



**The challenges in Central European  
aquaculture:  
*From the perspective of a fish  
feed producer***

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# Introduction Garant-Tiernahrung



- Austrian cooperative compound feed producer with three production sites
- Owned by RWA (Raiffeisen Ware Austria)
- Two licensees (Unser Lagerhaus in Carinthia, Raiffeisenverband Salzburg) with a further four production sites
- Production of feed for farm animals, horses, game, rabbits and fish
- Fish feed production in Aschach since 1985; several investments in the fish feed production-line since 2012
- Fish feed export to 12 countries
- Garant brands:



Site Aschach



Site Pöchlarn



Site Graz



Extruder Aschach

# Fish feed business at Garant



## Fry Feed

Aqua Start 0,3 .....	3
Aqua Start 0,5 .....	4
Aqua Start 0,7 .....	4
Aqua Start 1,0 .....	5
Aqua Start 1,5 .....	5



## Trout Feed

Aqua Uni.....	6
Aqua Balance .....	7
Aqua Dynamic .....	8
Aqua Profi .....	9
Aqua Dynamic Swim .....	10



## Pigmented Feed

Aqua Profi Pigment.....	11
Aqua Pigment Swim.....	12



## Carp Feed

Aqua Classic .....	13
Aqua Omega.....	14
Aqua Vital Swim .....	15



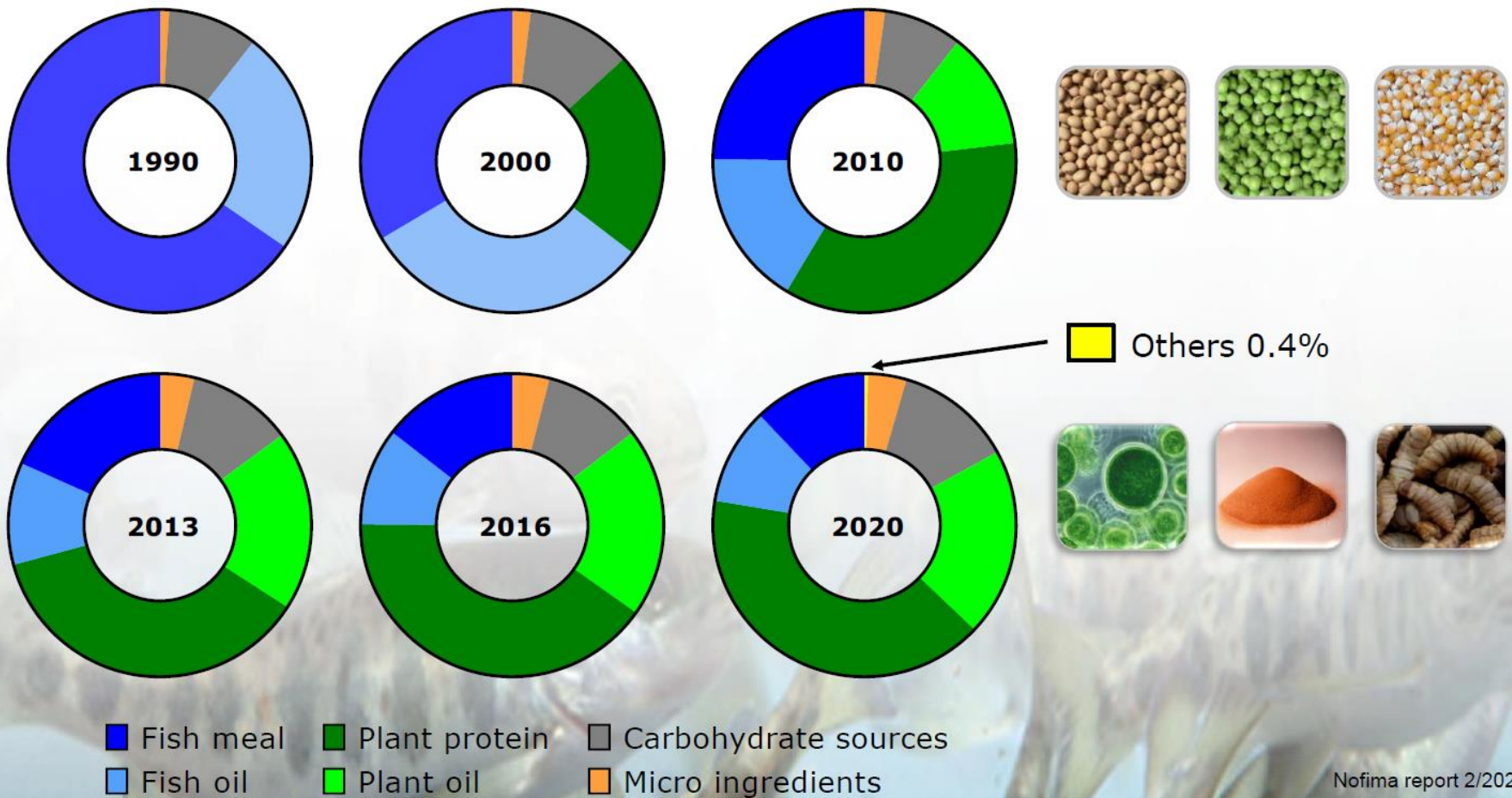
## Special Feed

<b>African Catfish:</b>	
Aqua Wels swim.....	16
Aqua Catfish swim .....	17
<b>European Catfish:</b> Aqua Uni.....	18
<b>Sturgeon:</b> Aqua Caviar .....	19



