What awaits the Fish Feed Industry towards 2030?

Current Trends & Expectations

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Dept. of Aquaculture

Outline

Global aquaculture & Challenges in the Aquaculture

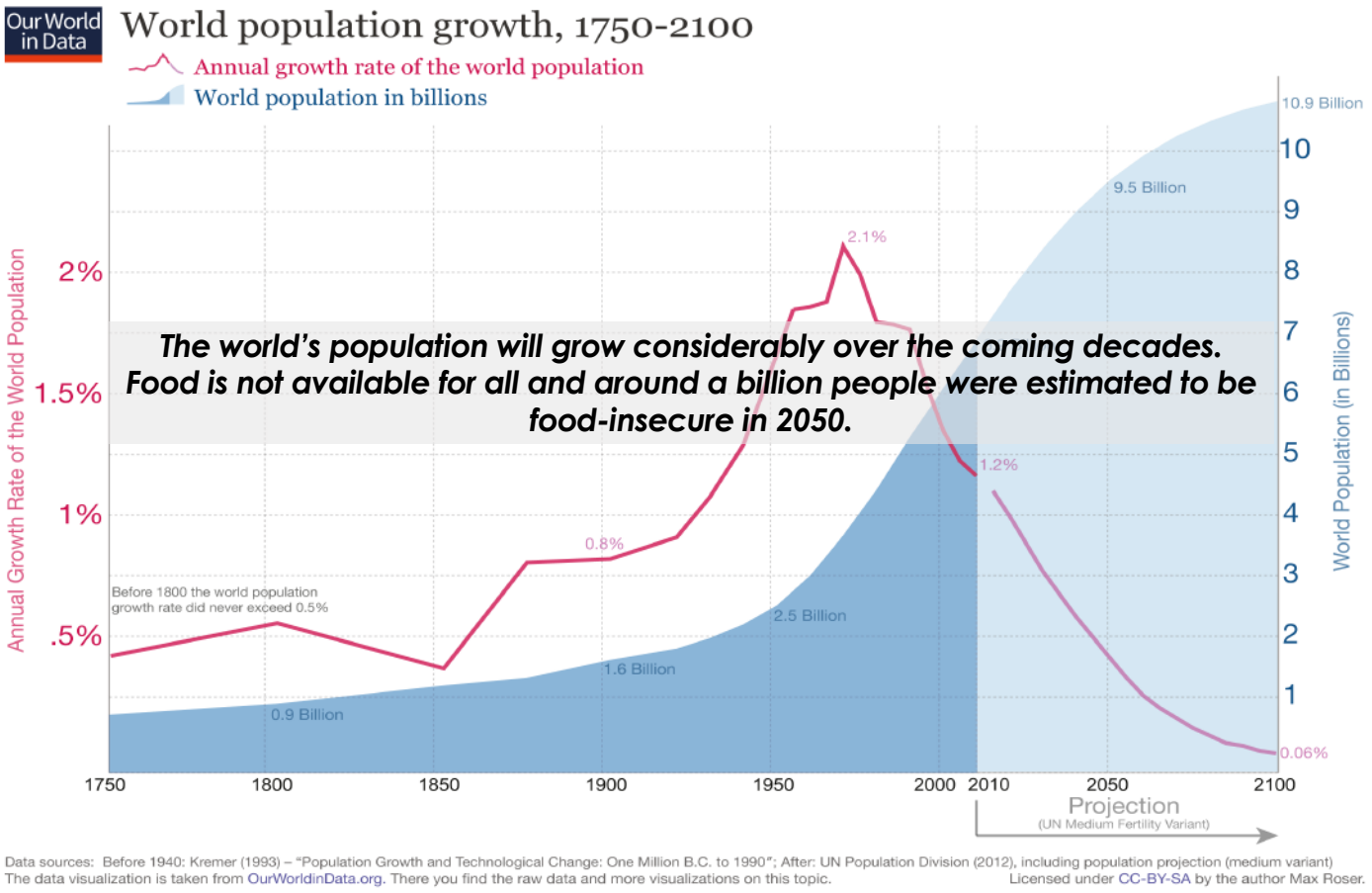
Same old story and «new love story»
Strategic ingredients and future direction

Future challenges and expectations

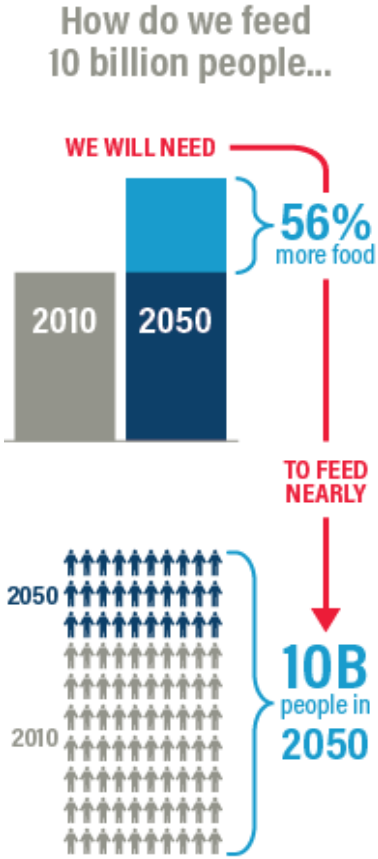
Global aquaculture & challenges

Global macro trends

Population Growth in 2050

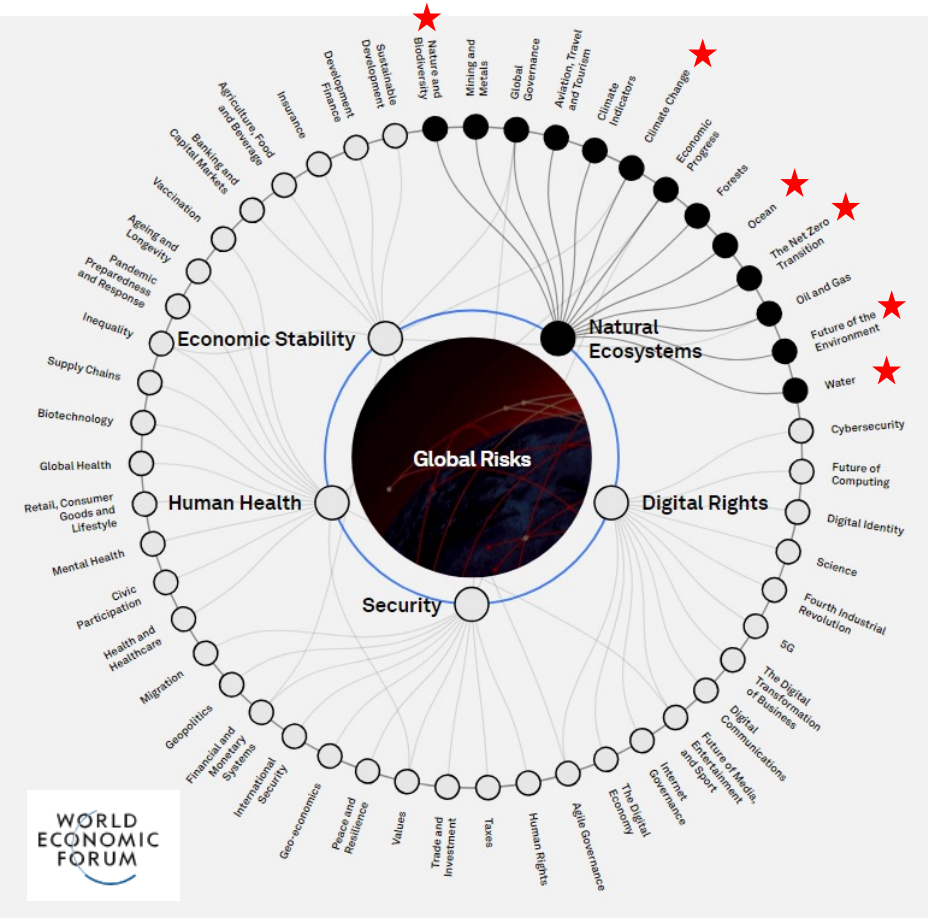


The world's population will grow considerably over the coming decades. Food is not available for all and around a billion people were estimated to be food-insecure in 2050.



Data sources: Before 1940: Kremer (1993) – "Population Growth and Technological Change: One Million B.C. to 1990"; After: UN Population Division (2012), including population projection (medium variant)
The data visualization is taken from OurWorldinData.org. There you find the raw data and more visualizations on this topic.

Global problems



Global Risks Report 2023

Top 10 Risks

"Please estimate the likely impact (severity) of the following risks over a 2-year and 10-year period"

WORLD ECONOMIC FORUM

	2 years	10 years
1	Cost of living crisis	Failure to mitigate climate change
2	Natural disasters and extreme weather events	Failure of climate-change adaption
3	Geoeconomic confrontation	Natural disasters and extreme weather events
4	Failure to mitigate climate change	Biodiversity loss and ecosystem collapse
5	Erosion of social cohesion and societal polarization	Large-scale involuntary migration
6	Large-scale environmental damage incidents	Natural resource crises
7	Failure of climate-change adaption	Erosion of social cohesion and societal polarization
8	Widespread cybercrime and cyber insecurity	Widespread cybercrime and cyber insecurity
9	Natural resource crises	Geoeconomic confrontation
10	Large-scale involuntary migration	Large-scale environmental damage incidents

Risk categories: Economic, Environmental, Geopolitical, Societal, Technological

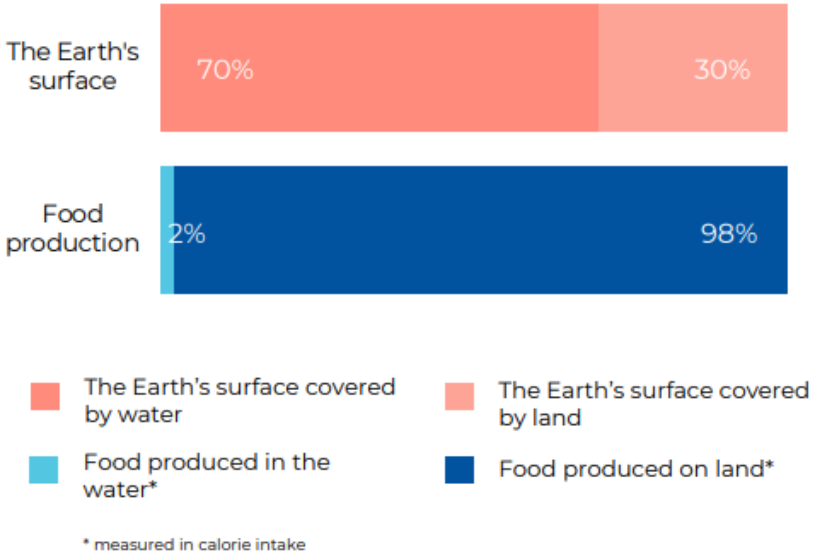
Source: World Economic Forum, Global Risks Perception Survey 2022-2023

