in Chile and Canada (high volumes expected) ✓ Competitively priced	✓ Various reports conclude that GM commodities approved by the EU are safe ✓ Research by Cargill and Nofima show promising results in salmon ✗ Strong resistance towards GMOs in agriculture and consumer food products in Europe - Europe has the world's strictest approval system for GMOs ✗ Many countries have banned the production, transport, and sales of GM canola

Sources: Nofima 2011, The Fish Site (2017), IntraFish 2016, Feed-X interviews, Ecologist 2012, Strategy& / PwC interviews, Technavio 2017, WWF (2016)

✗ = negative ✓ = positive ? = unknown

Bacterial proteins could be an alternative to fishmeal if produced sustainably

	Description	Category	Pros & Cons	Sustainability and other concerns
Fishmeal **Can be substituted by:**	Meals derived from whole fish and inedible by-products of fish.	7	✓ High protein content ✓ Significant volume available ✗ Expensive	✗ Anti-oxidants used to reduce flammability have recently been identified as toxic and they are passed through the food chain on to human consumption ✗ Fishmeal made mainly from by-product usually has a slightly lower protein content, a higher mineral content, a higher ash content and more problems with traceability, than meal made from whole fish
Corn and wheat gluten meals	Oils derived from maize and wheat plants.	8	✓ High protein content ✓ Significant volume available ✓ Cheap	✗ Concerns related to deforestation and soil erosion ✗ Concerns related to GMO-corn (Roundup Ready) and the development of resistant "superweeds," water use and increased pesticides usage on GM-crops ✗ Plants which could otherwise be used for human consumption
Soy meal	Meals derived from soy plants (not from concentrate or hydrolysates).	9	✗ Low protein content ✓ Significant volume available ✓ Cheap	✓ Has been used to replace fishmeal ✗ Concerns related to deforestation and destruction of habitat (Cerrado) ✗ Consumer skepticism in Europe (most soy is genetically modified)
Feather meal and poultry meal	Meals derived from animal by-products from poultry.	10	✓ High protein content ✓ Significant volume available ✓ Cheap	✓ Circular economy ✗ Despite the high protein share, feather meal is relatively cheaper than other protein meals, due to poor digestibility ✗ Prohibited in Europe due mad cow disease, consumer scepticism
Marine biotech hydrolysates	The breakdown of protein into smaller peptides and free amino acids through a hydrolysis process.	11	✓ High protein content ✗ Insignificant volume available (high investment costs, complex) ✗ Very expensive	✓ Circular economy ✗ Hydrolysis is a very complex process with high risks and investments costs. Most producers cannot scale up production enough for it to be a major input in feed. ✗ Fish protein hydrolysates (FPH) should be used higher in the food recovery hierarchy as food to humans
Microbial ingredients (bacteria, yeast, microalgae)	Microbial ingredients extracted from bacteria, yeast and microalgae.	12	✓ High protein content ✗ Insignificant volume available (not commercialised yet) ✗ Expensive	✓ Bacterial proteins show strong potential as alternatives to fishmeal ✗ Concerns related to methane from the fracking industry used as input in producing bacteria (Calysta)

Potential substitutes to fishmeal

Sources: Strategy& interviews, WWF, PwC report 2017

✗ = negative ✓ = positive ? = unknown

Insect proteins could be an alternative to fishmeal, but may lack acceptance by retailers

Potential substitutes to fishmeal

	Description	Category	Pros & Cons	Sustainability and other concerns
Mesopelagic fisheries	Oils and meals derived from the tissues of fish living in the inter-mediate pelagic water masses between the euphoric zone.	13	✓ High Omega-3 oil content ✗ Uncertainty regarding volumes (not exploited yet) ✗ Very expensive (costly to harvest)	✓ A large unexploited biomass of mesopelagic fish living in the deep ocean. This biomass has recently been estimated to be 10 billion metric tons, however, the real biomass is still in question. ✗ We lack a holistic assessment of the community and an understanding of the mechanisms controlling this biomass ✗ Unknown impacts on climate, and is a finite resource
Insect meal	Meals derived from various insects.	14	✓ High protein content ✗ Insignificant volume available (not commercialised yet) ✗ Expensive	✓ Promising research by Nifes shows that insect meal can replace fishmeal ✓ Circular economy: favorable nutrient content, and grows on animal manure or waste and therefore has a direct conversion of waste to valuable nutrients ✗ Insect-based proteins categorised as animal by-product (PAP)* in the EU poses a threat as retailers and consumers are sceptical about land-animal protein in fish
Guar and gum meal	Guar gum, also called guaran, is a substance made from guar beans.	15	✓ Moderate protein content ✓ Significant volume available ✓ Cheap	✗ Water use, deforestation, about 90% of seeds used in fracking (oil & gas) ✓ Rich source of highly digestible protein ✓ Good amino acids profile ✓ A cost-reducing replacement for soybean meal, soybean concentrate and fishmeal
Salmon protein hydrolysates	Protein derived from salmon by-products through hydrolysis.	16	✓ Moderate protein content ✗ Insignificant volume available (high investment costs) ✗ Expensive	✓ Circular economy ✗ Fish protein hydrolysates (FPH) should be used higher in the food recovery hierarchy as food to humans ✗ Not accepted by the EU and consumers in Europe for use in salmon feed. However, if the protein is hydrolysed to the extent that the origin is of no importance, it could potentially be used.
Marine bristle worms and invertebrate animals	Proteins derived from tunicates (marine invertebrate animals) and polychaete (marine bristle worms).	17	✓ Moderate to high protein content ✗ Insignificant volume available ? Price unknown	✓ Circular economy (bristle worms feed on silage, tunicates on plankton on nets, ropes, hard surfaces, etc.) ✗ Tunicates contain 90-95% water, therefore large volumes are needed ? Sustainable production and harvesting practices