# Change in fish feed formulations over the last 30 years

## Feed composition, Norwegian farmed salmon 1990-2020



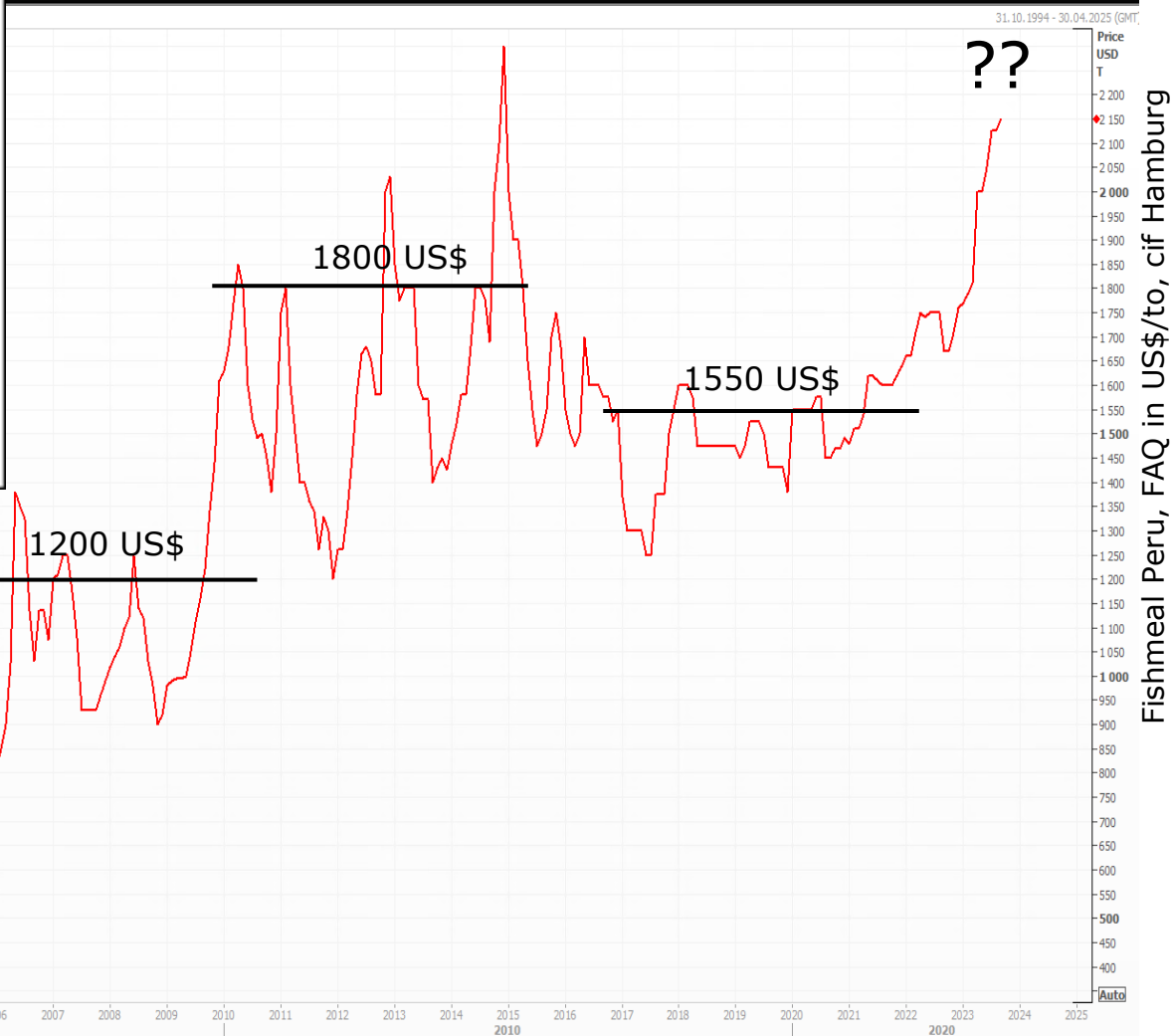
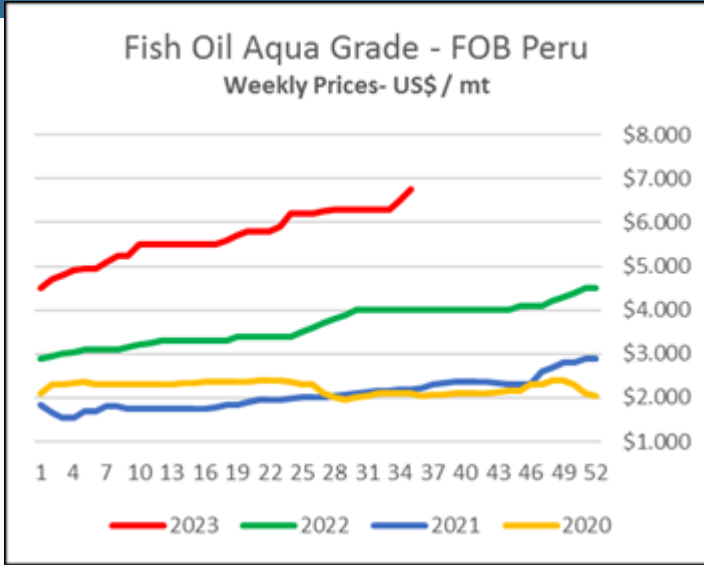
Nofima report 2/2022

