Today's outlook of omega-3 nutrition in shrimp: from nutritional requirement to tailored nutrition

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12th of November 2025, Fenacam - Natal

What do we know about omega-3 fatty acids in shrimp?

What are omega-3 fatty acids?

- **Fatty acids** are components of fats, oils, lipids.

→ **saturated**, **mono-unsaturated** or **polyunsaturated**

- **Long chain poly-unsaturated fatty acids** (LC-PUFAs):
  - ≥ 18–20 carbons
  - two main families: **n-6 and n-3** depending on the position of the first double bond from the methyl end group of the fatty acid.
  - **Main n-3s** in food sources are α-linolenic acid (ALA) (18:3), **docosahexaenoic acid** (DHA) (22:6), **eicosapentaenoic acid** (EPA) (20:5), and docosapentaenoic acid (DPA) (22:5).
  - **Main n-6s** include linoleic acid (LOA) (18:2) and arachidonic acid (ARA) (20:4).

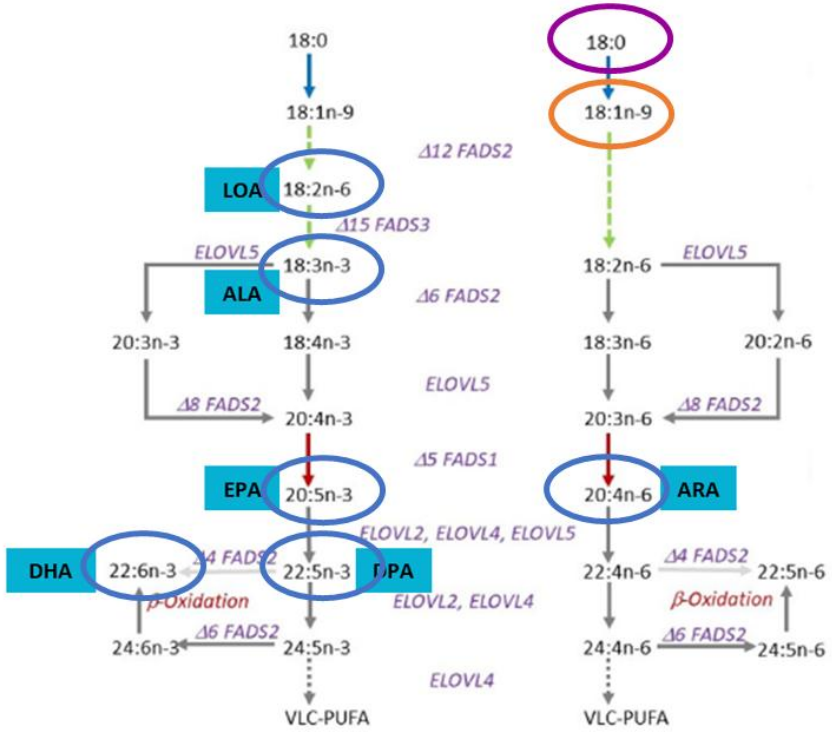


Figure 6. Biosynthesis pathways of long-chain polyunsaturated fatty acids. Shown are the enzymatic points where plants differentiate from animals, and where variation occurs among animals that influences their demands for shorter-chain polyunsaturated fatty acids (SC-PUFA) versus long-chain polyunsaturated fatty acids (LC-PUFA). Enzymes involved are detailed in purple italics.

Source: Glencross et al., 2024

What are omega-3 fatty acids?

Fatty acid profile varies dramatically between types of oils (marine *vs.* plant)

Table 1. Fatty acid composition (weight %) of a range of oils relevant for use in the diets of farmed Atlantic salmon

	Capelin oil	Sardine oil	Anchovy oil	Krill oil	Soybean oil	Olive oil	Sunflower oil	Linseed oil	Palm oil	Coconut oil	Maize oil	Rapeseed oil
12:0	–	–	–	–	–	–	–	–	–	48	–	–
14:0	6.3	7.2	7.8	16.3	–	–	0.1	0.1	1.1	24	–	0.1
16:0	11.0	16.2	18.2	19.0	10.9	11.8	6.3	5.3	40.0	9	10.3	4.7
18:0	0.9	2.9	4.2	1.4	3.9	2.5	4.9	3.2	4.1	3	1.8	1.6
Sum SFA	18.9	27.3	30.2	38.6	15.6	14.7	12.3	8.6	45.2	89	12.5	7.5
18:1n-7	1.9	3.1	–	7.8	1.3	2.2	0.7	0.7	–	–	0.6	3.0
18:1n-9 (OA)	6.7	9.3	16.0	15.8	21.9	71.4	23.0	17.1	41.1	9	31.1	56.7
20:1n-9	15.9	1.5	1.0	1.4	–	0.3	0.2	–	–	–	0.2	1.7
22:1n-9	2.3	0.2	0.3	0.6	–	–	–	–	–	–	–	0.8
22:1n-11	20.2	0.9	1.6	0.3	–	–	–	–	–	–	–	–
Sum MUFA	56.5	25.4	29.6	38.1	23.3	75.0	23.9	17.8	41.1	–	32.0	62.2
18:2n-6 (LA)	1.3	1.1	2.8	1.6	54.3	9.5	62.5	14.3	10.8	2	54.1	19.5
20:4n-6 (ARA)	–	0.8	0.1	0.1	–	–	–	–	–	–	–	–
Sum n-6	1.3	1.9	2.9	2.1	54.3	9.5	62.5	14.3	10.8	–	54.1	19.6
18:3n-3 (ALA)	0.7	0.6	1.8	0.8	6.5	0.7	0.5	57.0	0.3	–	1.3	9.4
18:4n-3	4.8	3.2	2.3	3.6	–	–	–	–	–	–	–	–
20:5n-3 (EPA)	7.5	18.4	14.8	6.4	–	–	–	–	–	–	–	–
22:5n-3 (DPA)	0.6	2.2	1.8	0.2	–	–	–	–	–	–	–	–
22:6n-3 (DHA)	5.7	12.3	10.9	2.3	–	–	–	–	–	–	–	–
Sum n-3	19.8	37.7	29.3	14.6	6.5	0.7	0.5	57.0	0.3	–	1.3	9.4
n-6/n-3	0.07	0.05	0.10	0.14	8.35	13.6	125	0.25	36	–	41.6	2.1

Source: Sissener et al., 2018

Vegetable oils lack long-chain n-3 PUFA EPA and DHA, and have a higher n-6 FA content compared with fish oils.

What do we know about omega-3 fatty acids in shrimp?