*Notes: *PAP – Processed Animal Protein*

Sources: Fishfarming expert 2017, Nifes 2011, Frontiers in Marine Science (2016), PwC interviews, Sustainable Business Toolkit, UniResearch, AgriMare Bio

✗ = negative ✓ = positive ? = unknown

Questions

#FEED-X2020
#KnowledgeXChange

KNOWLEDGE XCHANGE Webinar

FEED X

PROJECT

Session 2: Future Feed Ingredient Opportunities - Alternative Proteins, Oils and Technologies

#FEED-X2020
#KnowledgeXChange

KNOWLEDGE CHANGE

Webinar

FEED

PROJECT X

8 Selected Innovations

#FEED-X2020
#KnowledgeXChange

KNOWLEDGE X CHANGE

Webinar

FEED X

- Micro Algae
- Single Celled Proteins
- Insects on food by-products
- Feed ingredient technology

Innovafeed

PROJECT X

KNOWLEDGE X CHANGE

FEED X

#FEED-X2020
#KnowledgeXChange

IInsects on food by-products

Esmée Fairbairn FOUNDATION

WWF

UNIVERSITY OF CAMBRIDGE

eit Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

Soil Association

One planet eat with care

innova FEED

FOR A SUSTAINABLE AQUACULTURE

Our mission

InnovaFeed brings insect rearing at a pioneering industrial scale unlocking full potential of insect to match 21st century food challenges

InnovaFeed has developed unique technology with proven bioconversion capabilities at large scale…

Gouzeaucourt (FR)

- **4,000 m²** for commercial scale production
- **Certified with the highest quality, safety and ethics standards** (GMP+, FOS/FOE)
- **Pilot factory** used for industrial processes fine tuning and R&D development
- In operation since 2017

Nesle (FR)

- **15,000 tons** per year of protein meal over **25,000 m²** of production space
- Unique **co-location model** with industrial partners (Tereos and Kogeban)
- In operation since August 2020
- 110 jobs to be created

… with specific benefits across 21st century food challenges and in line with sustainable development goals

1 Food security

- **Performant alternative** to conventional feed ingredients :
  - Up to 100% replacement of fish meal in Salmonids diet
  - Improved performance and health at 10% inclusion in shrimp diet
- Natural solutions with **100% plant-based traceable substrate**

2 Sustainability

- **Limited energy consumption** with the use **by-products** and industrial symbiosis enabling **re-use of waste energy**
- **50-70%** impact on **CO2 emissions** vs. conventional ingredients

3 Biodiversity

- **Local production** and **circular economy** model
- **44,500t** of avoided fishing
- **No dedicated land** use to grow crops to feed insects thanks to use of agricultural by-products

InnovaFeed's replicable industrial model developed to produce high quality ingredients with the lowest environmental footprint

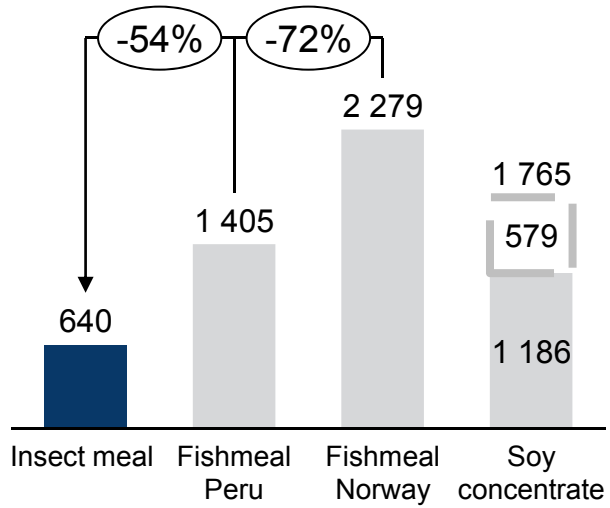
INNOVAFEED'S INDUSTRIAL SYMBIOSIS MODEL

- **Colocalisation with existing industrial players…**
  - **A feed manufacturer** (Tereos) to provide the agricultural by-products to feed the larvae
  - **An energy plant** (Kogeban) to fuel the farm
- **…to drastically reduce our environmental footprint**
  - **100% of renewable energy** including **60% waste energy**
  - **Direct pipeline providing wet by-products**
  - **Frass produced spread on lands** to close the nitrogen loop

Quantis

-80%

Reduction of InnovaFeed CO_2 footprint thanks to the symbiosis model



BioKind

PROJECT X

KNOWLEDGE X CHANGE

FEED X

#FEED-X2020
#KnowledgeXChange

Single Celled Proteins

Esmée Fairbairn FOUNDATION

WWF

UNIVERSITY OF CAMBRIDGE

eit Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

Soil Association

One planet eat with care

BIOKIND

BIOKIND

Turning crop side streams into single-cell protein

Who are we

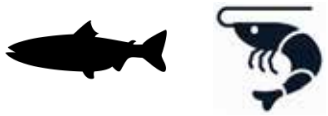
- UK company formed in 2018 at Imperial College London
- 3 Co-Founders
- Focus on upgrading crop side streams, e.g. stems, leaves

What do we do

Future plans

Near term:

- Scale-up to pre-commercial pilot production
- Test product with key customer



Mid term:

- Build commercial facilities (Southeast Asia)
- 100k ton per year plant capacity

Contact: max@biokind.co.uk

BIOKIND

Tebrito-Invertapro

KNOWLEDGE X CHANGE

PROJECT X

FEED X

#FEED-X2020
#KnowledgeXChange

Insects on food by-products

Esmée Fairbairn FOUNDATION

WWF

UNIVERSITY OF CAMBRIDGE

eit Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

Soil Association

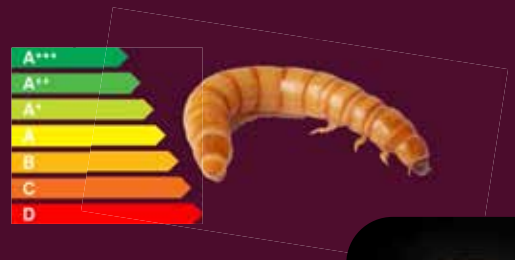
One planet eat with care

tebrito

Transforming the future of protein supply

invertapro

tebrito



- Tebrito uses insects to upscale residual food streams
- Innovation with pulp and paper industry
- No food for food
- Unique technology delivers plug & play protein suitable to food industry
- Naturally feeding the world, Plants, Animals, Humans

tebrito

- Pilot production site up-and-running
- Entering phase 2 to increasingly mechanise production
- Focus on Plant and Animal nutrition in the short-term