# Development of fishmeal prices

(Fishmeal 64% FAQ Peru in US\$/to, cif Hamburg)



Köster 2023\_KW 35

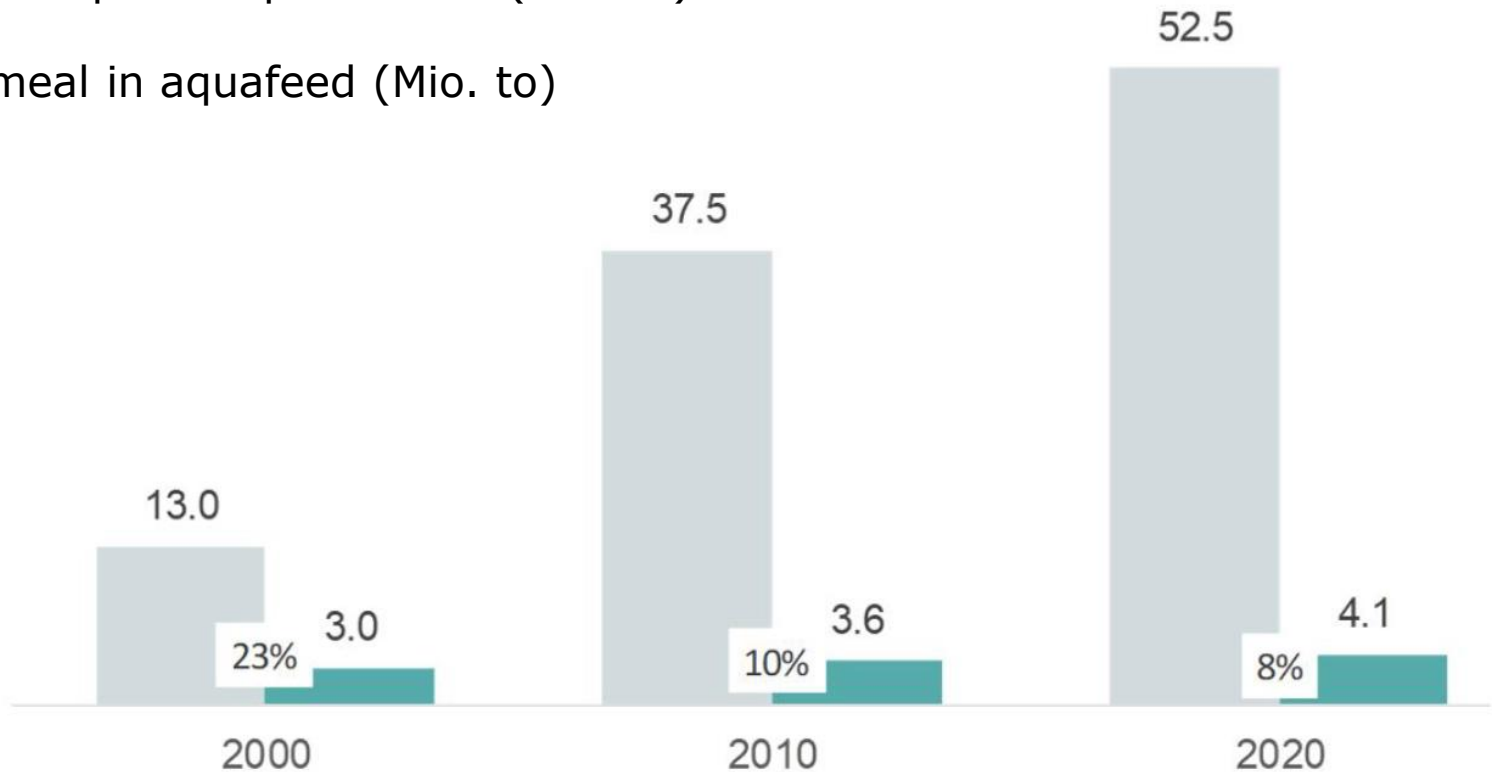


Fishmeal Peru, FAQ in US\$/to, cif Hamburg

# Strong global growth in aquafeed production



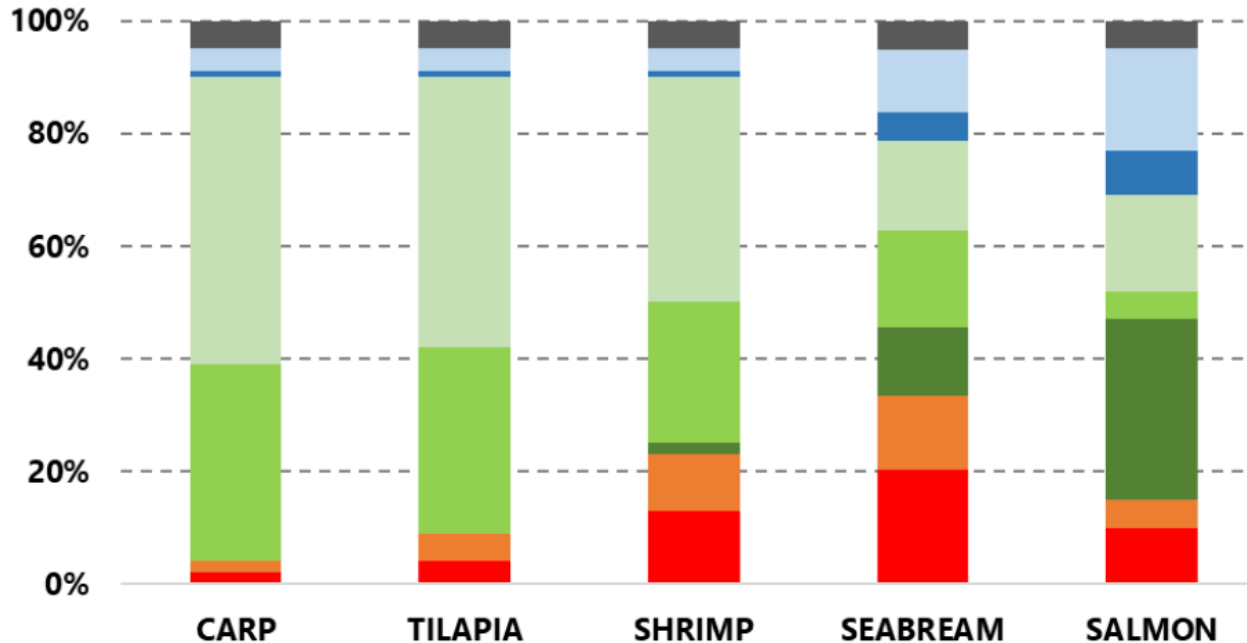