Omega-3 are critical for shrimp performances

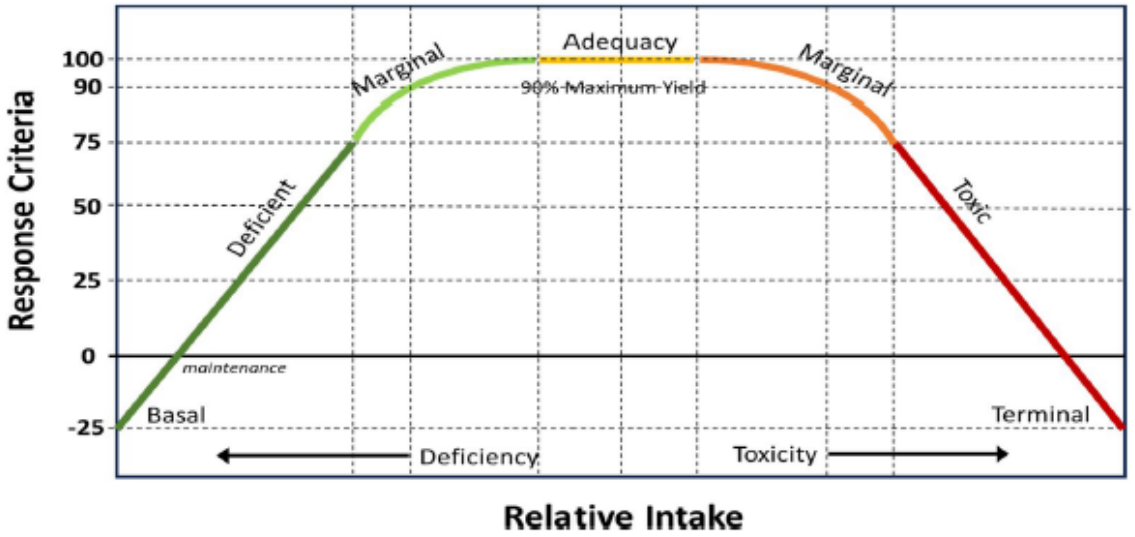
Long-chain omega-3 are a valuable ingredients to promote shrimp health and robustness, especially at crucial moments during animal development and growth and in challenging conditions.

LC-PUFAs are involved in cell synthesis and replication, Neural development, Endocrine function and control, Ion regulation, Immune function, Inflammation, reproduction

Omega-3 fatty acids are required nutrients for shrimp

Without N3 in the diet, shrimp could not sustain basic physiological functions and optimal performances

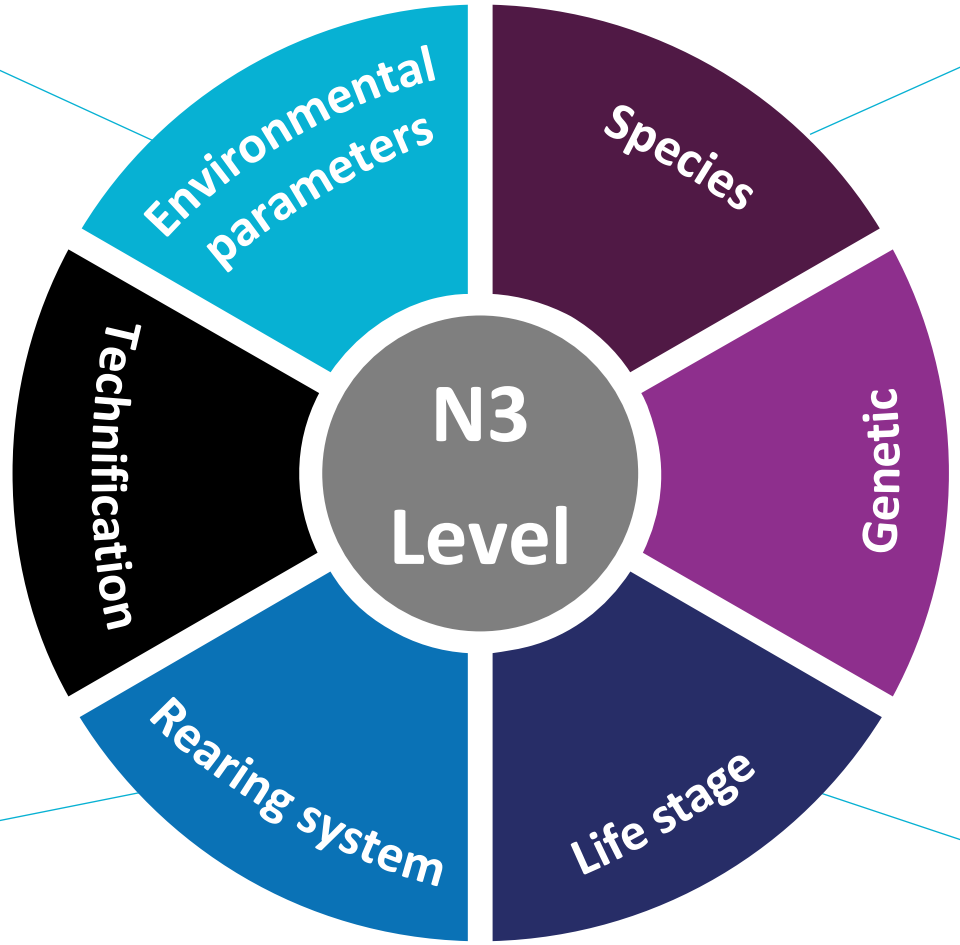
- **Shrimp have an absolute requirement for LC-PUFAs:** 18:3 n3 (ALA) and 18:2 n6 (LOA) can be converted into LC-PUFAs but not at a sufficient rate to sustain high growth.
- Requirement for omega-3 fatty acids:
  - Not (so) clear per fatty acids
  - Interactions between fatty acids (EPA and DHA with LOA and LA)
  - *NRC (2011)*: min. 0.5% EPA+DHA (EPA:DHA = 1)
  - *Glencross et al.(2024)*: min. 0.3% (vannamei, juvenile)



Source: Glencross et al., 2024

Multiple factors affecting optimal nutritional levels

Changing requirement(s) per production cycle and within each production cycle



High/low salinity, High/low temperature, rain/dry season, bacteria/virus

Vannamei /Monodon

Manual feeding, automatic feeding, “on demand”

SPF / SPR

Ponds system (intensive), Ponds system (semi-int.), Biofloc, RAS

Broodstock, larval, juvenile, adult

What do we know about omega-3 fatty acids in shrimp?