Food supply security – Blue solution

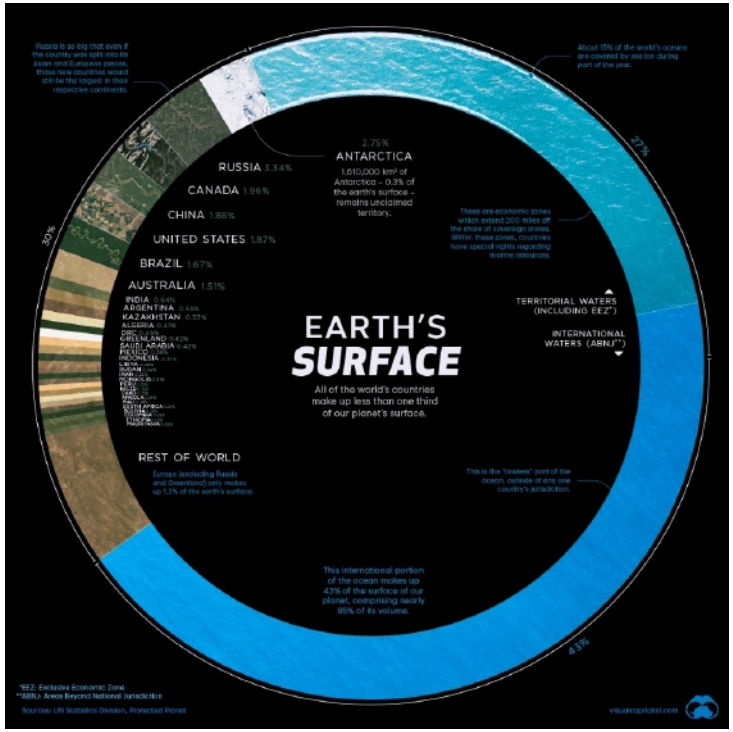
Oceans to become key to resolving «global protein needs»

70% of the Earth is covered by oceans, but only 2% of our food is obtained from the sea.

Aquaculture will be key in future food supply!

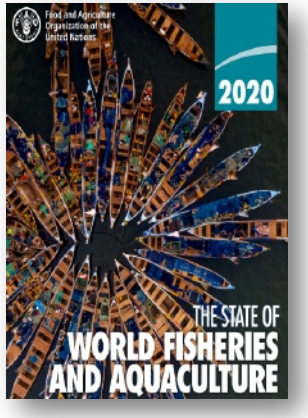


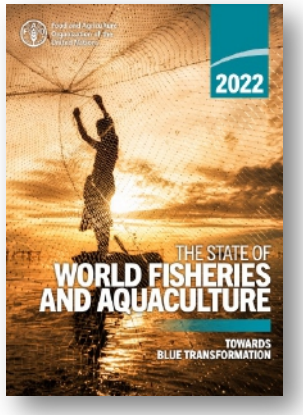
Source: NCE Seafood Innovation



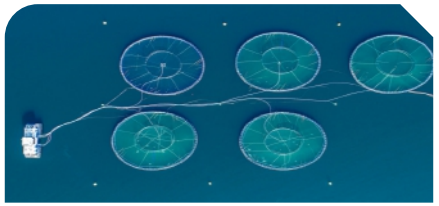
Source: Statista 2022; WRI, 2022

Blue transformation- 3 objectives





BlueTransformation



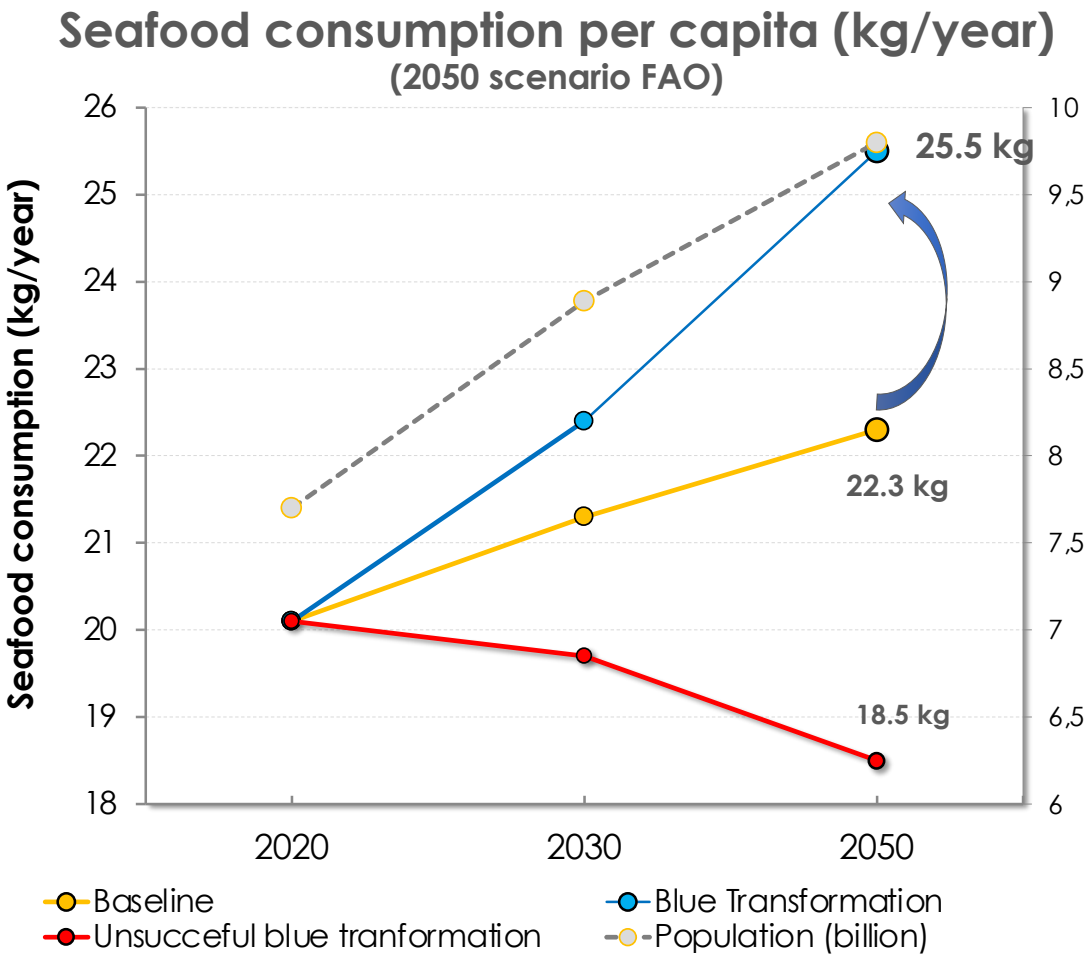
OBJECTIVE 1
Sustainable aquaculture intensification and expansion satisfies global demand for aquatic food and distributes benefits equitably.

OBJECTIVE 2
Effective management of all fisheries delivers healthy stocks and secures equitable livelihoods.

OBJECTIVE 3
Ubdated value chains ensure the social, economic and environmental viability of aquatic food systems.

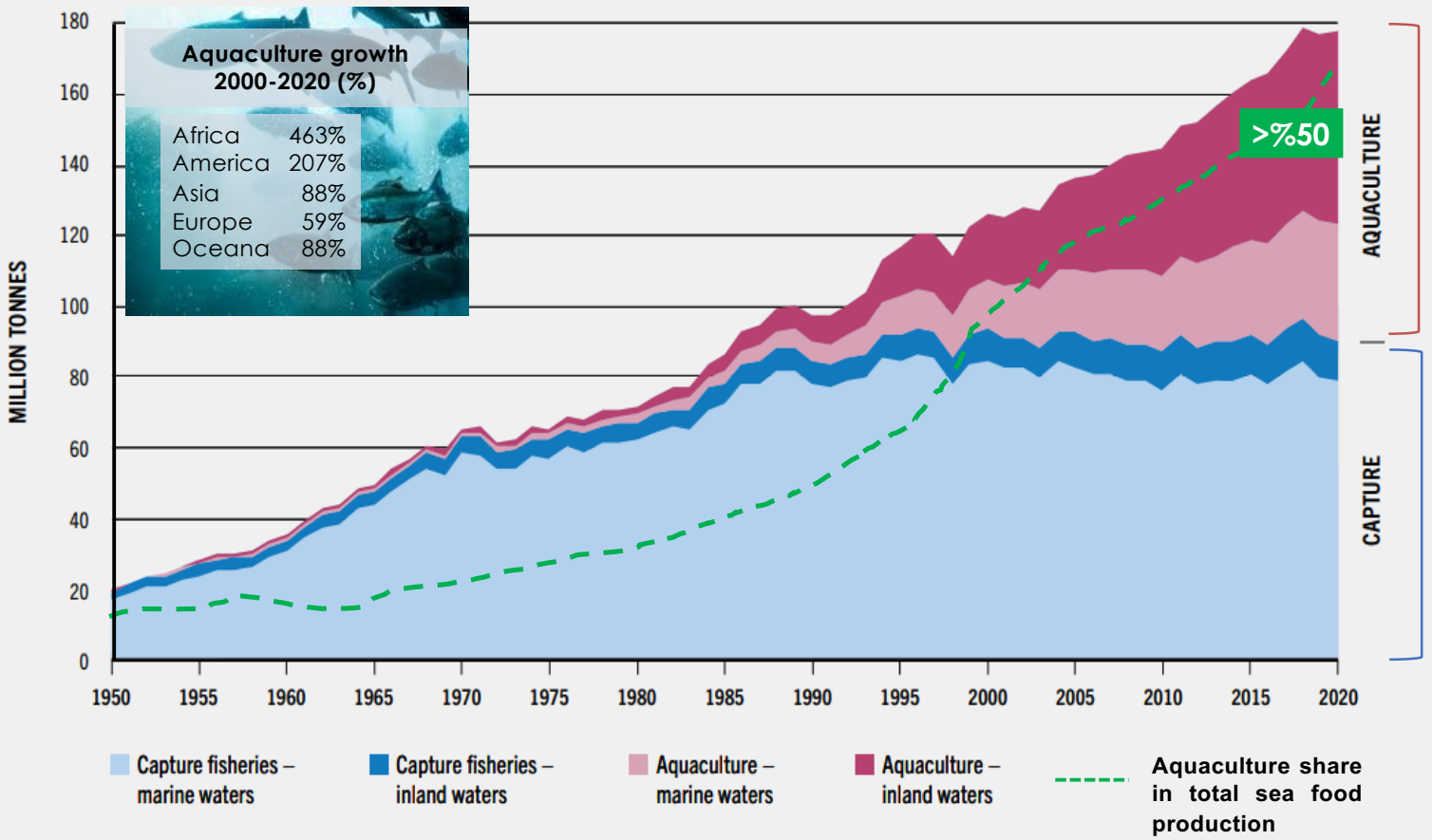
Source: FAO 2022

Blue transformation: «meeting expactations»



Source: FAO 2022

Total fisheries and aquaculture production «a new record 218 million ton» in 2022



NOTES: Excluding aquatic mammals, crocodiles, alligators, caimans and algae. Data expressed in live weight equivalent.
SOURCE: FAO.