- Global aquafeed production (Mio. to)
- Fishmeal in aquafeed (Mio. to)



# Raw material mix in "modern" aqua feeds



Source: Dias 2022

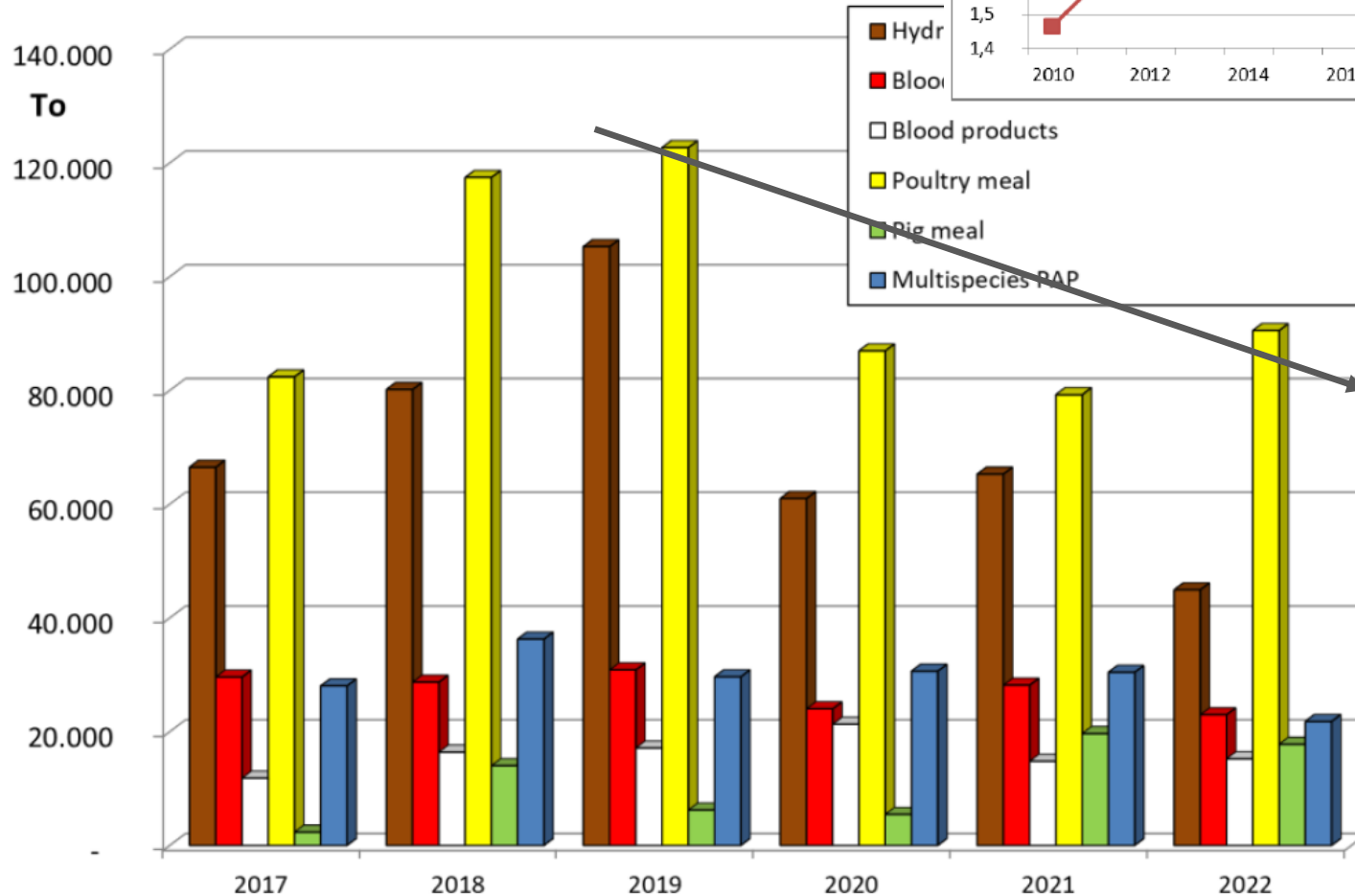
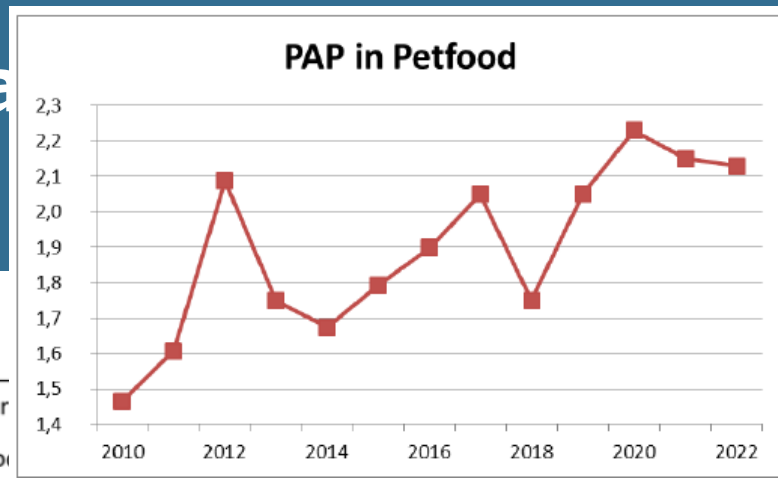