Nutrition: one size does not fit all (1)

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REVIEW ARTICLE

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Omega-3 Futures in Aquaculture: Exploring the Supply and Demands for Long-Chain Omega-3 Essential Fatty Acids by Aquaculture Species

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ABSTRACT

Long-chain polyunsaturated fatty acids (LC-PUFA), like 22:6n-3 (Docosahexaenoic acid; DHA) and 20:5n-3 (Eicosapentaenoic acid; EPA), are recognized for a range of important physiological roles in many aquaculture species. While the effects of EPA and DHA on a range of performance attributes and meat qualities are well recognized, an increasing awareness of their role in immune function, reproduction, bone formation and stress response is also emerging. Against this background of demand, global supplies of LC-PUFA are dominated by fish oil production from a diversified range of sources, though news sources are emerging. Among those aquaculture sectors that are the largest users of LC-PUFA resources (salmonids, shrimp, and marine fish), there are varying degrees of capacity by each to endogenously synthesize LC-PUFA and this affects the degree to which they must be obtained *via* the diet. Salmonids, which are the largest user of these nutrients possess some capacity to make EPA and DHA de novo, although evidence supports that salmonids perform better when provided with them preformed. Requirements by shrimp for LC-PUFA are variable, with evidence indicating that some species have capacity to desaturate and elongate fatty acids, whereas others do not. This is consistent with the observation that some species can utilize short-chain polyunsaturated fatty acids, whereas others need pre-formed LC-PUFA in their diet. A third group, marine fish, have limited ability to desaturate and elongate precursor fatty acids and therefore have a critical requirement for LC-PUFA in their diet. Evidence across multiple species indicates that demands for these fatty acids are greater when the animals are young,

KEYWORDS

DHA; EPA; metabolism; production; PUFA; requirement; supply

Diet Lipid Content (g/kg)	Diet EPA + DHA Content (g/kg)									
	3	6	9	12	15	18	21	24	27	30
100	3.5%	7.1%	10.6%	14.1%	17.6%	21.2%	24.7%	28.2%	31.8%	35.3%
120	2.9%	5.9%	8.8%	11.8%	14.7%	17.6%	20.6%	23.5%	26.5%	29.4%
140	2.5%	5.0%	7.6%	10.1%	12.6%	15.1%	17.6%	20.2%	22.7%	25.2%
160	2.2%	4.4%	6.6%	8.8%	11.0%	13.2%	15.4%	17.6%	19.9%	22.1%
180	2.0%	3.9%	5.9%	7.8%	9.8%	11.8%	13.7%	15.7%	17.6%	19.6%
200	1.8%	3.5%	5.3%	7.1%	8.8%	10.6%	12.4%	14.1%	15.9%	17.6%
220	1.6%	3.2%	4.8%	6.4%	8.0%	9.6%	11.2%	12.8%	14.4%	16.0%
240	1.5%	2.9%	4.4%	5.9%	7.4%	8.8%	10.3%	11.8%	13.2%	14.7%
260	1.4%	2.7%	4.1%	5.4%	6.8%	8.1%	9.5%	10.9%	12.2%	13.6%
280	1.3%	2.5%	3.8%	5.0%	6.3%	7.6%	8.8%	10.1%	11.3%	12.6%
300	1.2%	2.4%	3.5%	4.7%	5.9%	7.1%	8.2%	9.4%	10.6%	11.8%
320	1.1%	2.2%	3.3%	4.4%	5.5%	6.6%	7.7%	8.8%	9.9%	11.0%
340	1.0%	2.1%	3.1%	4.2%	5.2%	6.2%	7.3%	8.3%	9.3%	10.4%
360	1.0%	2.0%	2.9%	3.9%	4.9%	5.9%	6.9%	7.8%	8.8%	9.8%
380	0.9%	1.9%	2.8%	3.7%	4.6%	5.6%	6.5%	7.4%	8.4%	9.3%
400	0.9%	1.8%	2.6%	3.5%	4.4%	5.3%	6.2%	7.1%	7.9%	8.8%

Relationship between dietary lipid and N3 requirement

Growth, what about other performance targets?

Source: Glencross et al., 2024

What do we know about omega-3 fatty acids in shrimp?

Nutrition: one size does not fit all (2)

3 levels defining requirements

What do the two sea cage trials tell us about the EPA and DHA requirement of A. salmon? *

Nofima

Increasing the level of marine EPA and DHA fatty acids in feed from 5% and/or 6,5% to 10-11% of total fatty acids leads to;

- Increased growth, more robust salmon (in periods with stress, due to higher feed intake)
- Improved color, reduced liquid leakage and reduced occurrence of black melanin spots in fillet
- Improved fish welfare and **health**
- Improved zinc status in whole body
- Increased EPA + DHA contents in tissues

≤1g EPA+DHA/100g feed (3-4% av TFA) Not sufficient for health and growth	1-1.6 g EPA+DHA/100g feed (4-6% av TFA) OK in tanks on land, not in sea cages	1.6-3 g EPA+DHA/100g feed (6,5-11% av TFA)

6,5% EPA+DHA ➡ poorer fillet quality, growth and heart health than the 11% group.

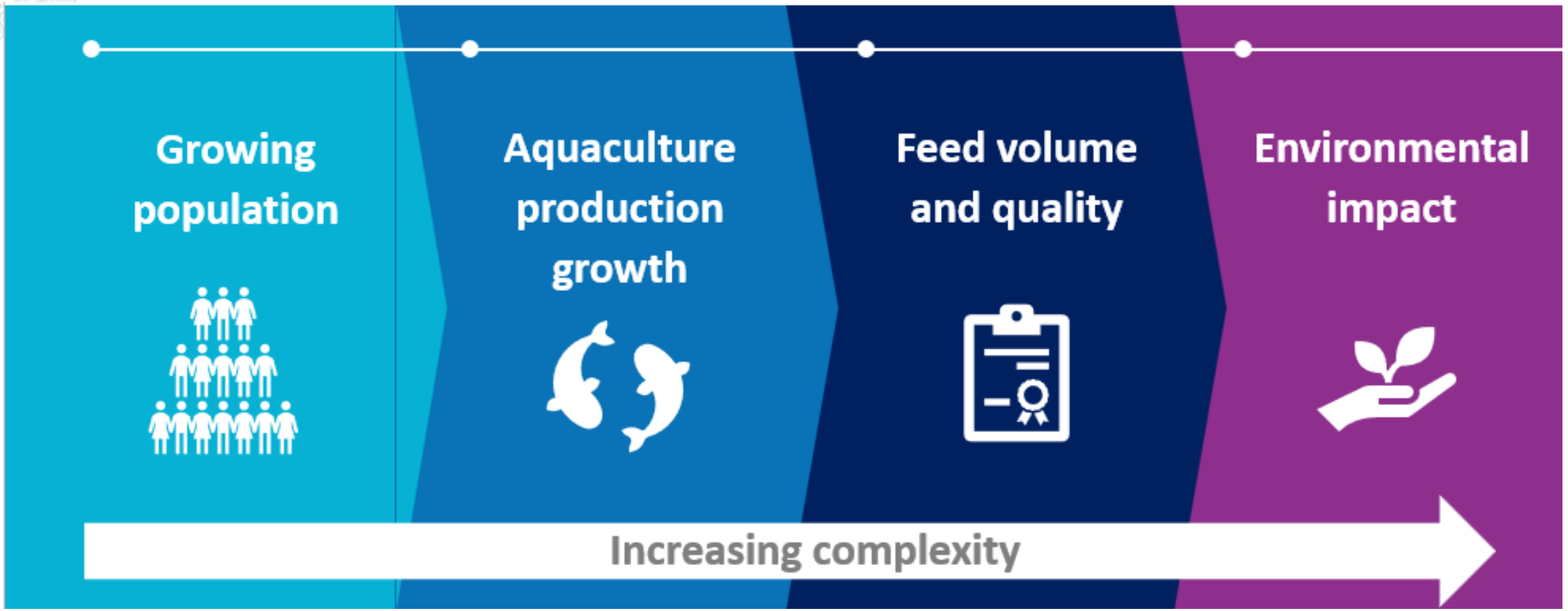
The industry now uses mostly 7%, but in some areas as high as 13%