Fisheries = 90.3 Mt 2.1% ↓

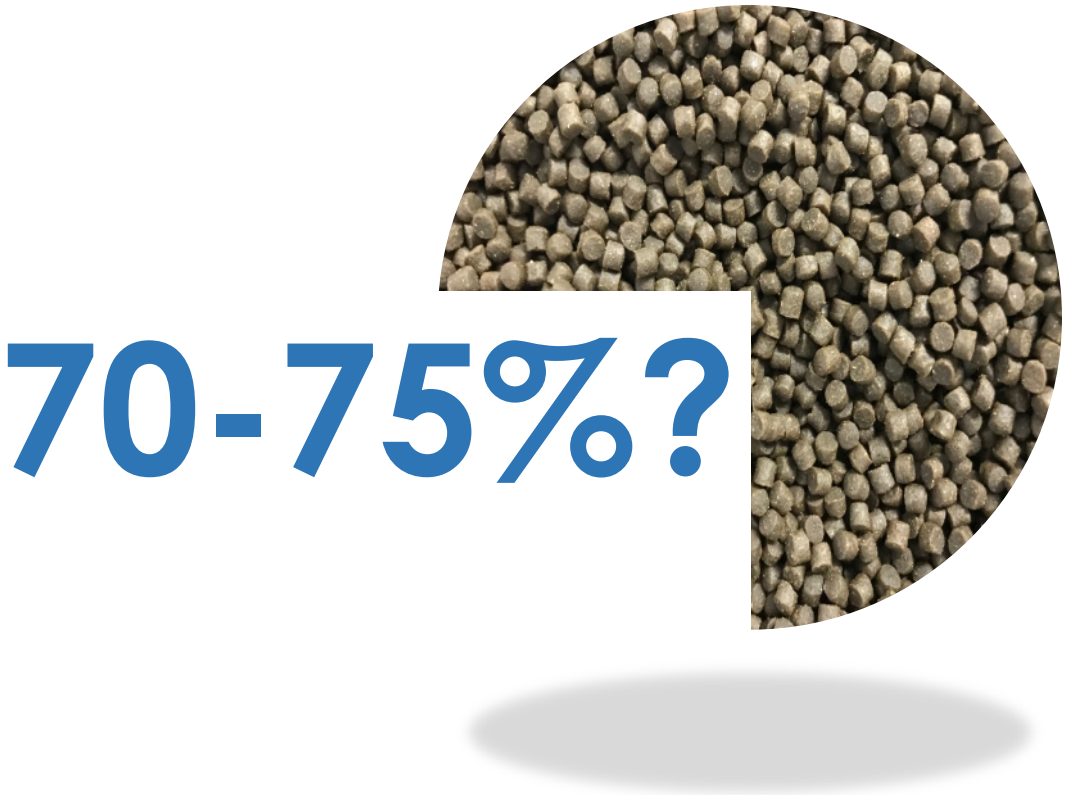
Aquaculture = 87.5 Mt 2.7% ↑

Alge production = 36 Mt 1.4% ↑

Total: 218 million ton
in 2022

Source: FAO 2022

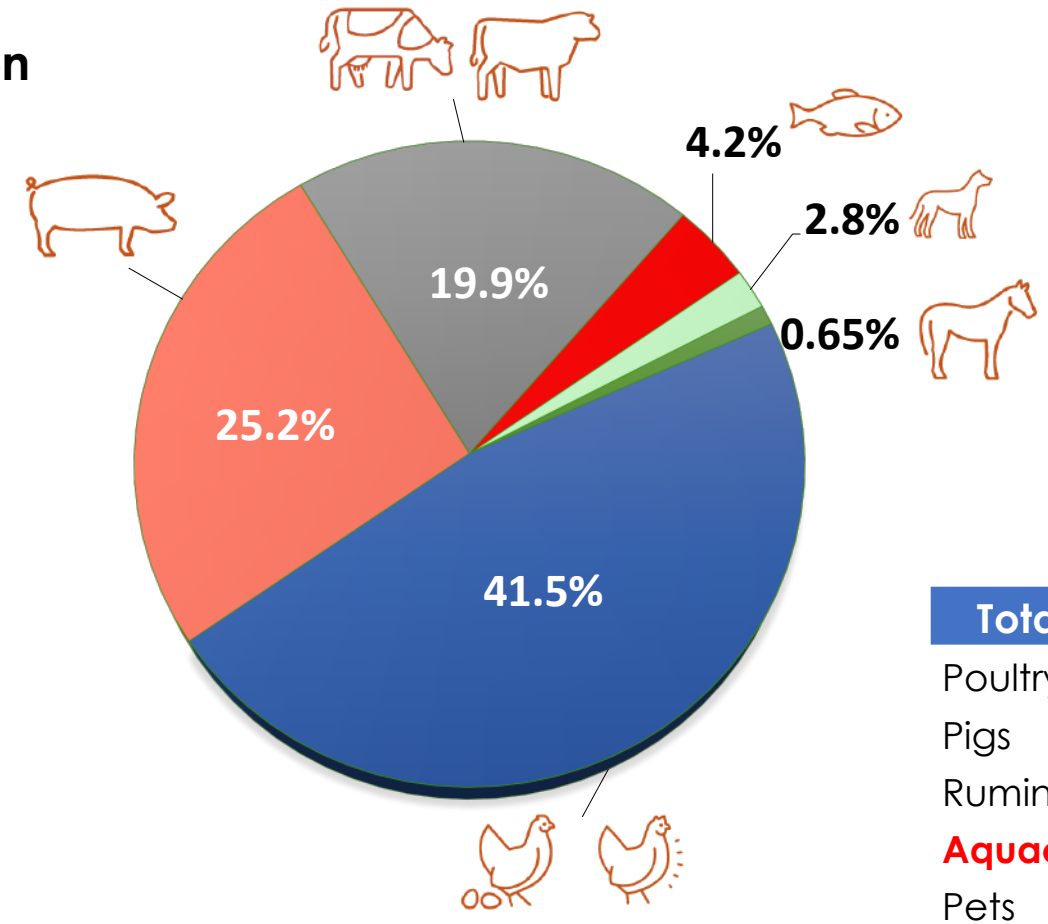
Total production cost «Aquafeed»



Global compund feed production in 2022

Total feed production

1,266 billion ton in 2022

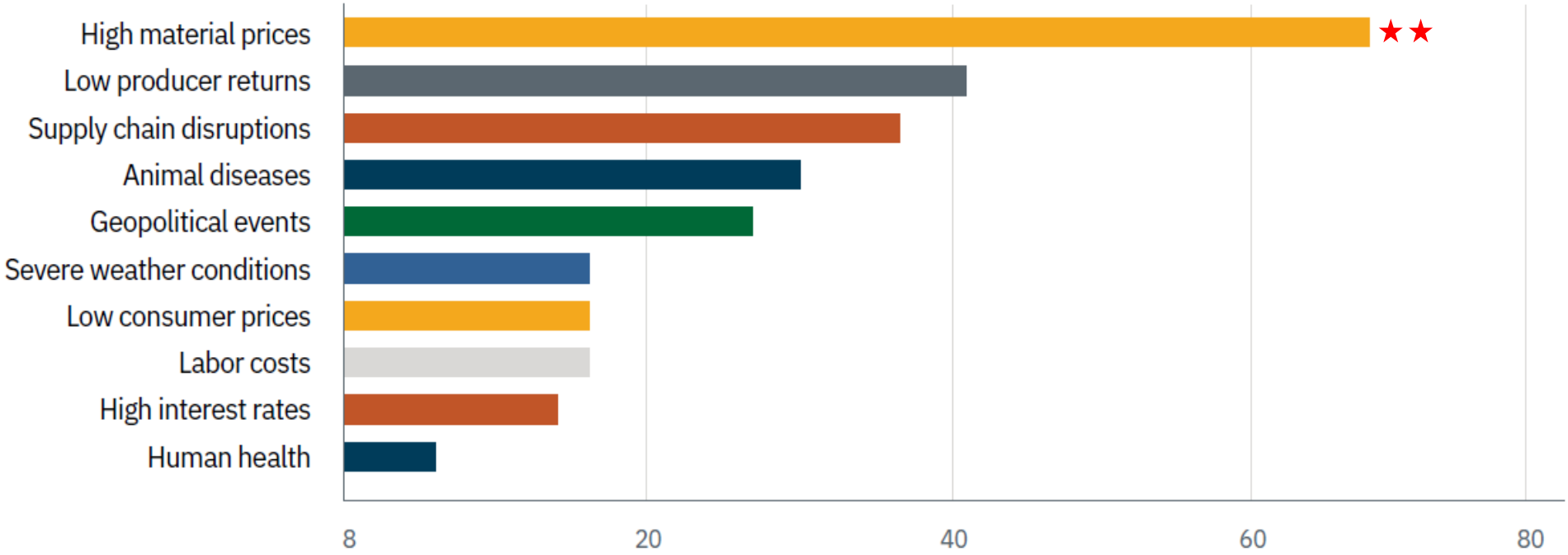


Total Feed (MMT) by species	
Poultry	525.8
Pigs	319.4
Ruminants	251.8
Aquaculture	**52.9**
Pets	35.3
Horses	8.2

Source: 2023 Alltech Agri-Food Outlook

Main constraints for global compound feed production

Survey respondents identified the biggest agri-related challenges in their country.