**Typical raw material change among species**

**... and among regions**

- Vitamins, minerals, additives
- Vegetable oils
- Fish oil
- Cereals and pulses (wheat, corn, cassava, peas, faba,...)
- Oilseed meals (soybean, rapeseed, sunflower, peanut,...)
- Plant protein concentrates (soy, wheat gluten, corn gluten, pea)
- PAP: processed (land) animal proteins
- Fishmeal

# Use of processed animal products in fish feed in



a clearly declining trend since 2019!



# Many start-ups and several large production facilities for insect meals

- Approved for aquaculture in the EU since 2017
- International Platform on Insects for Food and Feed (IPIFF)  
<https://ipiff.org/>
- Most insect meals come from the larvae of the black soldier fly and the yellow mealworm
- Several large plants are in operation, under construction and in planning
- Production volume 2021: 12.500 to; by 2025 a production volume of 186 kTo is expected (rather optimistic assumption)

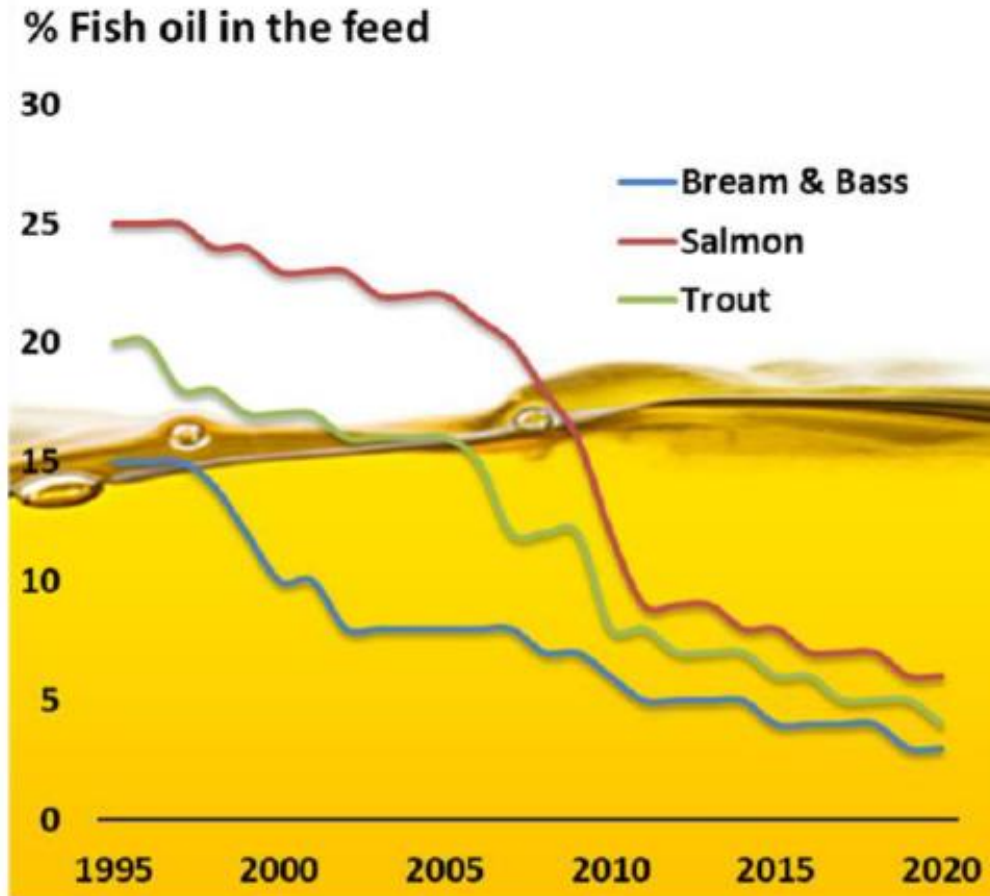


Ynsect, yellow mealworm; ~35 kTo