Towards replicable automated mid-sized production sites from 2024:

- Employee 25
- Turnover 10m€
- -73,500,000 kg Co2 eq.*
- Gross profit margin 50%+

Tebrito-Invertapro

KNOWLEDGE X CHANGE

PROJECT X

FEED X

#FEED-X2020
#KnowledgeXChange

Insects on food by-products

Esmée Fairbairn FOUNDATION

WWF

UNIVERSITY OF CAMBRIDGE

eit Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

Soil Association

One planet eat with care

tebrito

Transforming the future of protein supply

Invertapro

Invertapro

- Circularity
- Locally produced upcycled protein
- Sustainbilty from A-Z

Capital and support

BIR
Innovation Norway
Climate-KIC
REGIONALE FORSKNINGSFOND VESTLANDET
Forskningsrådet
Fana Sparebank
Nordea
Voss kommune
BAN Bergen
SparebankenVest

Accredations

SPIR!
Finalist

Climate Launchpad
Finalist Norway

SparebankenVest
Innovation prize

Avfall Norge
Winner Waste management prize

Winner Environmental Prize

ÅRETS HAGEPRODUKT 2019
Winner Gardening product of the year

Finalist EU Sustainble feed

FEED-X Challenge
Winner

NORGESVEL
DET KONGELIGE SELSKAP FOR NORGES VEL
Startup of the year Royal Norwegian society for development

Knowledge and resource partners

NÆRINGSHAGEN PÅ VOSS
INSTITUTE OF MARINE RESEARCH
HAVFORSKNINGSINSTITUTTET
connect NORGE
VIS
TEKNOLOGISK INSTITUT
NHH
HEIDNER
ipiff
Norsk Landbruksrådgiving
NTNU
ACCEL
NIBIO
NORSK INSTITUTT FOR BIOØKONOMI
NMBU
Norges miljø- og biovitenskapelige universitet

Technology and resources

Certified Organic waste

Black Soldier Fly
(Hermetia Illucens)

Mealworm
(Tenebrio Molitor)