*Source: presentation by Bente Ruyter, IFFO May 2025

Complexity is the new normal

Complexity is the new normal

Our challenges

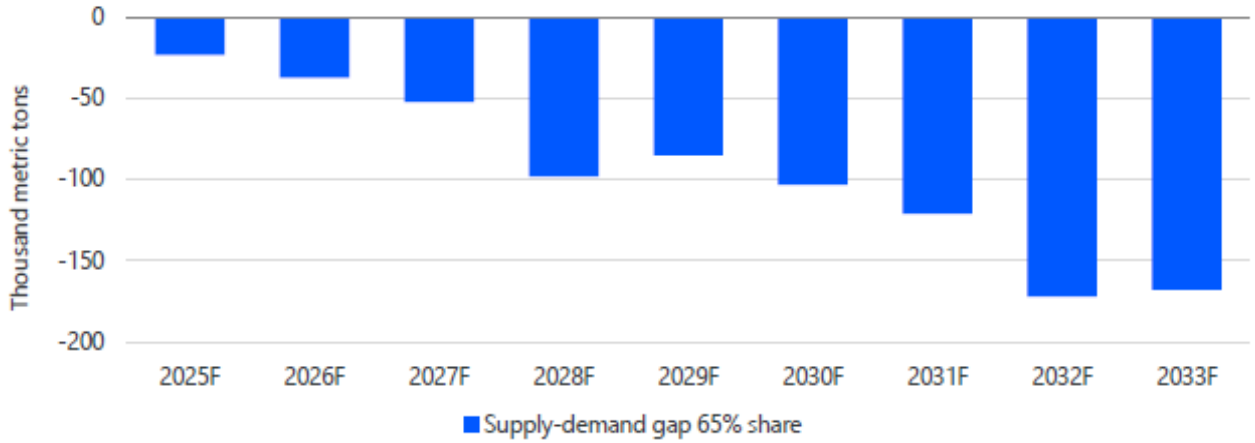


Complexity is the new normal

As demand grows, so does the gap between sources of Omega-3

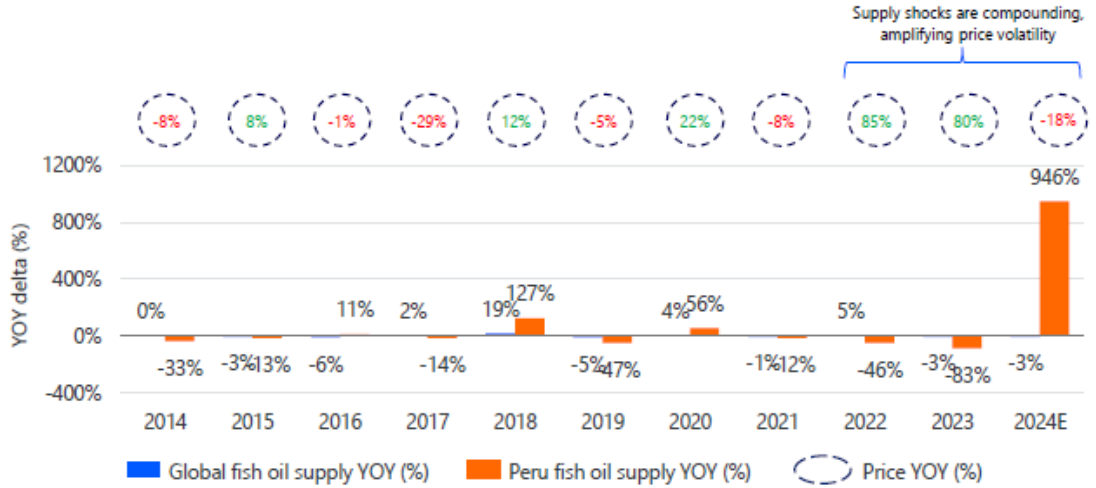
New sources of Omega-3 are needed to grow aquaculture responsibly

Figure 3: Demand for fish oil has historically increased at 2%-4% annually, therefore an additional 20,000-40,000 metric tons are needed every year



Source: FAO, Holterman, RaboResearch 2025

Figure 6: The market's ability to absorb disruptions has weakened and even minor disruptions in Peruvian supply can lead to amplified price reactions