Innovafeed, black soldier fly ; ~35 kTo

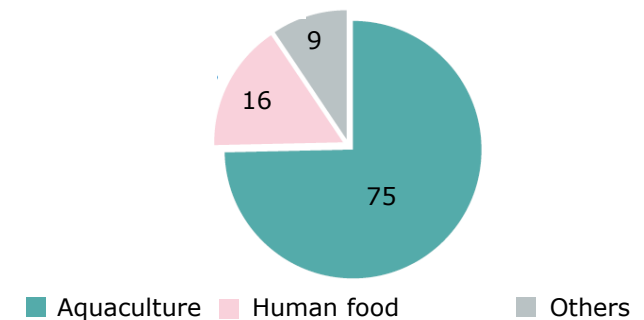
# Gradual replacement of fish oil



The general reduction of fish oil levels in aquafeeds was achieved by vegetable oils (and partly by animal fats)

**BUT:**  
**The dependence on fish oil is still high!**

**Global use of fish oil in %**

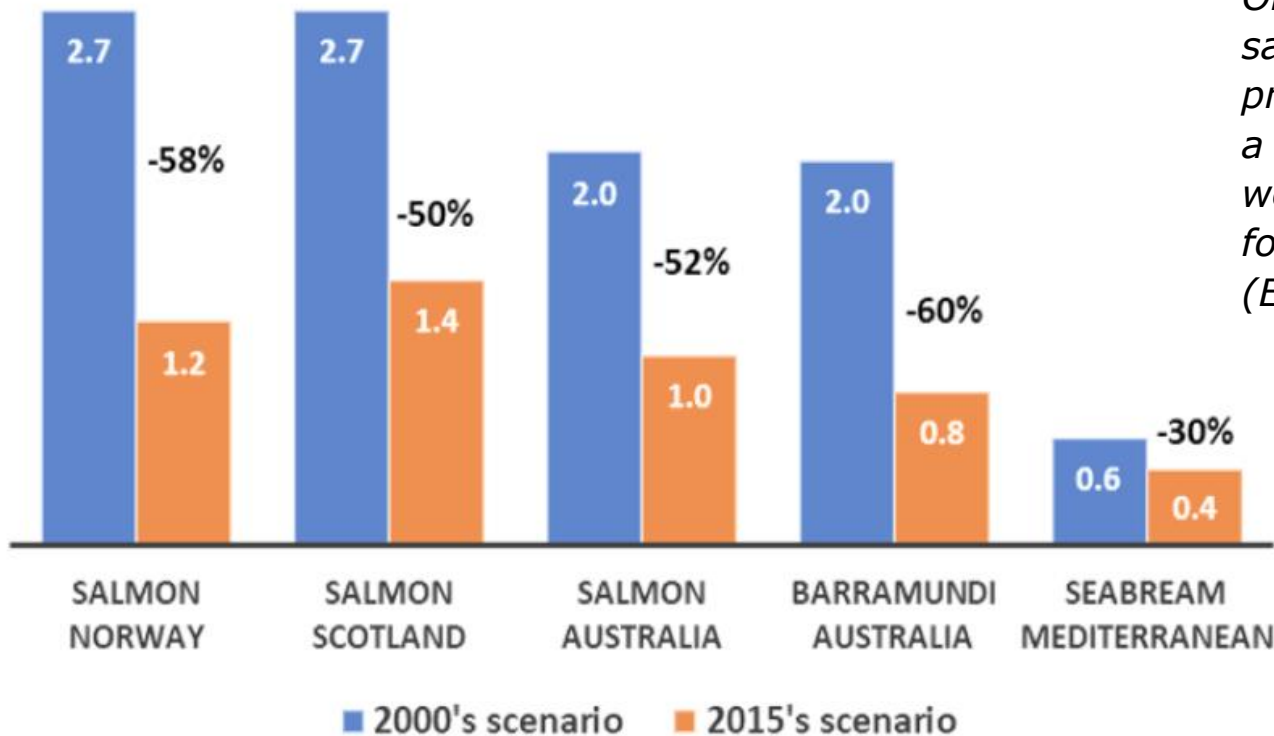


Source: IFFO, 2022

# Fish oil replacement by plant oils has consequences...



## Change in EPA+DHA content (g/100 g) in fish fillets between the years 2000 and 2015



*One portion of farmed salmon (130-150 g) still provides 1,5 g EPA+DHA, a dose that covers the weekly recommendation for healthy adults (EFSA, 2012)*

Sources: NIFES (2016), Sprague et al. (2016), Nichols et al. (2014), Vasconi et al. (2017)

# Marine algae oils a new EPA+DHA source



Marine microalgae (especially Schizochytrium) accumulate DHA-rich oils or DHA+EPA-rich oil

Today, microalgae are cultivated on an industrial scale under hetero-trophic conditions through fermentation and produce omega-3 fatty acids from sugar.