ValProMic

PROJECT

KNOWLEDGE CHANGE

FEED X

#FEED-X2020
#KnowledgeXChange

Single Celled Proteins

Esmée Fairbairn FOUNDATION

WWF

UNIVERSITY OF CAMBRIDGE

eit Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

Soil Association

One planet eat with care

ValProMic

VALPROMIC NV

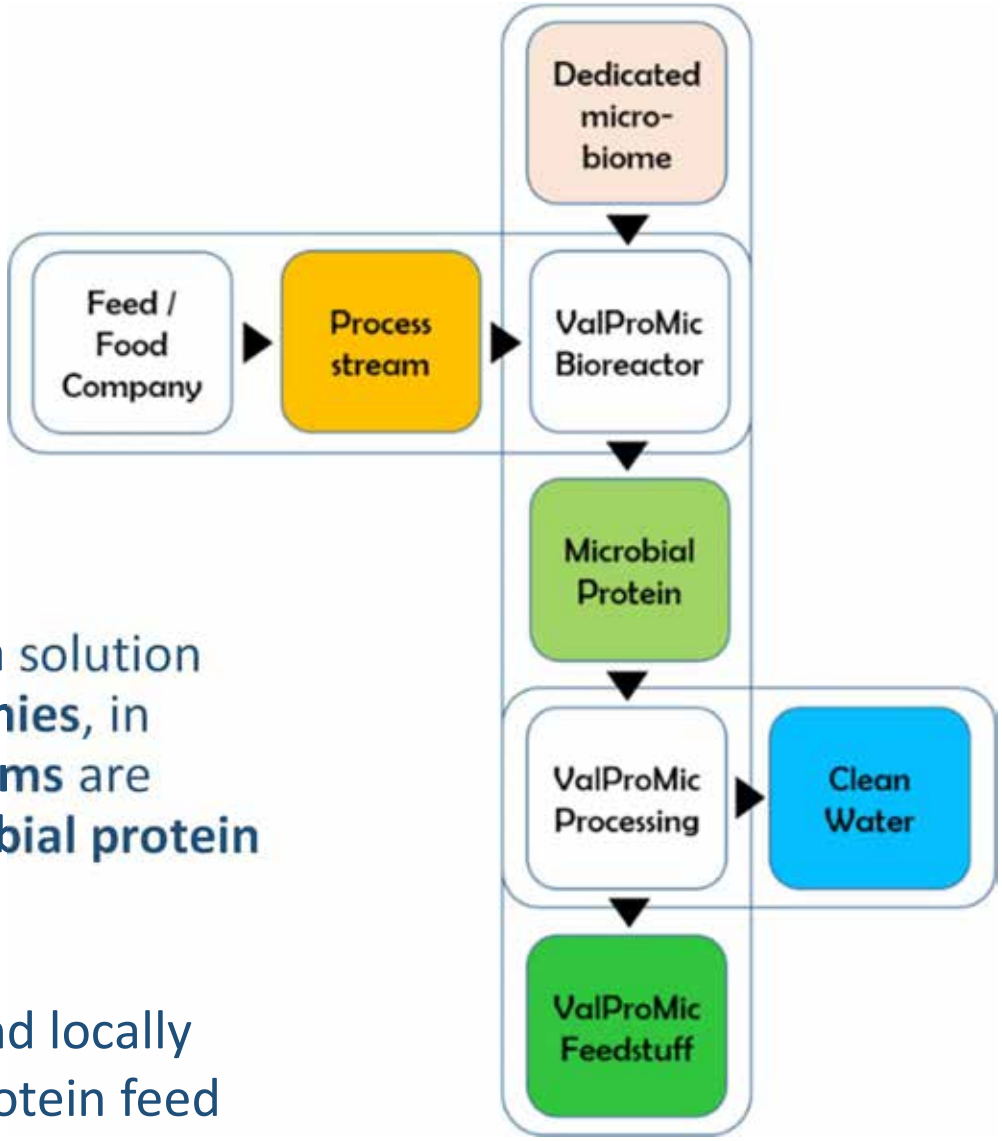
is a collaboration between

Agristo we love potatoes

Clarebout FROZEN POTATO PRODUCTS

Avecom Bioproducts & Apps

Akwadok BVBA



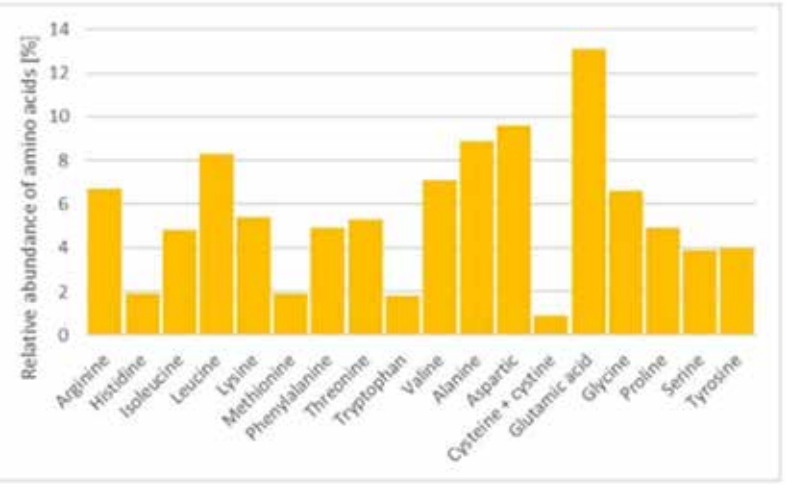
ValProMic wants to supply a solution for **Food processing companies**, in which **diluted process streams** are upgraded to valuable **microbial protein (SCP or single cell protein)**

A sustainable, affordable and locally produced alternative for protein feed

CURRENT AND FUTURE PLANS VALPROMIC NV

Demo scale: 30 MT/year

- The protein rich end product (approximately **70% protein**) is suitable as protein source in e.g. pig feed or aquaculture.
- The amino acid profile is **nutritionally favorable** with a high content of most of the essential amino acids.
- Our SCP has an excellent digestibility, feed uptake and conversion (piglets, shrimps).
- The product is **not genetically manipulated** and produced under **strictly controlled conditions**.



Business case 2500 ton/year is under validation

UniBio

PROJECT X

KNOWLEDGE X CHANGE

FEED X

#FEED-X2020
#KnowledgeXChange

Single Celled Proteins

unibio

Esmée Fairbairn FOUNDATION

WWF

UNIVERSITY OF CAMBRIDGE

eit Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

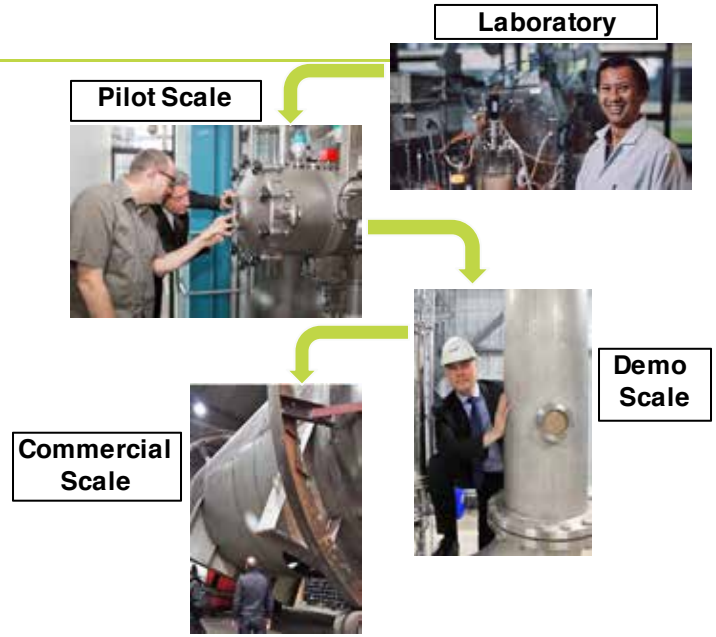
Soil Association

One planet eat with care

Unibio Snapshot

"World leader in producing high value protein from methane or natural gas"

- Industrial biotech company, **focused on high value protein production**
- Sustainable **game-changing technology** with superior attributes for land usage, quality and carbon footprint
- **Owns the intellectual property rights** to a U-Loop® fermentation technology
- **2 Licence Agreements signed** (Russia and US).
- **Developed to commercial scale** using a capital light licensing strategy
- Produces a **high-quality protein**, Uniprotein® for animal feed. Approved by the EU
- **Large global market, strong customer interest, hugely favourable megatrends**
- A base of solid owners including the Mitsubishi Corporation