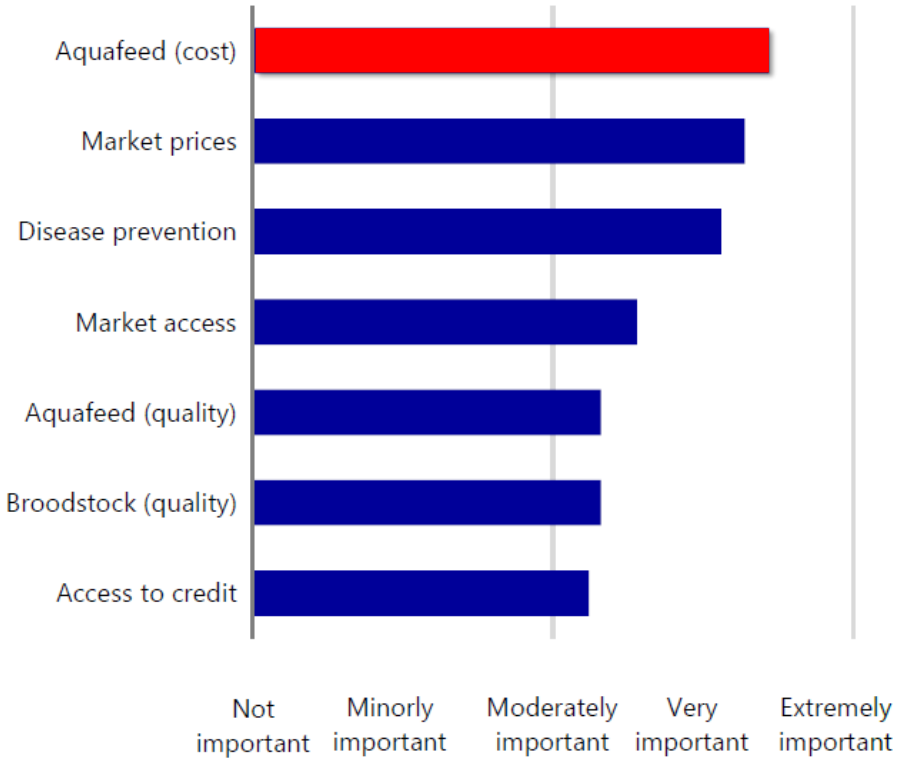


**Multiple choice question: Numbers indicate number of times the option was selected.*

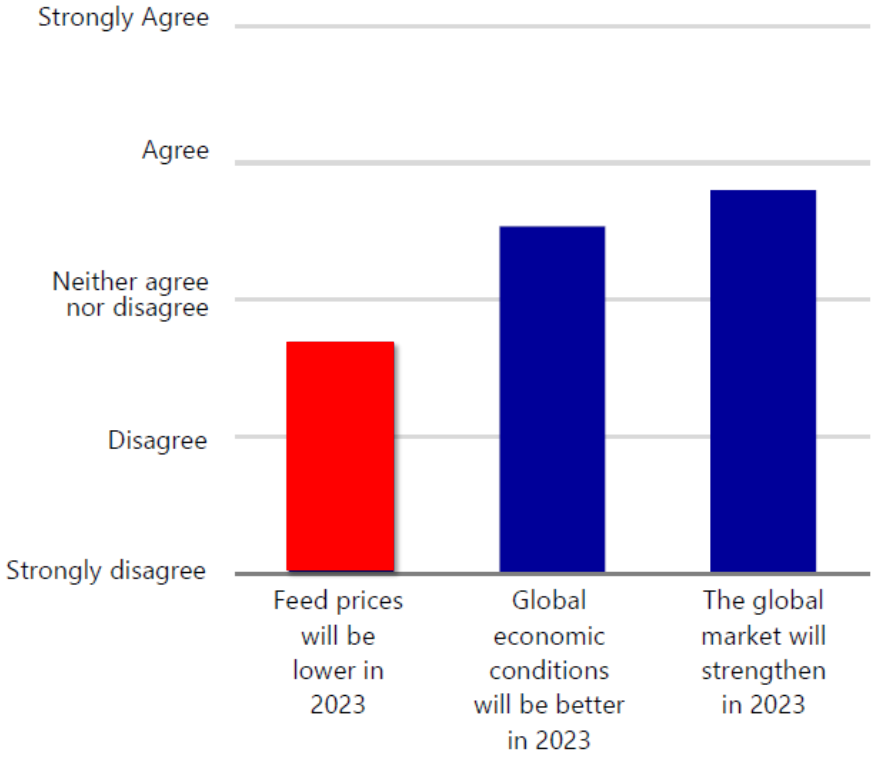
Source: 2023 Alltech Agri-Food Outlook

Main constraints for global compound feed production

Feed cost back as the top concern for industry participants, 2022



Industry pessimism due to economic and market uncertainties, 2022



Source: GOAL Survey 2022, Rabobank 2022

Global commercial aquafeed and marine fish production

Aquafeed production 2018-2025 %5/year

Estimated aquafed used

69.6

57.0

52.5

Marine fish prodcution

59.0

49.3

45.4

Fish production 2018-2025 %4,2/year

Production (.000 ton)

80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0

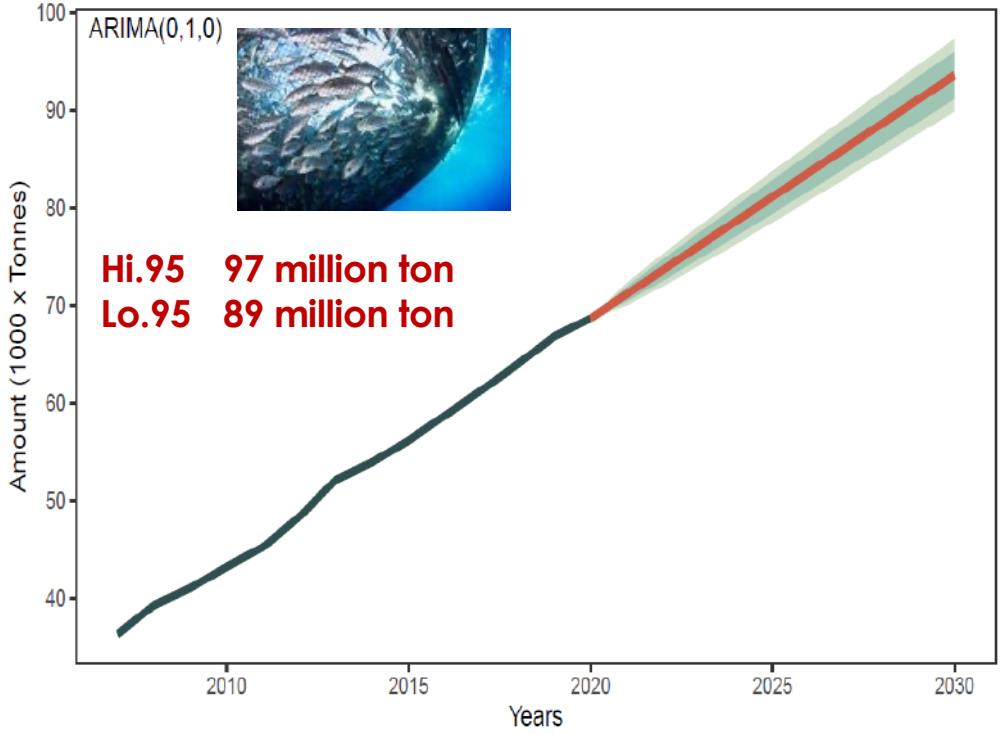
2000 2005 2010 2015 2020 2025

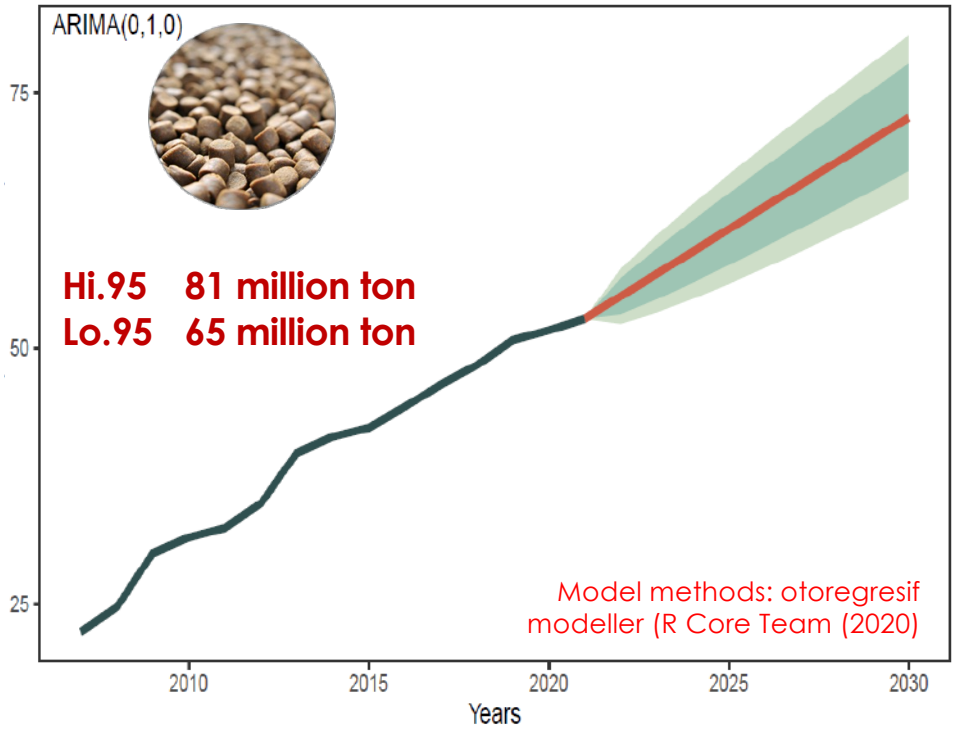
Source: Tacon et al. 2022

2020→2030 aquaculture and aquafeed production – **Global***

		Confidence interval (80% & 95%)*			
Production	Ort.	Lo.80	Hi.80	Lo.95	Hi.95
2030	**93.604**	91178	96031	89893	97315

		Confidence interval (80% & 95%)			
Feedx1000	Ort.	Lo.80	Hi.80	Lo.95	Hi.95
2030	**72.596**	67361	77831	64590	80603





*The quatities of fish & crustacean species farmed in freshwater and sea water are taken into account.