Veramaris production site in Nebraska, production of EPA+DHA-rich algae oil

## Commercial algae oils, *Tocher et al. 2019*

Product	Development Partners	Source	Type	Lipid Content
AlgaPrime™ DHA	Corbion (TerraVia/Bunge) <sup>e</sup>	Microalgae	Algal biomass	60
DHAGold™	DSM Nutritional Products	Microalgae	Algal biomass	49
DHA Natur™	ADM Animal Nutrition	Microalgae	Algal biomass	50–60
ForPlus™	Alltech Coppens <sup>f</sup>	Microalgae	Algal biomass	61
Nymega™	Heliae Development <sup>g</sup>	Microalgae	Algal biomass	65
Veramaris® Oil	Veramaris <sup>h</sup>	Microalgae	Oil	100

# Sustainability aspects will become more important in the future...

Inputs from technosphere: materials/fuels	Amount	Unit
Fish FF meal industry mix (NO)	150	kg
Krill meal (UR) at mill (NO)	40	kg
Soy bean concentrate (BR) at feed mill (NO)	150	kg
Pea protein (RER) at feed mill (NO)	100	kg
Wheat gluten (NL) at feed mill (NO)	100	kg
Maize gluten meal (FR) at mill (UK)	45	kg
Wheat HP (DE) at feed mill (NO)	105.75	kg
Fish FF oil industry mix (NO)	65	kg
Rapeseed oil (UK) at feed mill (NO)	185	kg
Vitamins and minerals at feed mill (NO)	15.25	kg
Sodium phosphate (RER) market for sodium	30	kg
L-Lysine (NL) at feed mill (NO)	12	kg
Methionine (NL) at feed mill (NO)	2	kg
Add line		
Inputs from technosphere: electricity/heat	Amount	Unit
Electricity, medium voltage (NO) market for	172.6	kWh
Heat, district or industrial, natural gas (Europ)	363.4	MJ
Diesel, burned in agricultural machinery (GLC)	8.55	MJ

**Formulation**

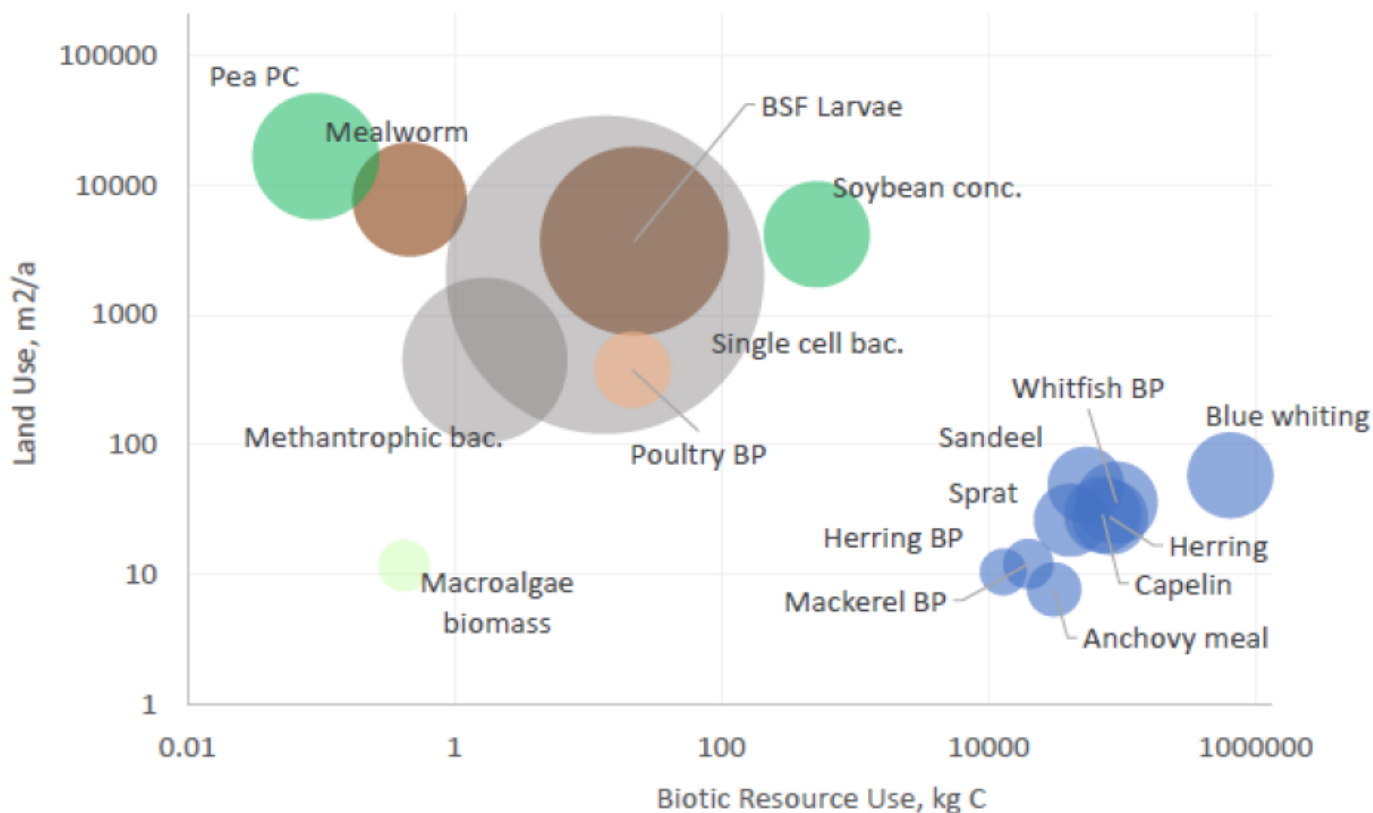
- Primary** (red bracket): Fish FF meal industry mix (NO), Krill meal (UR) at mill (NO), Soy bean concentrate (BR) at feed mill (NO), Pea protein (RER) at feed mill (NO), Wheat gluten (NL) at feed mill (NO), Maize gluten meal (FR) at mill (UK), Wheat HP (DE) at feed mill (NO), Fish FF oil industry mix (NO), Rapeseed oil (UK) at feed mill (NO), Vitamins and minerals at feed mill (NO), Sodium phosphate (RER) market for sodium, L-Lysine (NL) at feed mill (NO), Methionine (NL) at feed mill (NO).
- Ingredients production Secondary** (green bracket): Fish FF meal industry mix (NO), Krill meal (UR) at mill (NO), Soy bean concentrate (BR) at feed mill (NO), Pea protein (RER) at feed mill (NO), Wheat gluten (NL) at feed mill (NO), Maize gluten meal (FR) at mill (UK), Wheat HP (DE) at feed mill (NO), Fish FF oil industry mix (NO), Rapeseed oil (UK) at feed mill (NO), Vitamins and minerals at feed mill (NO), Sodium phosphate (RER) market for sodium, L-Lysine (NL) at feed mill (NO), Methionine (NL) at feed mill (NO).
- Industrial emissions Background** (blue bracket): Electricity, medium voltage (NO) market for, Heat, district or industrial, natural gas (Europ), Diesel, burned in agricultural machinery (GLC).