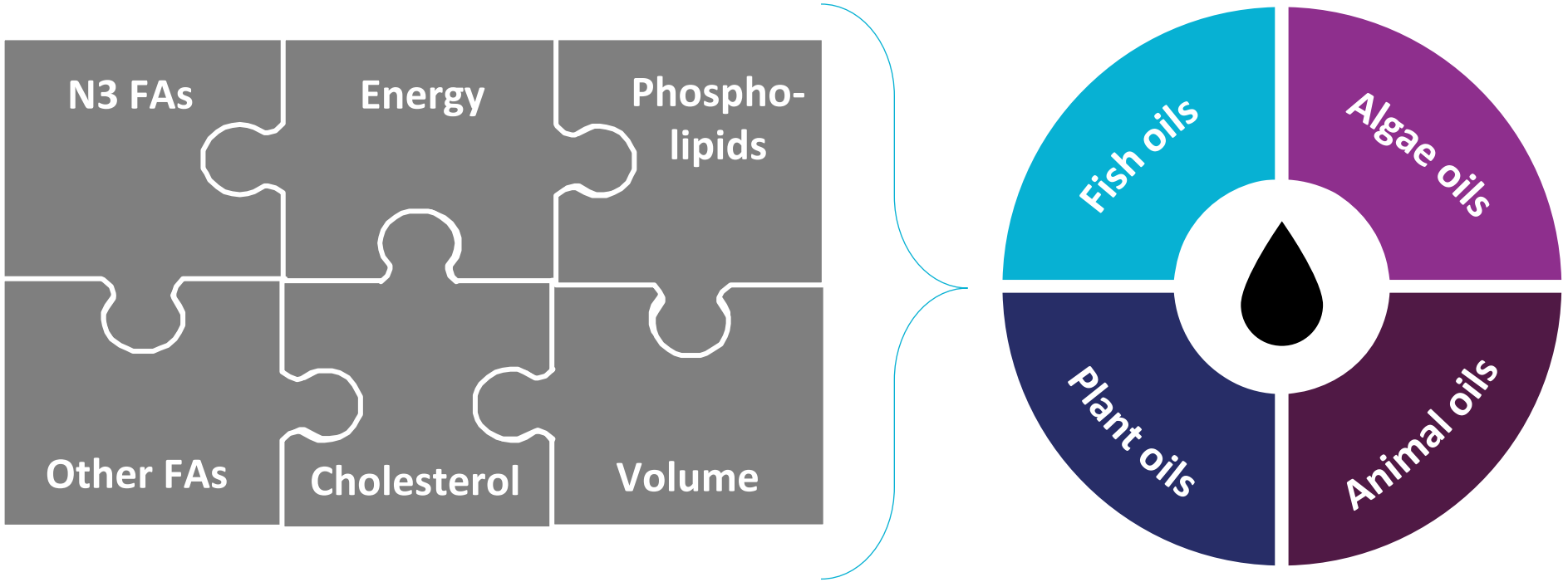
Source: Holterman, RaboResearch 2025

Complexity to source N3 raw materials at adequate quantity, quality and price

Source: RaboResearch, September 2025

Complexity is the new normal

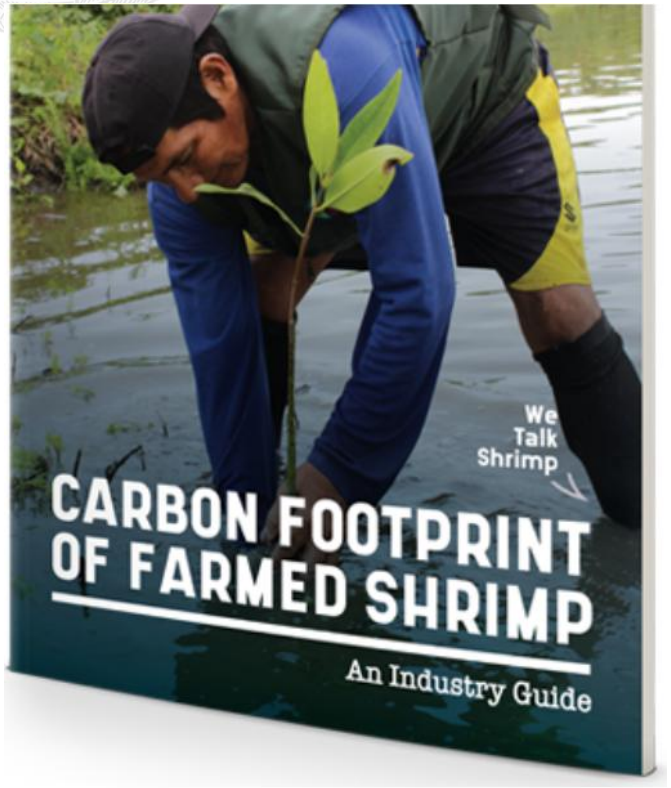
Formulation: Matching nutrients and broaden ingredients basket

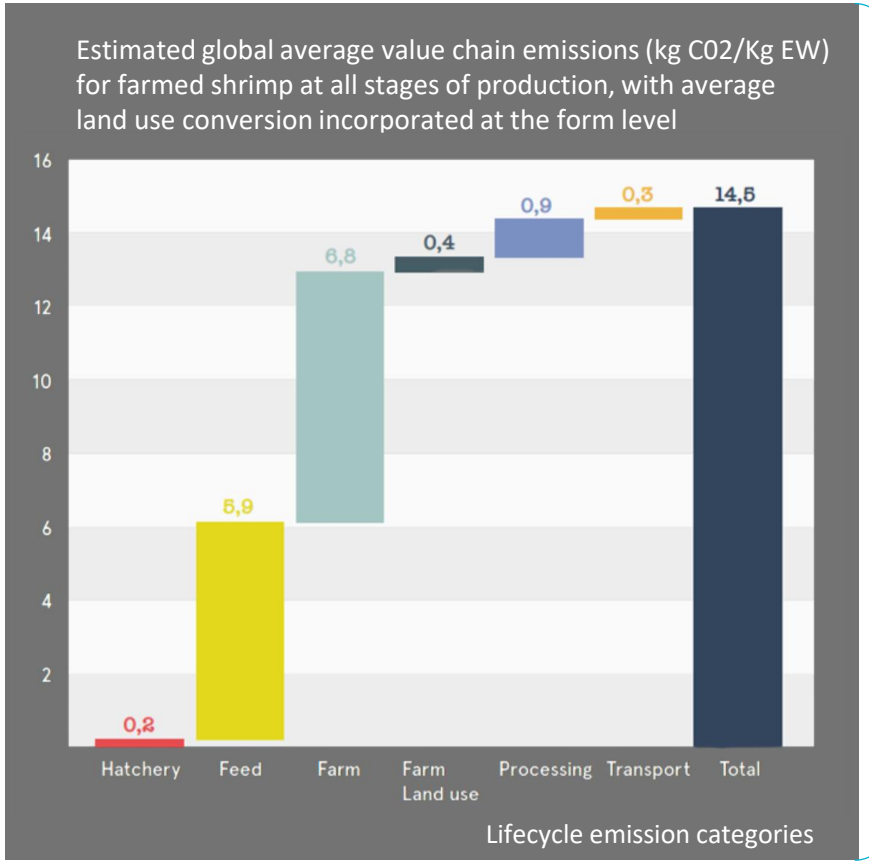


Complexity to formulate for the right nutritional levels, quality, and cost

Complexity is the new normal

It is not only about nutrients... (1)





FCR → FFDR → LCA

Complexity to measure and report on the right impact

Source: The carbon footprint guide (2025)

Complexity is the new normal

It is not only about nutrients... (2)

Ticket to Play: These criteria represent the essential requirements that suppliers must meet to enter the aquaculture feed market.

Ticket to Stay: These criteria reflect ongoing requirements for suppliers to remain competitive and relevant in the long term.