OUR VISION

DECOUPLING

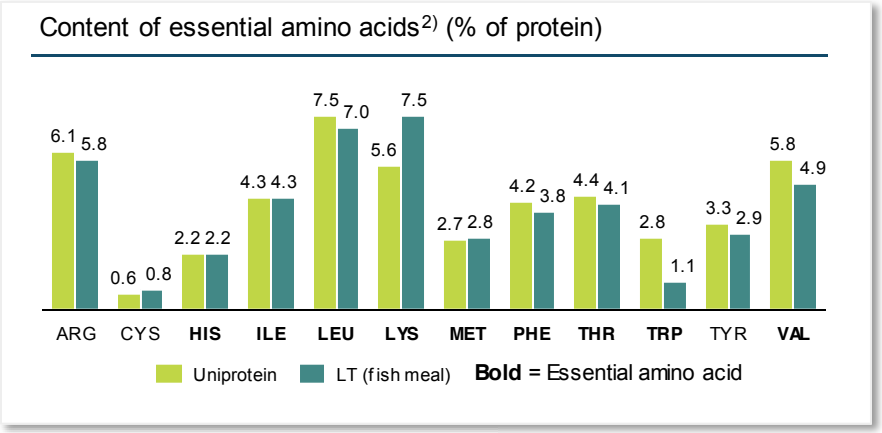
PROTEIN PRODUCTION
FROM

FARMING AND FISHING

High quality product, promising test data, no off-take risk

- **Uniprotein® - superior product performance and appealing product characteristics**
  - Protein-rich biomass (≈70% protein)
  - Better amino acid composition than fishmeal
  - Can be used as a direct supplement in animal feed compounds
- **Approved in EU for animal and fish feed**
- **Feeding trials show promising results**
  - Updated test on juvenile rainbow trout, carp, tilapia, shrimp, salmon and piglet feed
- **Unibio offering off-take agreements on full or part of the production capacity**
- **FEED-X Partner,** shifting protein production from conventional to sustainable methods
- **NEXT STEPS**
  - **Feed: Sustainability from field to fork.** Collaboration with sustainable pig producer to produce climate neutral pork
  - **Food: Non-land or ocean-based food ingredients**

Superior quality and several applications



BioPower Technologies

PROJECT X

KNOWLEDGE X CHANGE

FEED X

#FEED-X2020
#KnowledgeXChange

Feed ingredient Technology

bp TECHNOLOGIES

Esmée Fairbairn FOUNDATION

WWF

UNIVERSITY OF CAMBRIDGE

eit Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

Soil Association

One planet eat with care

At the heart of our Process
Functional Powders

- The micronization process using RESS (Rapid Expansion of Supercritical Solutions) method - raw material is fed between **two fast rotating rotors of unique design**, creating an effect of „vacuum bomb" and bursting the particles with „centrifugal forces" .
- Average grain size between 1 and 200 µm depending on materials
- Operational plants manufacture modified **biomass micropowder fuel, dietary fibres apple, oat , tomato, beetroot, sugar beet and Calcium Carbonate**
- Typical granulations

  minerals: D<50 - 3 µm and D<50 - 1,5 µm

  fibre: D<50 - 50 µm and D<50 - 25 µm

- **Advantages** of the RESS micronization method are:
  - Temperature below 120c for short retention time milliseconds
  - Chemical uniformity of particles,
  - **Significant increase in total particle surface**
  - Uniformity of fragmentation and size of the particles
  - **Repeatability, continuity and speed** of the process; one step milling
  - **High-quality fibre** with **costs significantly lower** than similar products manufactured by other technologies
- **Industrial Capacity 1 Tonne + per hour per unit**

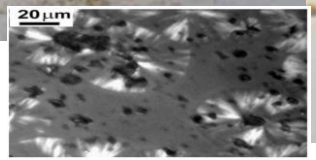
Examples

Vanilla Pods

Apple Pomace

Oat Husks

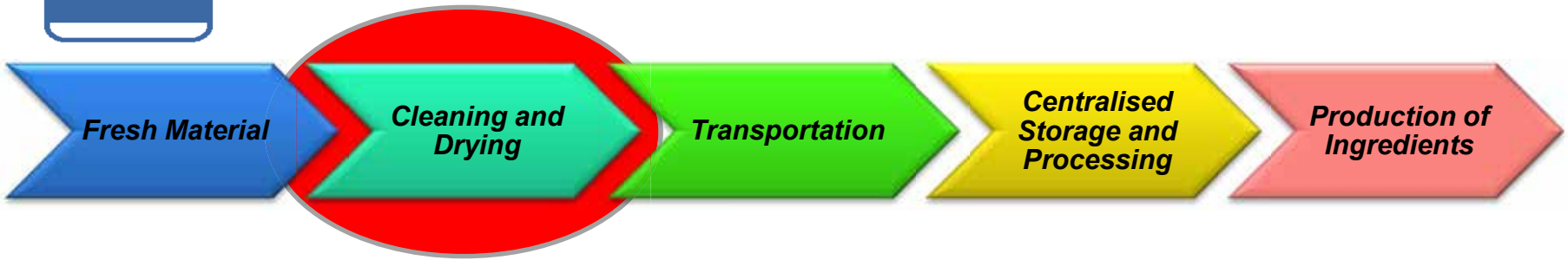
Wheat Straw



Tomato Skins and Seeds

Sugar Beet

Largest Challenge – Cost of Drying



Common Challenge

- Fresh Material contains typically 80 - 95% Moisture resulting in short shelf life
- Fresh material could contain pesticides residues, bacteria and dirt
- Drying material can be energy intensive
- Dry Material is 1/10th the weight of fresh materials – cheap to transport
- Dry Micronised Material has a shelf life of 2 years
- Remain in Food Chain
- Retain maximum valuable component
- Industrial Scale Volumes
- Flexibility for distributed supply chain, centralised coordinated processing

In progress New Multi Effect Drying system

- Modular Drying
- Scalable Sizes
- Planning for Drying as a service
- 300Kg Unit under fabrication
- 2 tonne per hour unit - design complete and funded for development Q4 2020

Veramaris

KNOWLEDGE X CHANGE

PROJECT X

FEED X

#FEED-X2020
#KnowledgeXChange

Micro Algae Oil

Esmée Fairbairn FOUNDATION

WWF

UNIVERSITY OF CAMBRIDGE

eit Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

Soil Association

One planet eat with care

veramaris

A JOINT VENTURE OF DSM AND EVONIK


TO SUCCEED HERE
WE STARTED HERE
veramaris®
A JOINT VENTURE OF DSM AND EVONIK

A finite resource – **fish oil** a barrier to sustainable growth.

veramaris®
A JOINT VENTURE OF DSM AND EVONIK

SPEED UP!