In the future, feed producers will have to consider **sustainability indicators** in addition to nutritional and technical constrains

>> Need for standardized and "neutral" sustainability indicators.

Impact category /	Unit	Total	Salmon T1	Fish FF meal	Krill meal	Soy bean	Pea protein	Wheat gluten	Maize gluten	Wheat HP (DE)	Fish FF oil	Rapeseed oil (UK)	Vitamins and
Cumulative Energy use (non renewa	MJ	2.23E4	x	3.58E3	2.28E3	3.31E3	1.58E3	3.67E3	615	306	1.16E3	2.69E3	303
Consumptive Water Use Blue	m3	27.7	x	0.913	0.575	0.438	7.39	0.971	1.44	0.0417	0.286	0.641	2.02
Biotic Resource Use	kg C	5.31E4	x	4.53E4	472	77.3	x	x	x	x	7.25E3	x	0.00997
Land competition	m2a	2.83E3	x	8	17.6	622	597	348	58.9	109	1.25	1.03E3	5.17
Cumulative energy use (renewables	MJ	1.41E3	x	67.6	43	366	55	52.7	12.9	3.51	18.4	24.4	15.6
Global warming (GWP100a)	kg CO2 eq	1.9E3	x	247	175	201	132	355	42.6	41.8	79.9	380	18.5
Ozone layer depletion (ODP)	kg CFC-11 eq	0.000134	x	3.97E-5	2.46E-5	6.37E-6	1.08E-5	7.29E-6	5.6E-6	6.22E-7	1.15E-5	5.41E-6	1.8E-6
Photochemical Oxidation Potential	kg C2H4 eq	1.3	x	0.0955	0.0796	0.838	0.027	0.0329	0.00472	0.00544	0.0294	0.129	0.00796
Acidification	kg SO2 eq	20.3	x	3.38	2.4	1.33	1.27	2.66	0.364	0.622	1.02	5.83	0.121
Eutrophication	kg PO4--- eq	12.8	x	0.689	0.425	1.14	1.29	2.2	0.316	0.584	0.208	5.22	0.034
Embodied Fish	kg Fish In	1.13E3	x	630	268	x	x	x	x	x	235	x	x
GWP LUC	kg CO2 eq	845	x	0.182	0.168	820	3.4	5.97	0.0229	2.02	0.0379	12.7	0.126
Consumptive Water Use Green	m3	1.29E3	x	x	x	387	307	112	25.4	49.5	x	409	x

# Conflicts between impact categories are often unavoidable



Land Use, Biotic Resource Use and Global Warming Potential (bubble size) major feed ingredient (1 tonne production)

Bubble size: increasing carbon footprint



# Conclusion



- Fish meal and fish oil were the dominant raw materials sources in fish feed until 2000 and were then replaced to a large extent by vegetable and animal proteins and fats
- Alternative raw materials such as algae oil, insect meal etc. will be used in fish feed in the future. The level of use will be determined by the relative price of this raw materials
- Sustainability indicators will be an integral part of the recipes in the future.