The Skretting Targeting Matrix

Sustainability	Ingredient performance	Supplier capabilities
Low(er) environmental footprint	Fit for purpose nutritional profile	Quality certifications: FAMI-QS, ISO 9001, HACCP, GMP+, ASC
Biodiversity impact	Regulatory compliance	Quality assurance processes/regulatory compliance
Social impact: Human rights/ethical labour	Market demand and acceptance	Financial security
LCA (ISO 14040/44, PEFCR, GFLI)	Cost competitiveness	Purpose and vision/cultural fit
Contribution to circular economy	Quality documentation	Market understanding
Food/feed competition	Scientific data/trials	Innovation capability/customisation options
Animal welfare and performance	Physical properties	Network/innovation ecosystem
Continuous footprint reduction/pathway	Scalability potential	Competence mix

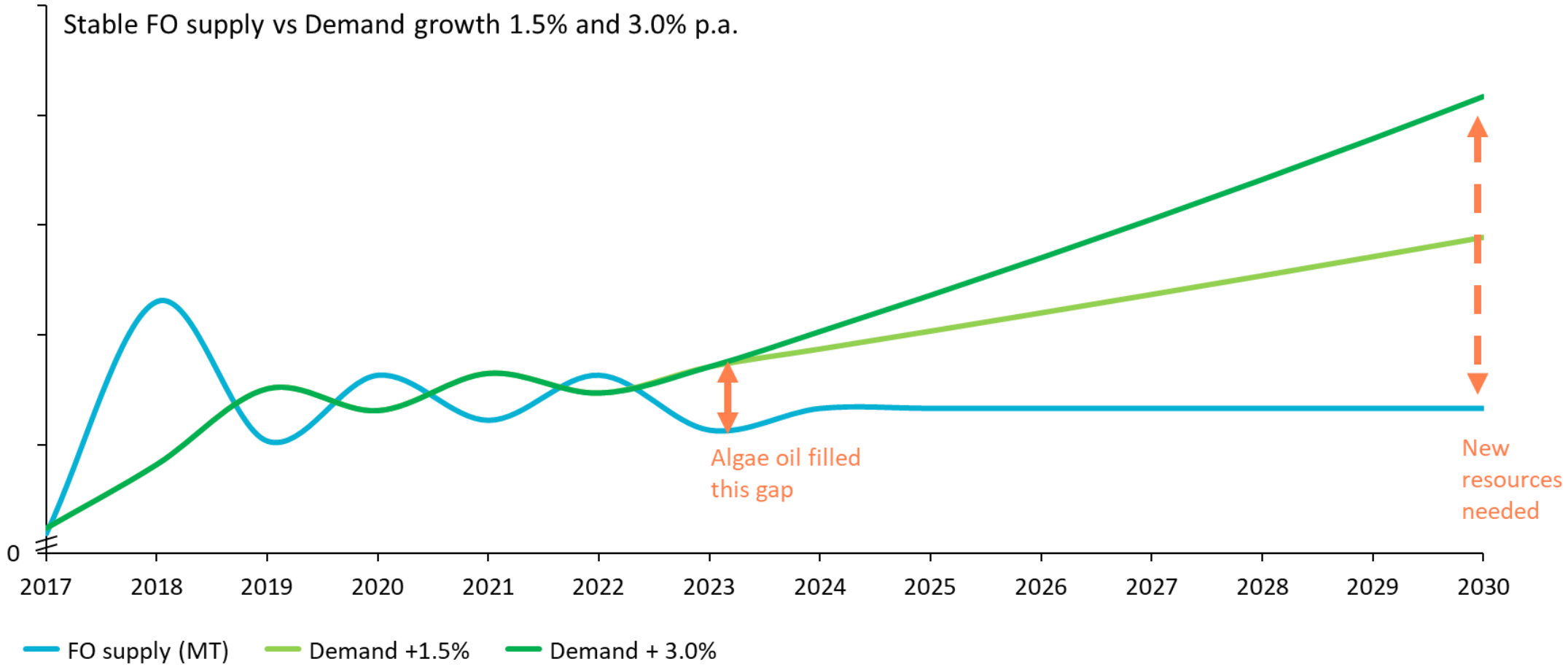
Complexity to source the right “long-term” ingredient

Source: Skretting impact report 2024

Tackling today’s challenges

As demand grows, so does the gap between sources of Omega-3s

Sustainable alternative sources are needed to build resilient supply chains



Source: Aquafeed Summit with industry leaders, NASF 2025.

Tacking today's challenges

Technology and feasibility

Production algae omega-3 DHA: Corbion has created a process that is highly sustainable

Limited transport, close to sugar cane fields

Sugarcane waste

Power generation

Omega-3 high DHA content

Over-the-fence Power generation

Responsible sourced Sugarcane

Sugar mill / bio-refinery

Closed-tank Fermentation

Downstream processing

AlgaPrime™ by Corbion

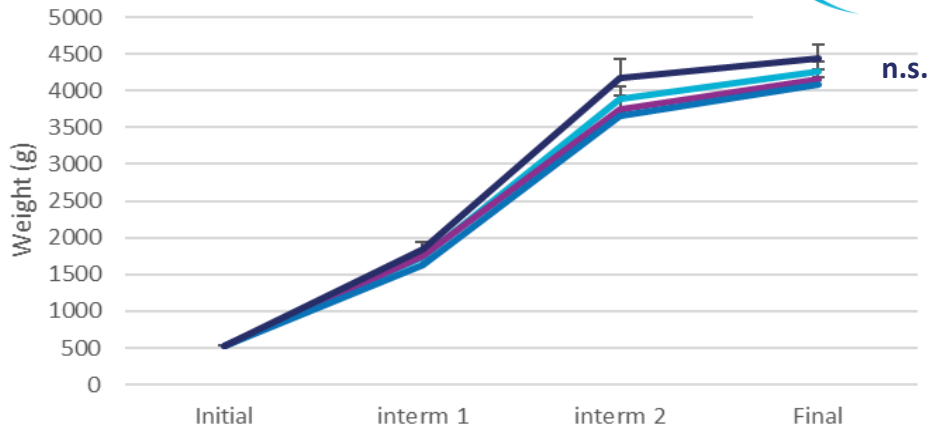
Produced in Brazil in an area far away from the Amazon Verified deforestation free