Source: Eroldoğan et al. (in preparation)

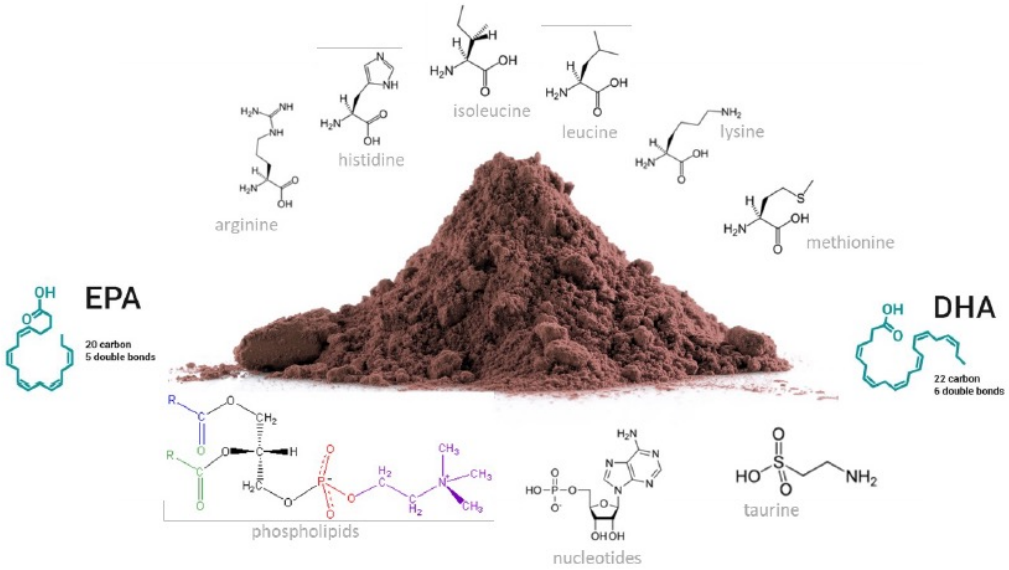
Same old story and «new love story»
Strategic ingredients and future direction

«**Alternative**» raw material for the current growth

Source: Brett Glencross, IFFO

Ingredient evaluation – raw ingredient quality

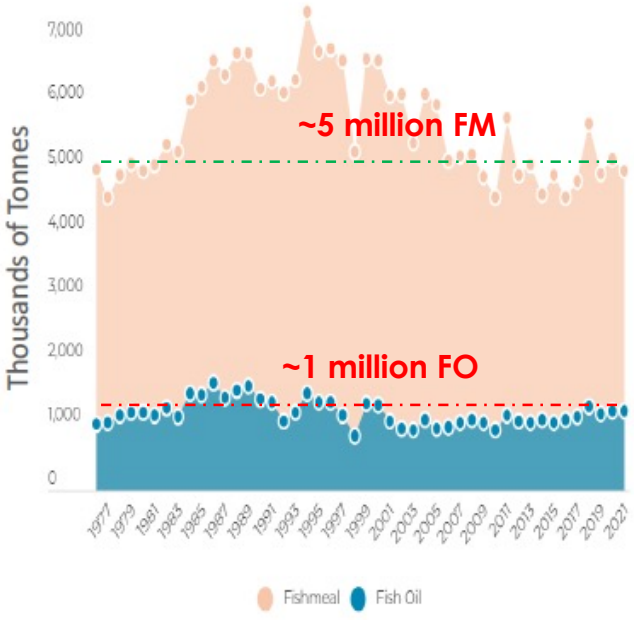
1) Sustainability
2) Compositional analysis
   - *Nutrients, protein, energy, AA, FA etc.*
   - *Anti-nutrients, evolved in a protective or developmental role*
3) Palatability & Feed intake
4) Digestibility, Appareant digestibility coefficients
5) Funtionality, durability, expantion, oil absorbtion, water stability
6) Growth, gain, FCR, feacal production, product quality

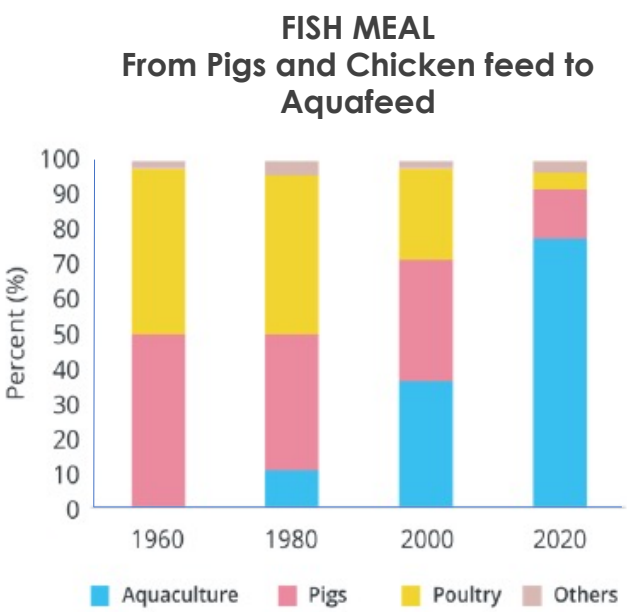


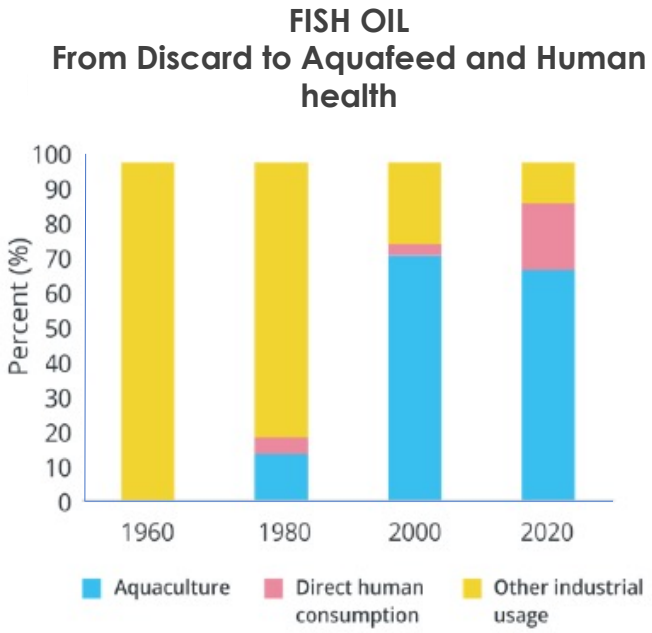
Fish meal & Fish Oil meet all these criteria

Most certainly a finite or an endangered resource

Ingredient evaluation – raw ingredient quality







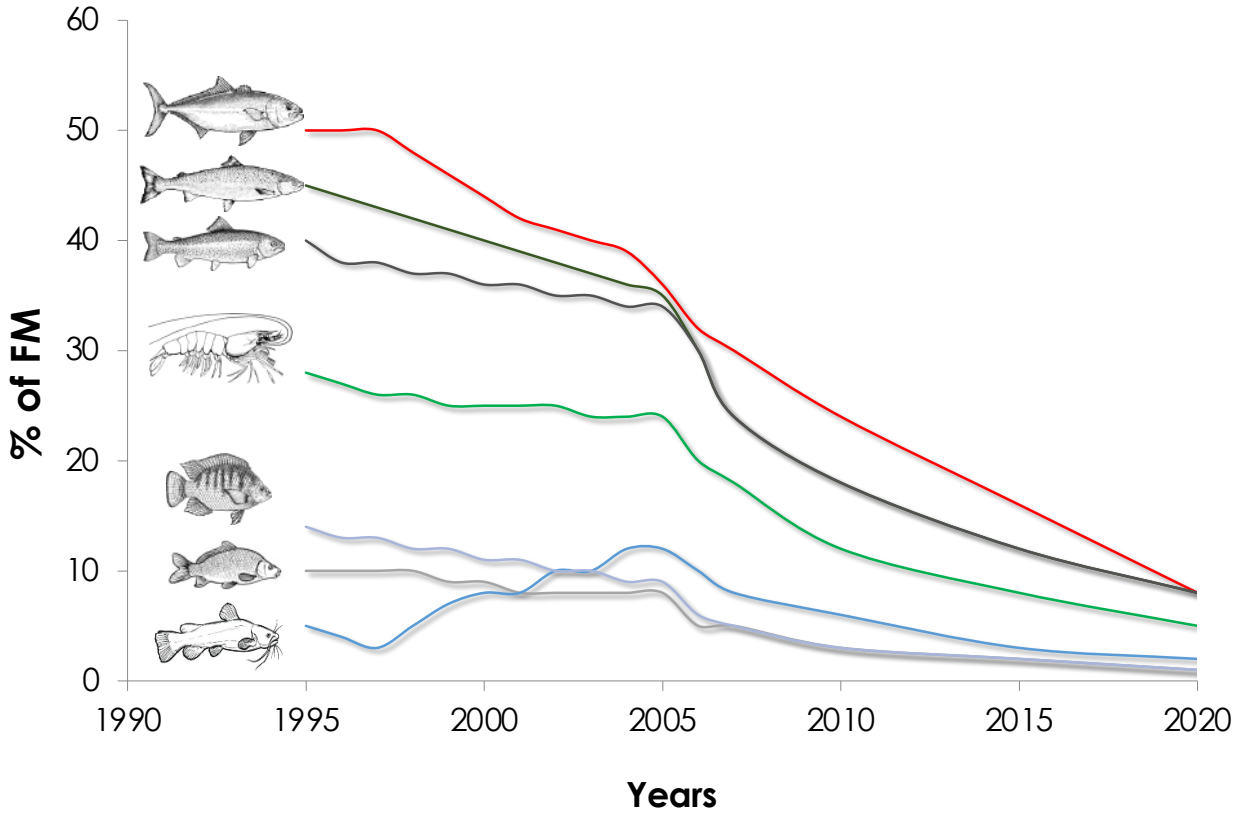
The FM&FO with the greatest puschasing power takes a growing share of the supply.