Leading retailers already moving to algae omega-3 across Europe

MORE SUSTAINABLE
raised on algae

In-store poster

Trout w. Zero Wild Fish*
with Veramaris, rich in EPA&DHA

* FFDR = Zero

More algal-fed salmon faster
Tesco at NASF

Launched algae-fed salmon
Shrimp possibly next

Announced algae salmon
In spite of COVID19

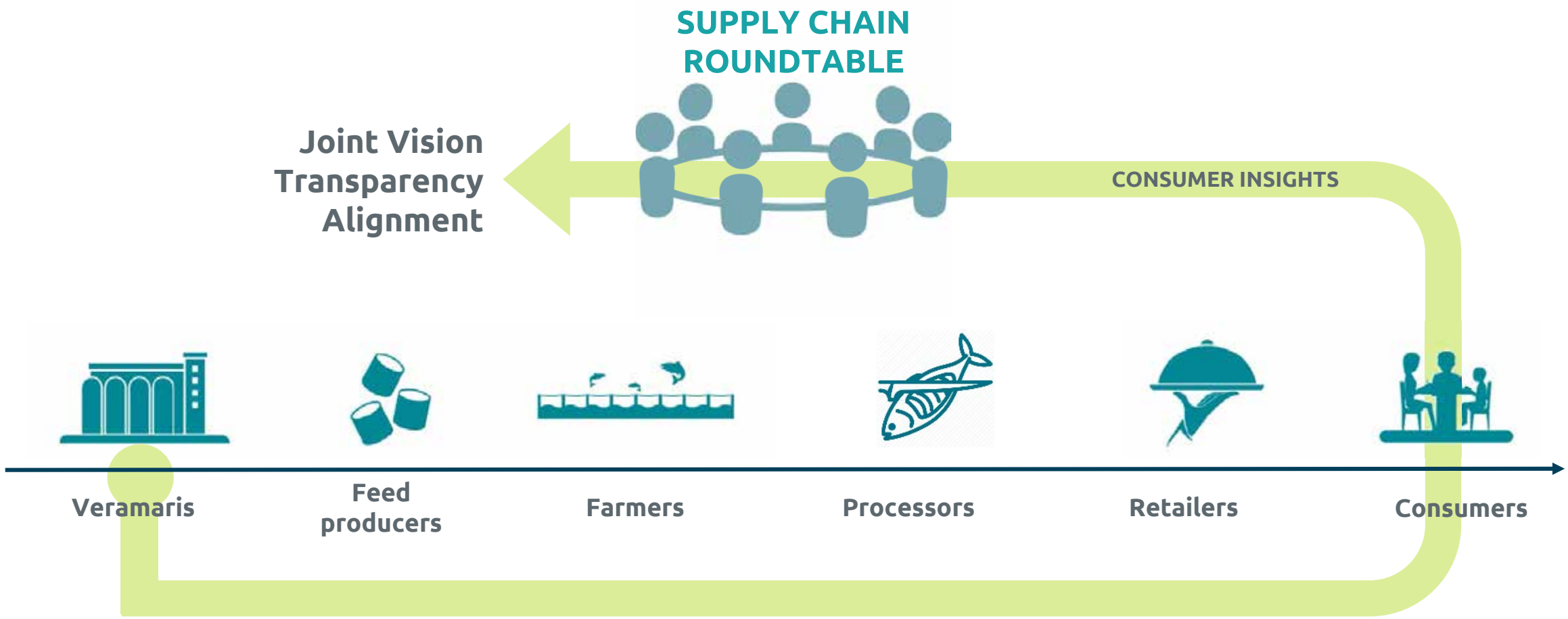
12% Growth for the category

veramaris®
A JOINT VENTURE OF DSM AND EVONIK

veramaris®
A JOINT VENTURE OF DSM AND EVONIK

THE VERAMARIS BUSINESS MODEL

Collaborate for adoption at speed – win for all along the value chain.



veramaris®
A JOINT VENTURE OF DSM AND EVONIK

Panellists & Questions

#FEED-X2020
#KnowledgeXChange

PROJECT

KNOWLEDGE

CHANGE

Webinar

FEED

KNOWLEDGE X CHANGE

Panel: Exploring Future Opportunities

Webinar

13.35 BST (22.35 pm Sydney, 14.35 CET)

Marte Vassbotten
Manager, Seafood,
PwC Bergen,

Marcela Navarro
CEO, Project X

Thomas Velacott
CEO & Innovation Lead
WWF CH

Pablo Fleiss
Chief Economist EAP,
World Bank

Henrik Stamm Kristensen
Founder, CEO,
Blendhub

Liz Bowels
Associate Director
Farming and Land Use,
Soil Assoiciation,

FEED X

#FEED-X2020
#KnowledgeXChange

Panel: Exploring Future Opportunities

KNOWLEDGE X CHANGE

Webinar

- What are the main market opportunities to the commercialisation of alternative nutrients – ie oils and proteins?
- What does the future for collaboration look like for alternative oils and proteins in sustainably fed food value chains?

- **Business competitive advantage and survival is fundamentally linked to well functioning, healthy ecosystems. The degradation of these ecosystems has a direct impact on local and global feed / food supply chains.- What do you see happening today to avoid system degradation in food/feed supply chains?**
- There are some key observations with consumers; where younger people seem to value sustainability more, how do see us reaching these more aware generations?

- What is the role of data. A nice to have or an opportunity?
- With consumers demanding a stronger connection to their food, transparency and sustainability in where it comes from, what are the opportunities?