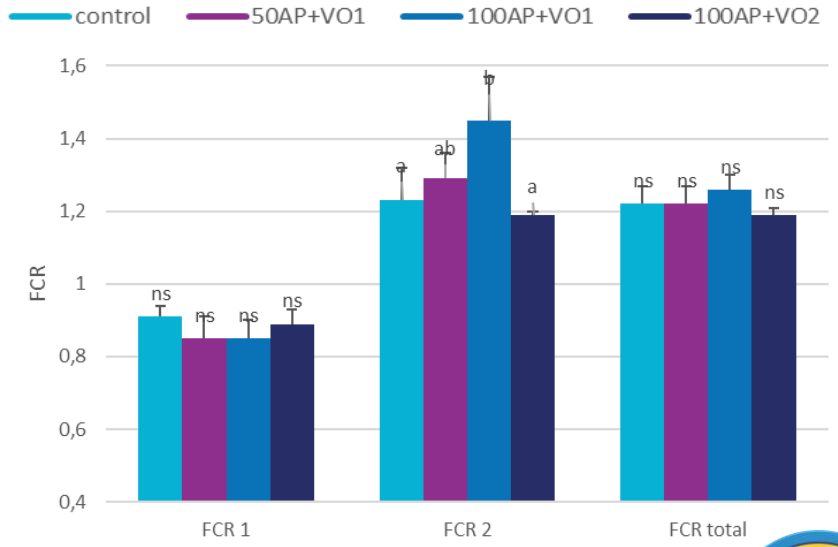
Raw sugar

Tacking today's challenges

Creating value for fish and shrimp producers

- Species: Atlantic salmon (initial weight 532 ± 3.1g)
- 12 sea cages (125 m^3), triplicate per dietary treatment
- Norway, Sept '19 to October '20 (sea temp.: 3.8-14.8°C)
- 369 feeding days
- 4 experimental diets (7 and 9 mm) with EPA+DHA at 8% total fatty acids:
  - Control diet with fish oil and rapeseed oil ( )
  - AlgaPrime™ replacing 50% ( )or 100% ( ) of the sum of EPA+DHA from fish oil



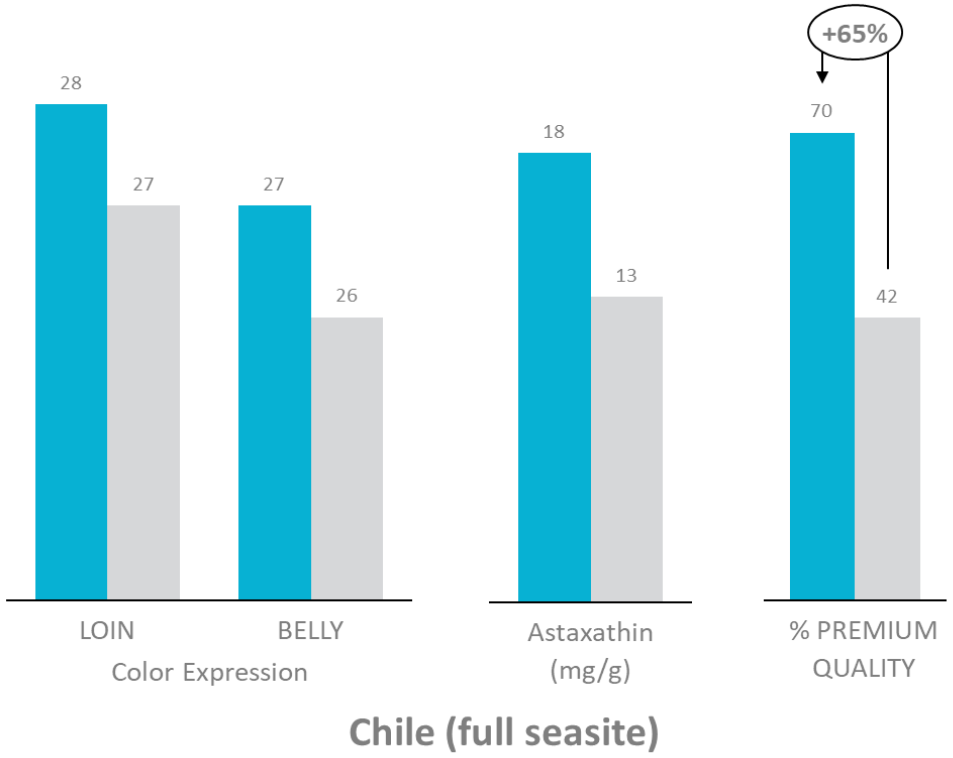


AlgaPrime™ (AP) can replace fish oil without negative effect on growth and feed conversion ratio (FCR)

Tacking today's challenges

Creating value for fish and shrimp producers

- Customer trial in Chile
- Species: Rainbow trout (initial weight 1.6 kg)
- Trial at sea until harvest size, 3 replicate cages per dietary treatment
- One control diet + one diet with AlgaPrime™
- 3.1% EPA+DHA (% diet) in both diets