Source: Brett Glencross, IFFO

FM substitutes – Percentage of FM used in aquafeeds 1995-2020

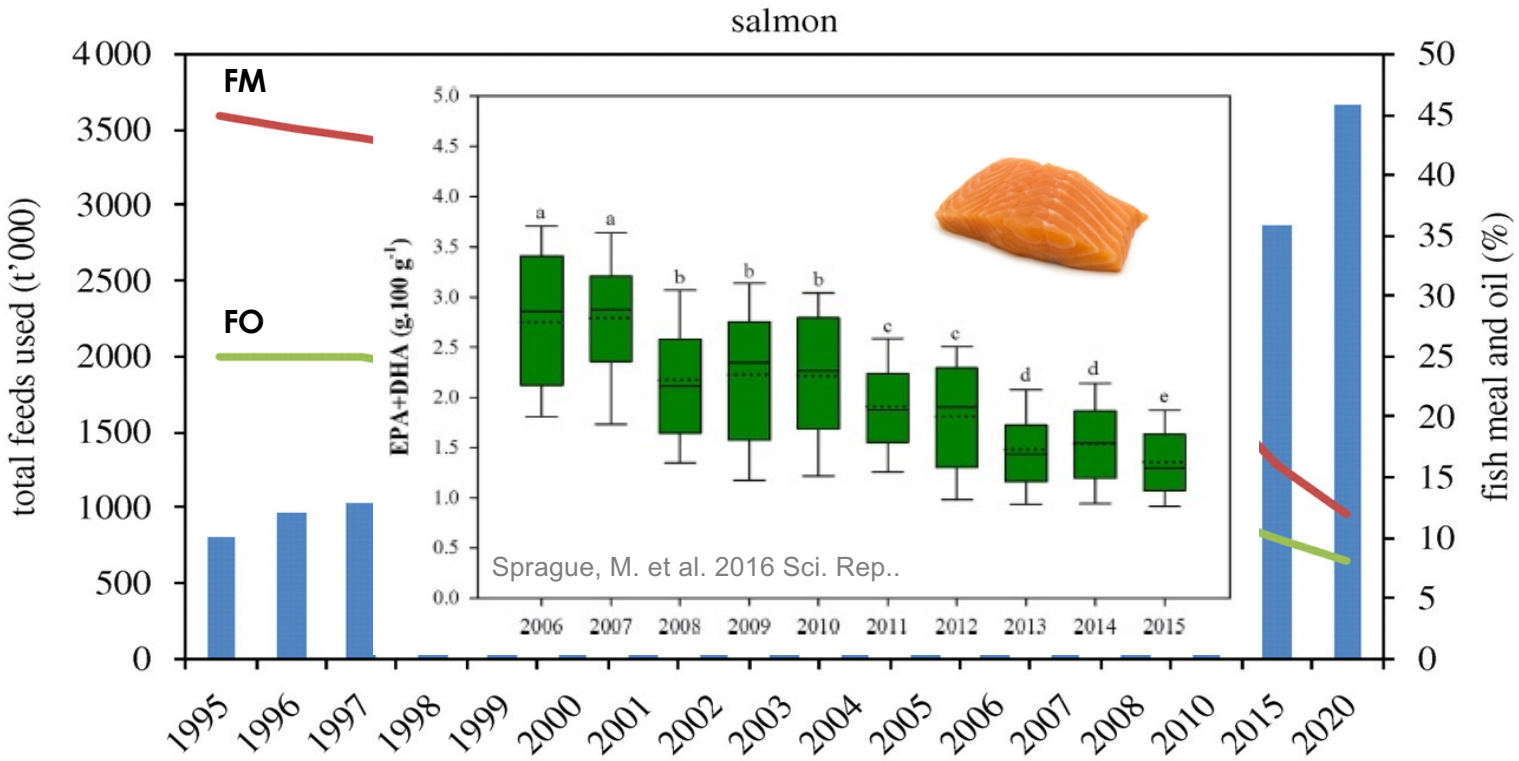
There are several factors to consider when using feed ingredients to replace fishmeal including:

- ❑ Nutritional value
- ❑ Customer acceptability
- ❑ Availability
- ❑ Price or cost
- ❑ Effects on growth
- ❑ Effects on health status



Source: Tacon & Metian 2008

«same old story» replacement of FM & FO in aquafeed



Source: John Bostock et al. (2010)

Current litelature – try to find functional raw ingredients

North American Journal of Aquaculture 81:13–39, 2019
© 2018 American Fisheries Society
ISSN: 1522-2055 print / 1548-8454 online
DOI: 10.1002/naaq.10067

FEATURED PAPER

Thoughts for the Future of Aquaculture Nutrition: Realigning Perspectives to Reflect Contemporary Issues Related to Judicious Use of Marine Resources in Aquafeeds

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Received: 28 February 2020 | Revised: 29 May 2020 | Accepted: 15 June 2020
DOI: 10.1111/anu.13138

REVIEW

Aquaculture Nutrition WILEY

A feed is *still* only as good as its ingredients: An update on the nutritional research strategies for the optimal evaluation of ingredients for aquaculture feeds

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Abstract
The choice of strategies used to assess ingredients can have a strong impact on the interpretation of their quality. In an attempt to standardize the assessment process, a structured approach using five steps for assessing the quality of ingredients was proposed over a decade ago. Since then, there has been considerable progress in the

fishes MDPI

Review

The Application of Single-Cell Ingredients in Aquaculture Feeds—A Review

Brett D. Glencross [1,*], David Huyben [1,2] and Johan W. Schrama [3]

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2 Department of Animal Biosciences, University of Guelph, Guelph, ON N1G 2W1, Canada
3 Aquaculture and Fisheries Group (AFI), Wageningen University and Research, 6700 HB Wageningen, The Netherlands; johan.schrama@wur.nl
* Correspondence: b.d.glencross@stir.ac.uk

Received: 1 June 2020; Accepted: 30 June 2020; Published: 16 July 2020

Abstract: Single-cell ingredients (SCI) are a relatively broad class of materials that encompasses bacterial, fungal (yeast), microalgal-derived products or the combination of all three microbial groups into microbial biofloc and aggregates. In this review we focus on those dried and processed single-cell

REVIEWS IN FISHERIES SCIENCE & AQUACULTURE
2020, VOL. 28, NO. 1, 43–56
https://doi.org/10.1080/23308249.2019.1649634
Taylor & Francis Taylor & Francis Group
Check for updates

Trends in Global Aquaculture and Aquafeed Production: 2000–2017

Albert G. J. Tacon
AquaHana LLC, Kailua, Hawaii, USA

Global aquaculture production reported in 2017 valued at US$ 139.7 billion (Figure

REVIEWS IN Aquaculture
Reviews in Aquaculture (2021) 13, 1156–1158 doi: 10.1111/raq.12567

Editorial

'Aquafeed 3.0': creating a more resilient aquaculture industry with a circular bioeconomy framework

As aquaculture continues to grow, so does the requirement for environmentally sustainable and cost-effective aquafeed. With an expected increase in aquafeed

all about valorization – and keeping the value of biomass cascading. The extensive organic biomass and waste streams from agriculture, forestry, fisheries, food and feed

REVIEWS IN FISHERIES SCIENCE & AQUACULTURE
2022, VOL. 30, NO. 2, 271–279
https://doi.org/10.1080/23308249.2021.1898539
Taylor & Francis Taylor & Francis Group
Check for updates

NOTE

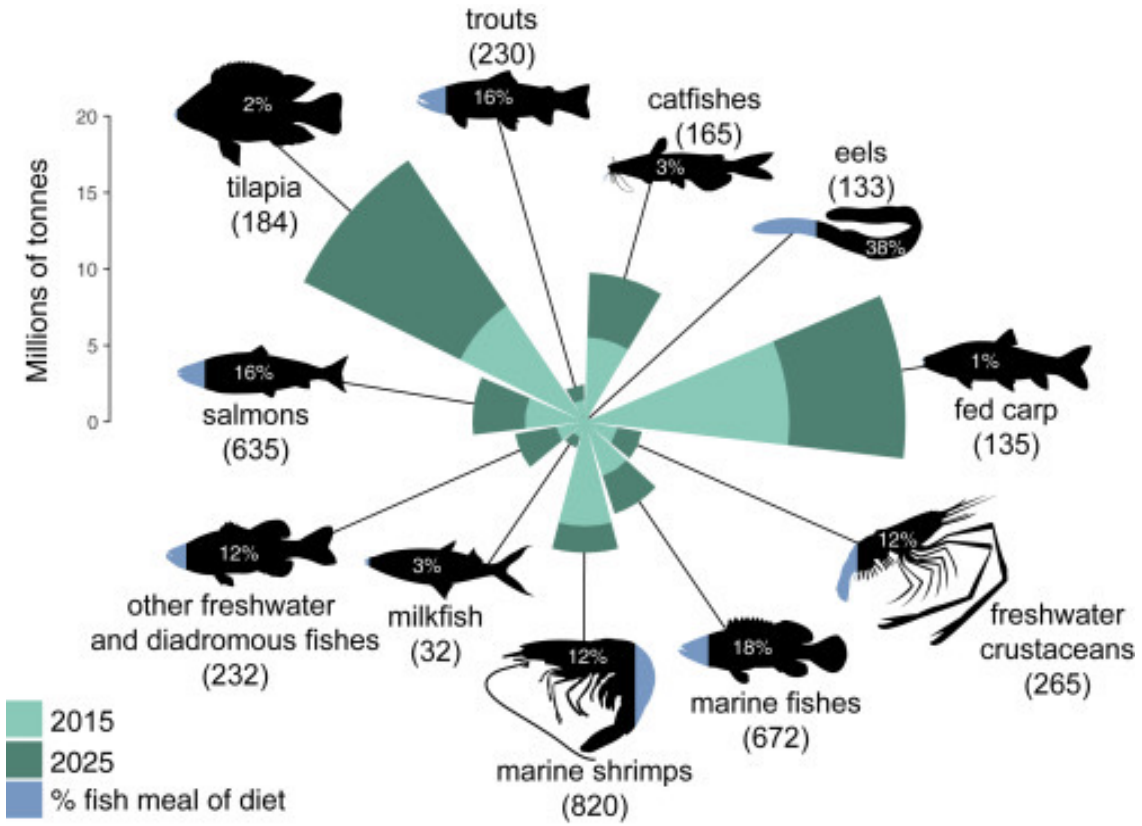
Future Feeds: Suggested Guidelines for Sustainable Development

Albert G. J. Tacon[a], Marc Metian[b], and Aaron A. McNevin[c]
[a]Aquahana LLC, Kailua, Hawaii, USA; [b]International Atomic Energy Agency, Monaco, Principality of Monaco; [c]World Wildlife Fund, Washington, DC, USA

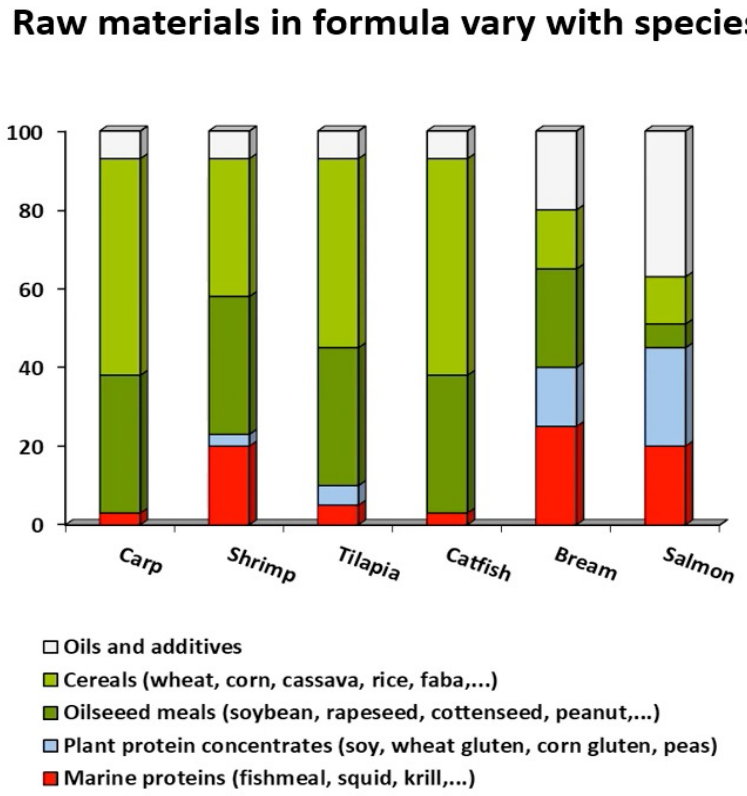
ABSTRACT
Whilst the aquaculture sector continues to grow and make an ever increasing contribution to world food supplies, there is a need to ensure that the sector continues to develop in a socially, economically and environmentally sustainable manner, in line with the United Nations sustainable development goals. The present paper focusses on the major perceived sustainability issues related to feed inputs for finfish and crustacean aquaculture species, including sustainability issues related to feed formulation and ingredient selection, feed manufacture and feed quality, on-farm feed use and impacts, and fish quality and food safety.