FEED X

#FEED-X2020
#KnowledgeXChange

PROJECT X

Session 3: Ecosystem Dependence and Post COVID trends – Feed to Food

#FEED-X2020
#KnowledgeXChange

KNOWLEDGE X CHANGE

Webinar

FEED X

PROJECT X

3 Final Innovations

#FEED-X2020
#KnowledgeXChange

KNOWLEDGE X CHANGE

Webinar

FEED X

BetaHatch

PROJECT X

KNOWLEDGE X CHANGE

FEED X

#FEED-X2020
#KnowledgeXChange

Insects on food by products

Esmée Fairbairn FOUNDATION

WWF

UNIVERSITY OF CAMBRIDGE

eit Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

Soil Association

One planet eat with care

Beta Hatch

A Sustainable Protein: The Yellow Mealworm

The yellow mealworm

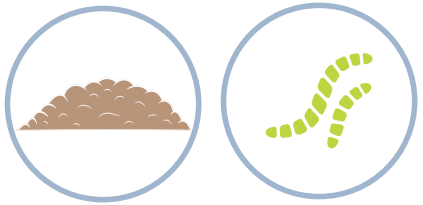
Tenebrio molitor

Historically a stored grain pest, domesticated for decades as exotic animal food, this dry adapted beetle has great potential as an animal feed ingredient, but it has never been grown at industrial scale.

Technology & innovation are needed to scale the production of mealworms as animal feed.

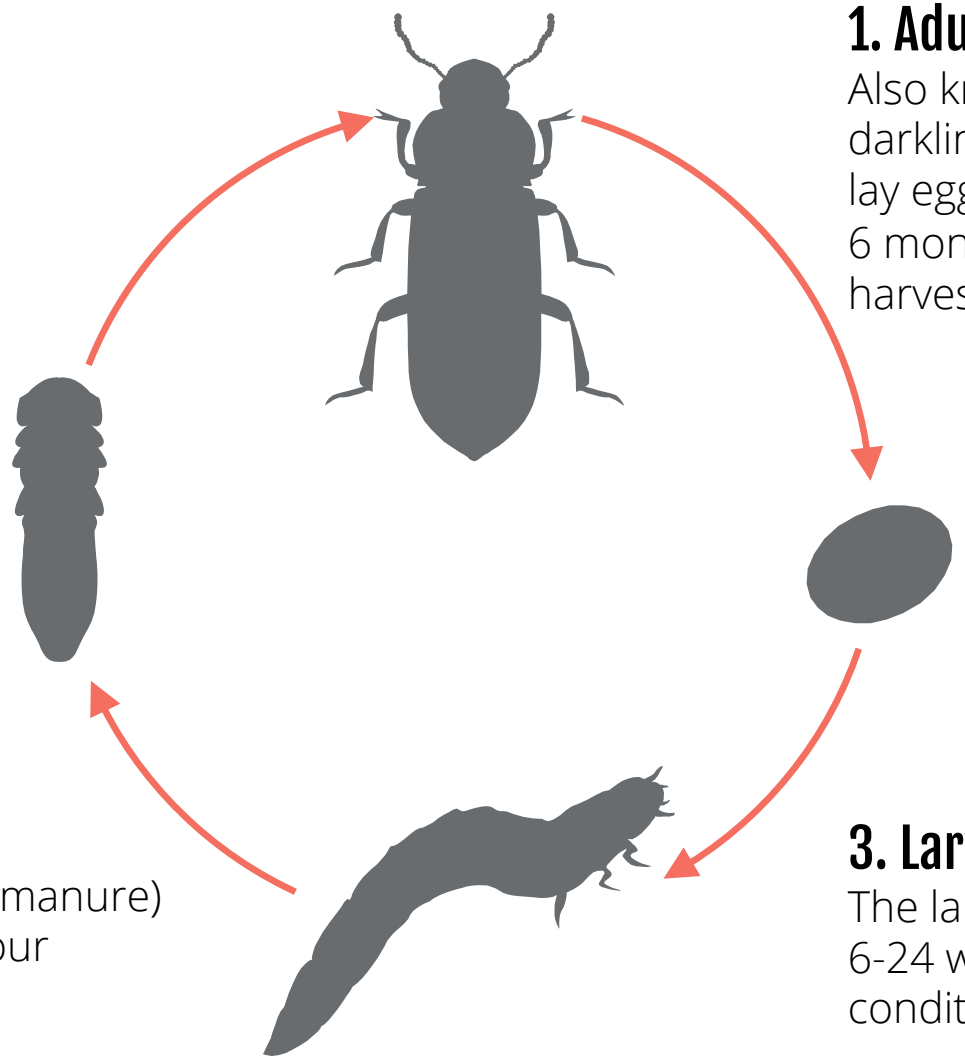
4. Pupae

About 10% of the larvae are allowed to become pupae to reproduce. A stage of metamorphosis lasting about a week, the pupal life stage is vulnerable because they cannot move.



Frass and Mealworms

We harvest frass (insect manure) and the mealworms as our products.



1. Adult Beetles

Also known as the darkling beetle, adults lay eggs for up to 6 months, with eggs harvested daily.

2. Eggs

The earliest life stages are some of the most vulnerable to climate conditions. Eggs are incubated until larvae hatch, typically 7 days.

3. Larvae – Mealworms

The larval life stage lasts 6-24 weeks depending on conditions and diet.