AlgaPrime™ dietary inclusion can help improving fillet quality

Fed diet with AlgaPrime™

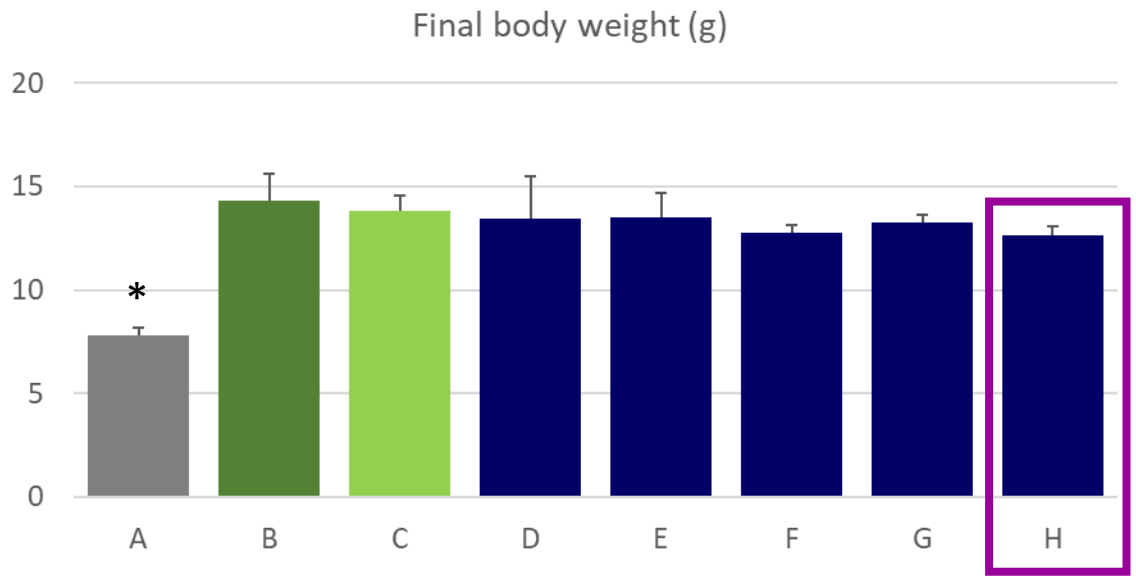
Fed control diet

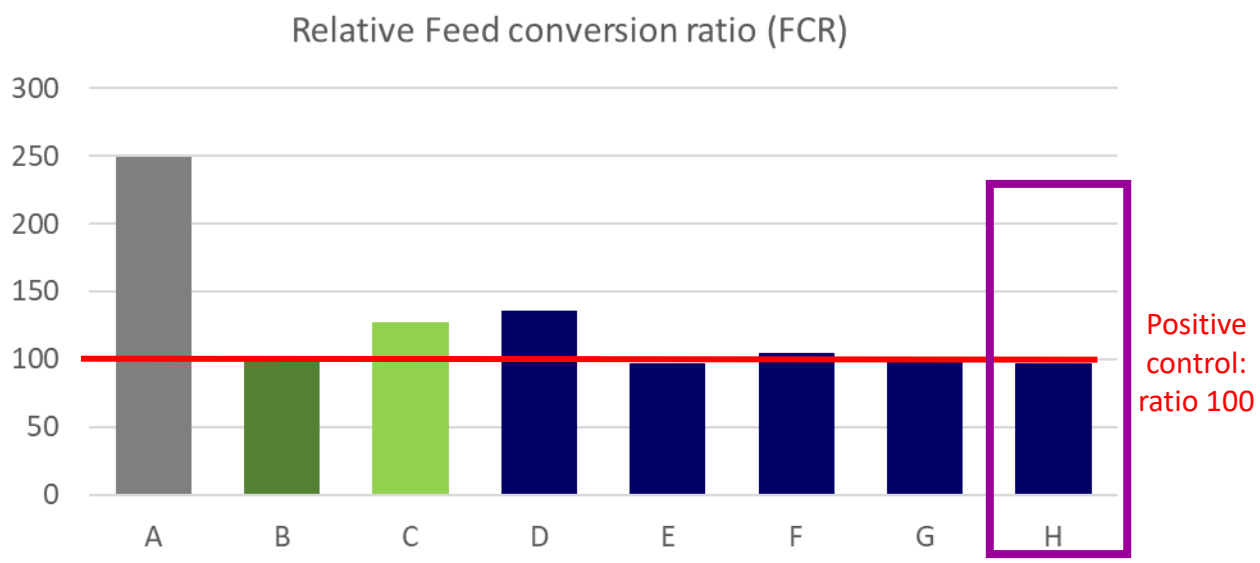
Source: trials with customers in Chile, 2023

Tacking today's challenges

Creating value for fish and shrimp producers

- Species: *Litopenaeus vannamei*
- Initial bodyweight: 1.9 ± 0.1g
- 56 feeding days trial – Recirculation system; salinity: 25 ppt; temperature: 27.4 ± 0.9°C; > 80% sat. DO
- 30 shrimp / tank (eq. 100 shrimp/m^2), 3 replicate tanks / dietary treatment
- 8 diets: 1 negative control (no FM/FO - E+D ~ 0%), 1 positive control (FM/FO - E+D ~ 0.7%), 1 positive control (FM/FO - E+D 0.6%), 5 diets with AlgaPrime™ replacing FM and/or FO while keeping EPA+DHA (E+D) ~ 0.6% diet



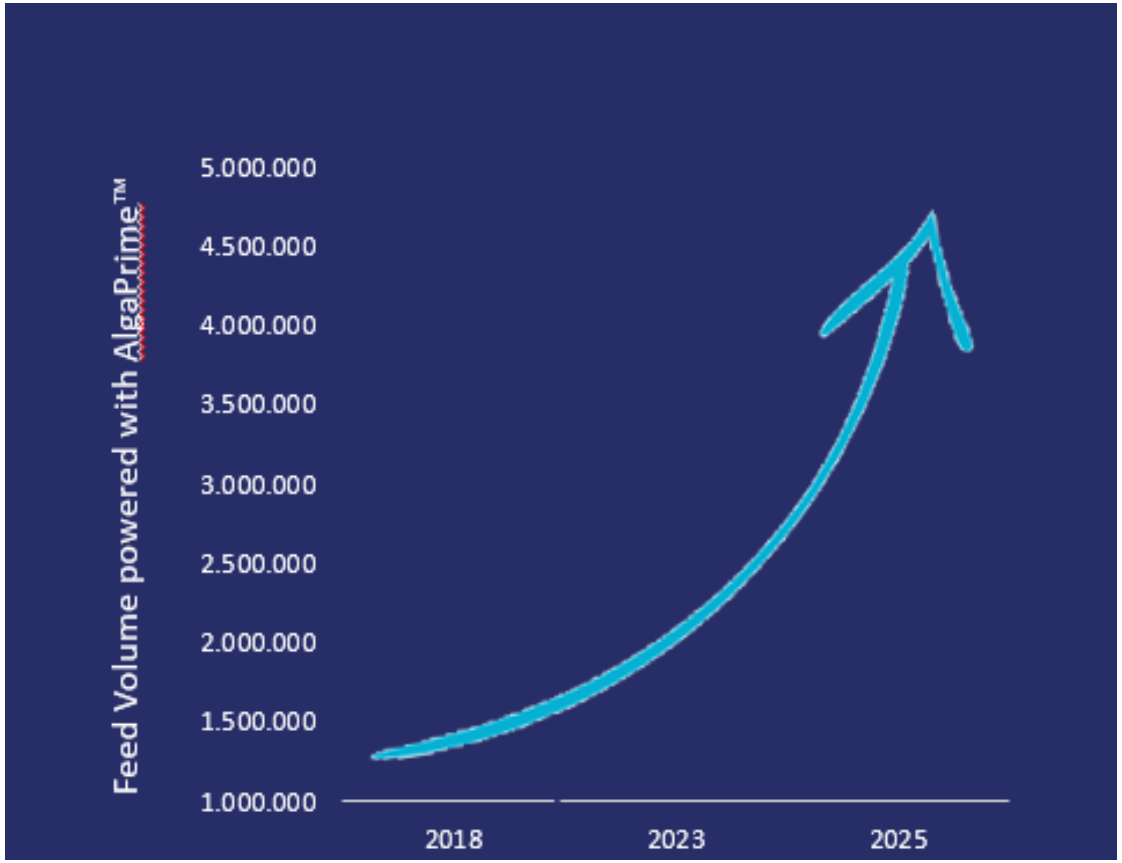


AlgaPrime™ can replace PUFA provided by fish oil and fishmeal without negative effect on growth and feed conversion ratio (FCR)

Source: internal R&D study

Tacking today's challenges

Evolving AlgaPrime™ for impact



AlgaPrime: Unexpected Algae Heroes

14 Apr 2025 – 4 min read

As the global demand for sustainable aquaculture practices continues to rise, so does the need for alternatives to traditional fish meal and fish oil. One of the most promising innovations in this space is AlgaPrime, a revolutionary ingredient that provides a sustainable and nutritious source of omega-3 fatty acids, particularly DHA.

In 2025, AlgaPrime™ was included in over 4 Million tons of aquaculture feed

Tacking today's challenges

Sustainability at scale: life cycle assessment of algal omega-3

ISO 14040/44-compliant

Life cycle analysis peer reviewed and accepted for scientific publication in Algal Research in September 2021.

Tacking today's challenges

Value creation through innovation and collaboration

Corbion

Obrigada

Thank you

XXI FENACAM'25
NATAL/RN-BRASIL
11 a 14 de novembro de 2025