KEYWORDS
Aquaculture; sustainable aquafeeds; fish-in fish-out (IFFO); sustainable development; feed manufacture; on-farm management

«Current» aquafeed in diverce species cultivated

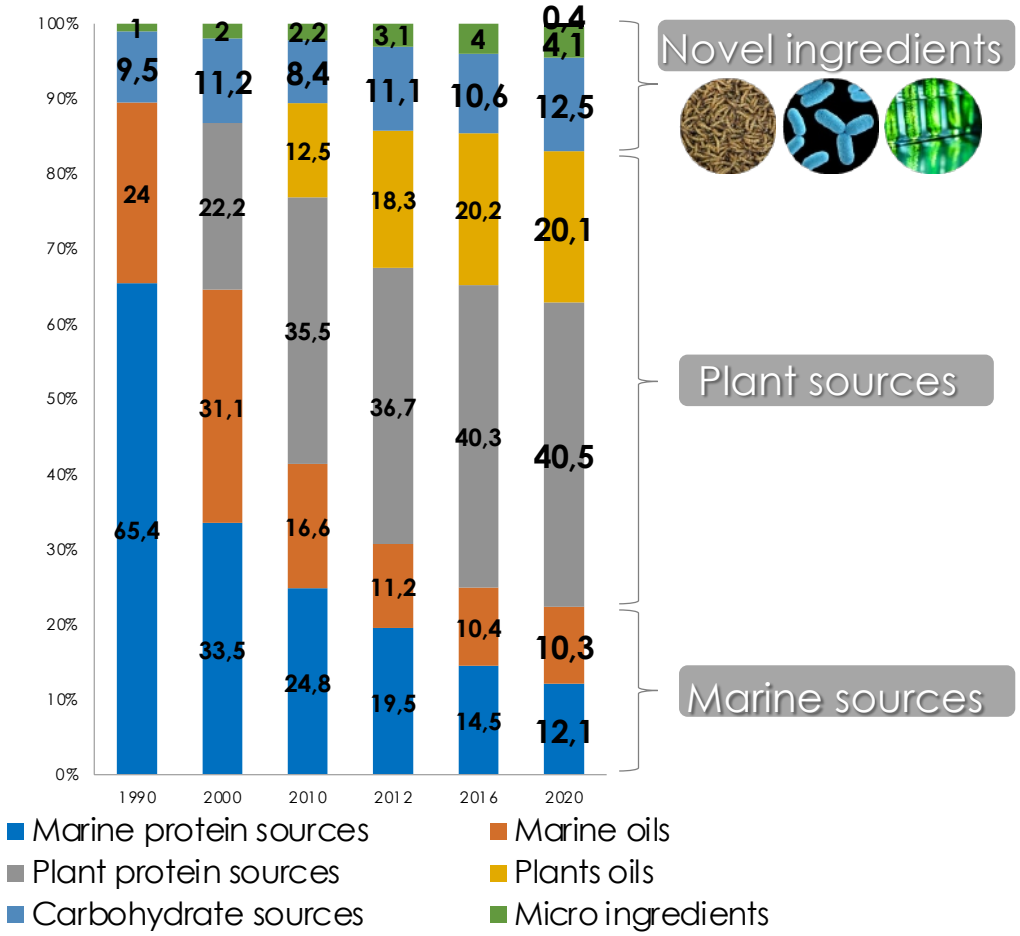


Hua et al., 2019



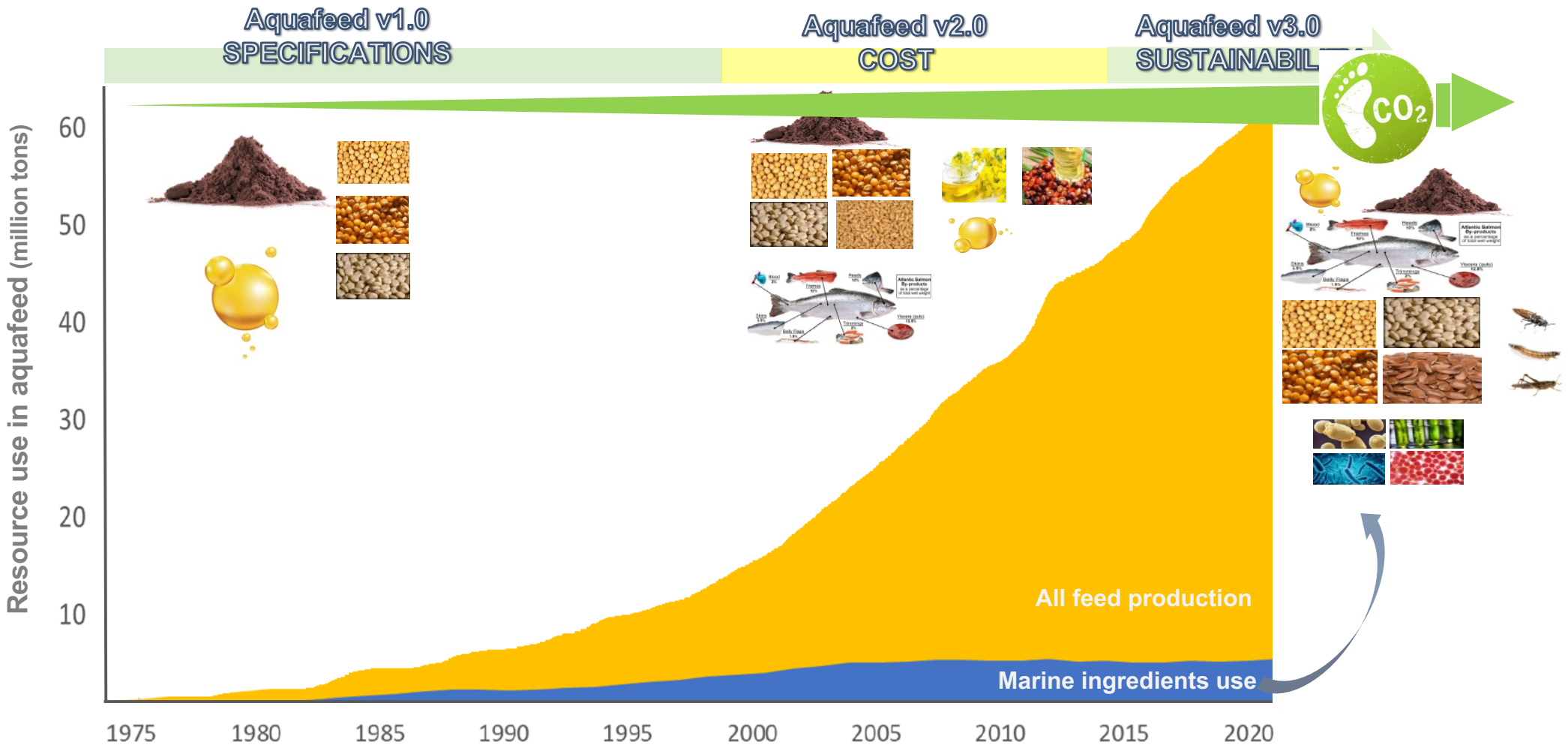
Source: Dr. Jorge Dias presentation
(https://www.open.edu/openlearncreate/mod/page/view.php?id=181866)

Changes in Norwegian Salmon feed formulation 1990-2020

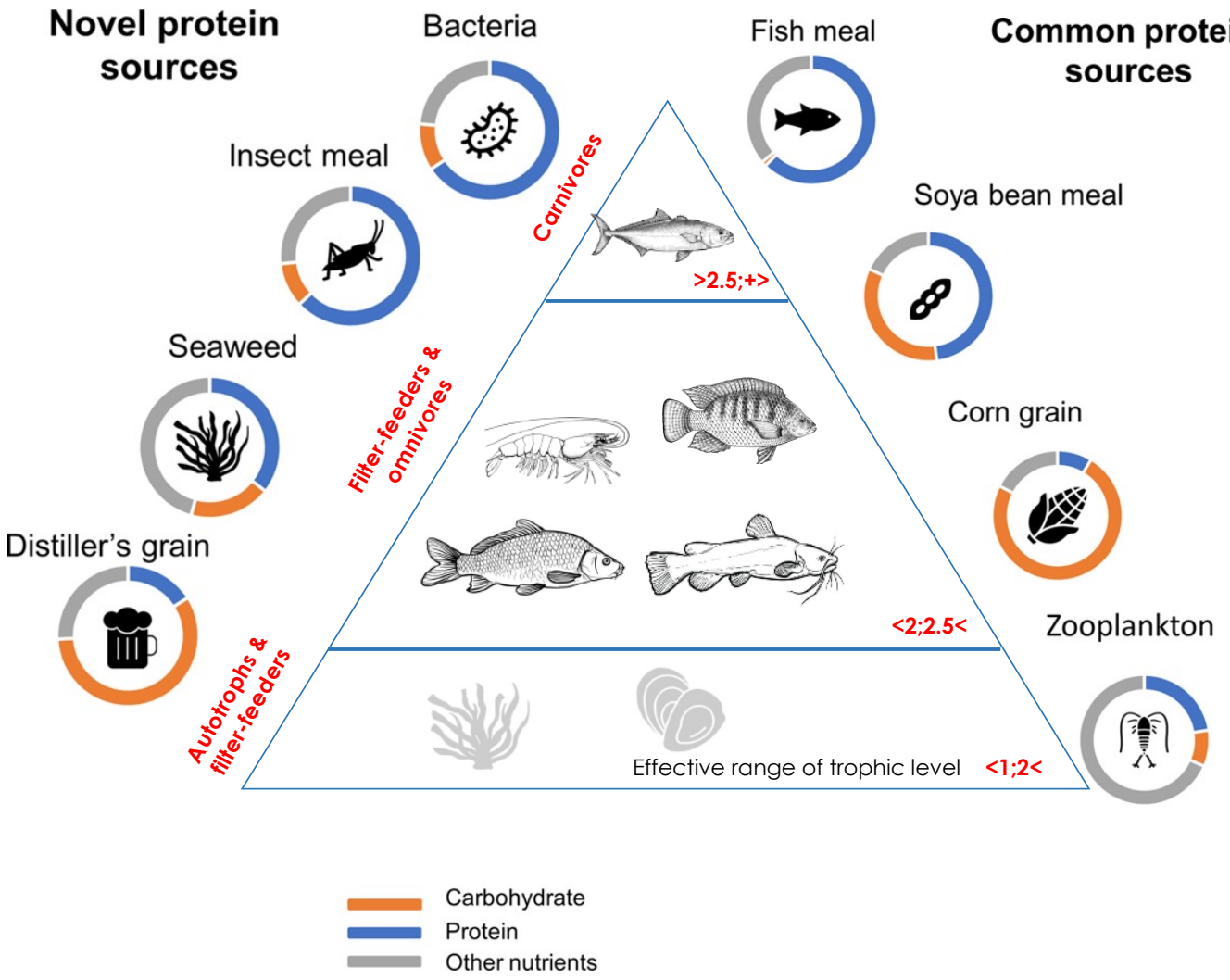


- **71% of Norwegian salmon feed** consists of plant sources.
- **>95%** of salmon feed raw materials are imported.
- By 2030, all raw materials are aimed to be from **sustainable sources.**