Insects Are a Nutritious and Natural Ingredient

Mealworms Provide the Most Nutrition per Unit of Protein

Feed Protein Source	DM (kcal/kg)
Dried mealworms	6730
Black Soldier Fly	6150
Whole soybeans	3350
Fishmeal	4890

Essential amino acids (mg/g)		Sulfur AA (mg/g)
Mealworm	437	26
Soymeal	439	24
Fishmeal	378	35

Poultry

Broilers fed mealworms convert their feed ration more efficiently; birds need less feed overall

Chitin and antimicrobial peptides in insects decrease the need for antibiotics

Aquaculture

Wild fish diets are up too 100% insects

Farmed fish fed exclusive mealworm diets do as well as on formulated control diets

Pet Food

Insect-based pet foods contain hypoallergenic proteins to combat common food allergies

Consumers demand a transparent and regenerative meat supply chain

Mealworms offer Greater Control than Other Proteins

Disease free

No heavy metals

Local supply chain

Unlike plants, mealworms can integrate nutrients into their biomass, allowing customization and eliminating the need for feed supplements

Insects are a Sustainable and Customizable Protein Source

Novo Nutrients

PROJECT X

KNOWLEDGE X CHANGE

FEED X

#FEED-X2020
#KnowledgeXChange

Single Celled Proteins

Esmée Fairbairn FOUNDATION

WWF

UNIVERSITY OF CAMBRIDGE

eit Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

Soil Association

One planet eat with care

novonutrients

feed from CO_2

novonutrients
food and feed from CO_2

the protein behind the protein™

carbon dioxide
emissions
hydrogen
oxygen, water, energy, inorganic mineral salts

[fermentation platform]
unlocking growth for input-constrained agrifood tech sectors

[manufacturers]

- Plant-based meat
- Cellular Agriculture

- Pets
- Aquaculture

Reduce costs, slaughter, fishing, water, land, fertilizer, and pesticide

From platform to partnerships

Leigh Cement
field lab: *biofuel* from CO_2, grant from CA Energy Commission

2017-18 Pivot to nutrition
recap, *food and feed from* CO_2™, IndieBio

In vivo trials
first feeding screening with salmonids, US Fish & Wildlife Service

DOE Grant
supercomputer modeling with National Renewable Energy Lab

2019 Pilot engineering
Black & Veatch

Feed-X
Joined Project X

2020 Pilot fabrication

Nutrition partnership
"Skretting to Test NovoNutrients Novel Protein Ingredients, Eyeing Off-Take Agreement"

2021 pilots
scaling up low-cost gas fermentation on 2+ sites: Chevron and (non-dilutively funded) Japan

novonutrients
food and feed from CO_2™

Protix

PROJECT X

KNOWLEDGE X CHANGE

FEED X

#FEED-X2020
#KnowledgeXChange

Insects on food by products

Esmée Fairbairn FOUNDATION

WWF

UNIVERSITY OF CAMBRIDGE

eit Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

Soil Association

One planet eat with care

PROTIX

FLYING R-EVOLUTION

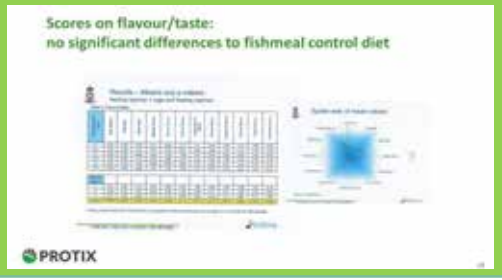
Insect Meal

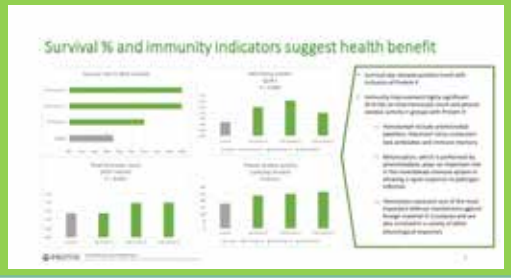
Solution for a variety of farmed animal diets

Atlantic salmon

Vannamei shrimp

Other animals





We have our first successful experiences in full chain concepts (retail & food service)

- ✓The original source of nutrients for many carnivorous species
- ✓Circular ingredient which also ensures re-use of food leftovers
- ✓ Produced at commercial scale and within a low footprint system
- ✓Room for further product and application innovations in future

Plans going forward - Values

- Private equity and Bank funded (Rabobank)
- Strong patent portfolio across each of the main production steps (breed, rearing, processing)
- Experience with wide variety of feedstocks and sourcing thereof facilitating global expansion; experience with working with companies across value chain
- Global partnerships allowing for further optimization and cost curve development (eg. Buhler, Hendrix Genetics)
- Ready for market acceleration now the first blueprint facility is operational; annual production of several thousands of tonnes finished product
- New (financial or trade) partners always welcome

120 FTE with variety of backgrounds

PROTIX BÜHLER

Panellists & Questions

#FEED-X2020
#KnowledgeXChange

PROJECT

KNOWLEDGE

CHANGE

Webinar

FEED

KNOWLEDGE X CHANGE

Panel: Future of Feed/Food - Post COVID Trends

Webinar

14.15 BST (23.15 pm Sydney, 15.15 CET)

Steve Evans
Director of Industrial Sustainability,
Cambridge University

Pablo Fleiss
Chief Economist EAP,
World Bank

Henrik Stamm Kristensen
Founder, CEO,
Blendhub

Marcela Navarro
CEO, Project X

FEED X

#FEED-X2020
#KnowledgeXChange

Panel: Future of Feed/Food - Post COVID Trends

KNOWLEDGE X CHANGE

Webinar

- How do you see the lessons from the FEED-X going beyond aquaculture – what of this approach can be applied to other sectors?
- At World Agri-tech we recently heard from Jesper Brodin – IKEA's CEO about the importance of taking action, "share more with others" and collaboration. What are the scalable sustainability collaboration models in the feed/food space you see emerging today? What makes these successful, sustainable and scalable?
- What does the post-COVID world look like and how have you built in resilience into your business to deal with future shocks
- Which mega trends, post COVID, excite and concern you most?

FEED X

#FEED-X2020
#KnowledgeXChange

Thank you, Merci, Grazie, Danke, Gracias

for attending the

KNOWLEDGE X CHANGE

Webinar

#FEED-X2020
#KnowledgeXChange

Exclusive Access:

We would be delighted to make available to you relevant Feed-X documentation that you might find of interest. This includes **Market Opportunity Report.** Please contact us on Contact: info@projectxglobal.com for more details.

FEED X

We would be happy to hear from you.

Please contact us at: info@projectxglobal.com