Evaluation of aquafeed formulation

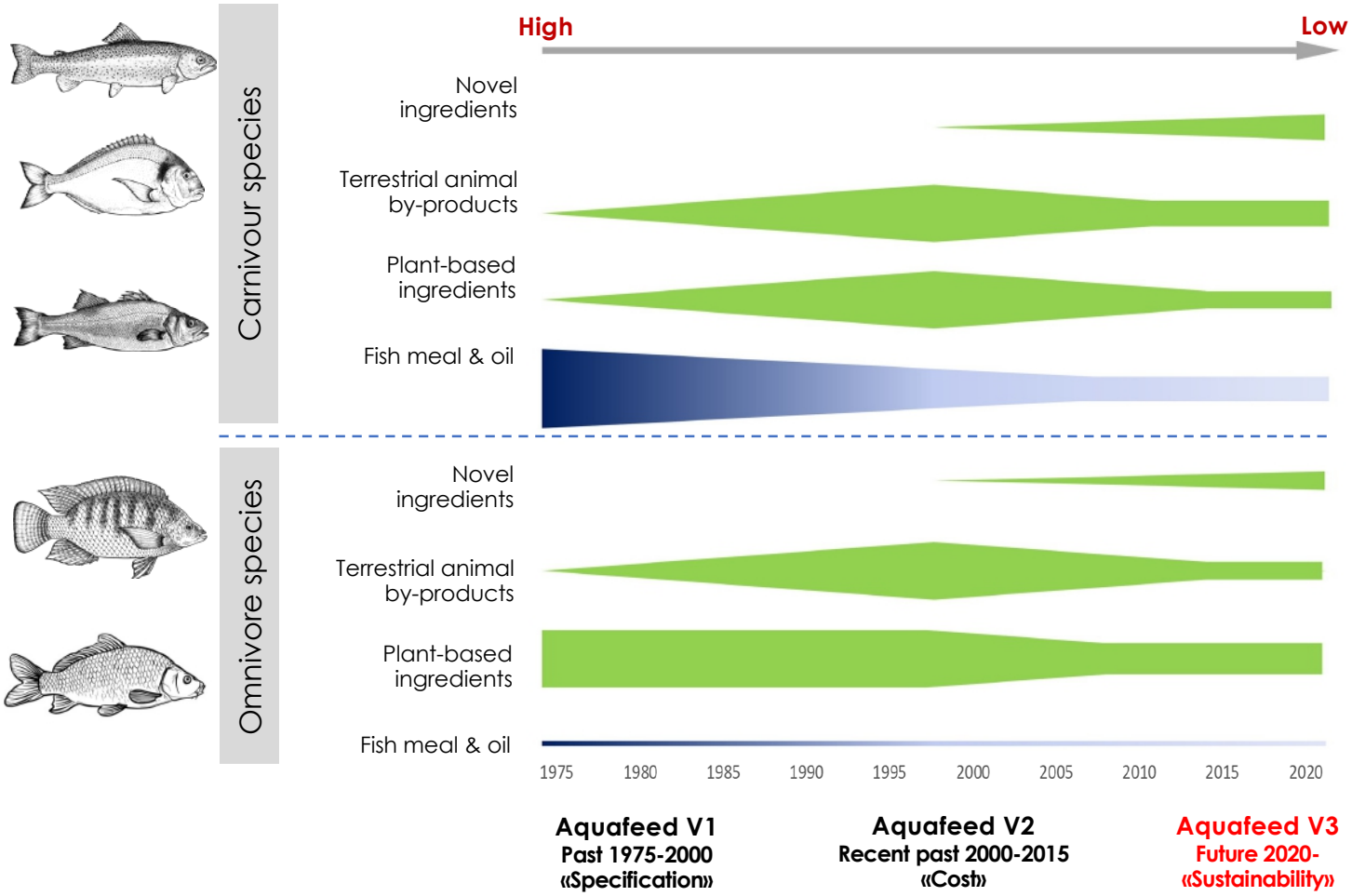


Changes in ingredient vs. trophic levels of cultured species



Source: modifed from van Riel et al., 2023

Alternative- there will be a need for «**circular raw materials**»



Source: modifed from Chary et al. (2023)

Novel «**blue**» feed ingredients

For novel ingredients to become relevant, they must be sustainable, meet well-established nutritional needs, and have high technical qualities

Sustainability should be measured along the entire value chain and include measures for both resource use, emissions and economical viability

Minimize use of natural resources

- Energy
- Area (incl. competition for food crops and land from bioenergy)
- Freshwater
- Fully utilize all bioresources (incl. animal by-products)

Minimize emissions and toxic materials

- GHG and local emissions
- Biodiversity and environmental ecosystem degradation
- Waste

Maximize sustainable economic growth

- Competitive prices in a global market
- National, sustainable value creation
- New value chains and circular business models

A common denominator for success with sustainability will be to establish production in circular hubs with shared resources.

Source: Future ingredients for Norwegian salmon feed Report 2022

Current & future potential blue raw materials

Harvested resources

Novel marine ingredients

- Mesopelagic fish
- *Calanus finmarchius*
- Krill

Plant-based ingredients**

- Grass
- Tree biomass

Farmed organisms

Insects

- Black soldier fly
- Mealworms

Marine low-trophic species

- Blue mussels***
- Polychaeta
- Gammaridae
- Tunicate
- Seaweed

Microbial ingredients

- Bacteria
- Yeast
- Fungus
- Heterotrophic microalgae

Photoautotrophic microalgae****

Underutilized resources

Land animal by-products***

- Poultry
- Pork

Marine by-products

- Whitefish
- Pelagic fish
- Aquaculture*

Source: Future ingredients for Norwegian salmon feed Report 2022

Production potential summarized







	Novel marine ingredients	Insects	Marine low-trophic species	Microbial ingredients	Photoautotrophic microalgae	Land animal by-products	Marine by-products
Volume potential by 2030*	●	●	●	●	●	●	●
Development level	●	●	●	●	●	●	●
Cost efficiency	●	●	●	●	●	●	●
Norwegian competitive advantages	●	●	●	●	●	●	●
Positive impact on sustainability	●	●	●	●	●	●	●
Customer acceptance	●	●	●	●	●	●	●
Scaling potential beyond 2030	?	●	●	●	?	?	?

Plant-based ingredients are not evaluated in depth due to lack of potential by 2030.

Low ● Medium ● High ● ? Uncertain

* High ≥ 30 000 tonnes

Source: Future ingredients for Norwegian salmon feed Report 2022

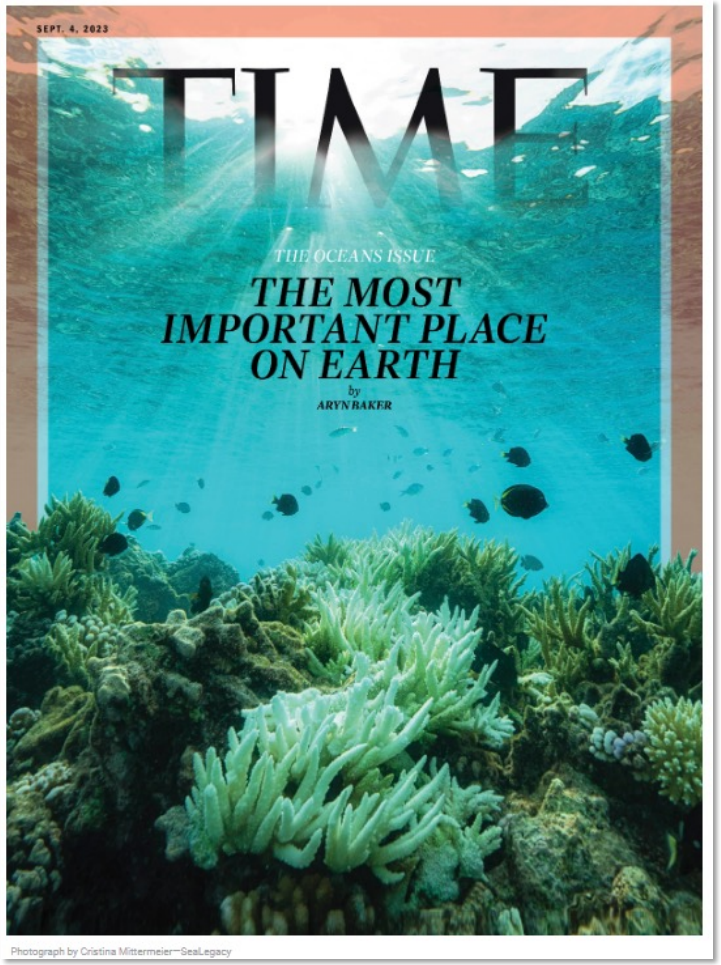
Future challenges & expectations

Future challenges & expectations

Protecting Ocens while thinking alternative feed ingredients.

What is often overlooked in many studies of future food security is:

- ❑ Economic impact of changes in supply
- ❑ Demand due to changes in food prices, household income,
- ❑ Consumer preferences.



«**feed cost**» ve «**global**» expectations towards 2030

- **Rational growth (production and aquafeed) strategies should be implemented…**
- By-products are no longer a niche, **circularity is going to become increasingly vital.**
- Blue alternative sources should be used. **No competition with human food sources / food-competing ingredients!**
- A general strategy should be developed for regional biological resources. **Local raw materials to be used…**
- Importance of «**sustainability**» will grow and become more objective…

Thank you for your attention

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www.fao.org/gfcm