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REVIEW

Contribution of Fish and Seafood to Global Food and Feed Supply: An Analysis of the FAO Food Balance Sheet for 2019

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ABSTRACT

The paper reviews the contribution of fish and seafood to food supply and feed supply at a global, regional and national level. Fish and seafood represents a healthier alternative to terrestrial meat and processed meat products; usually having a higher protein content on an edible fresh weight basis than terrestrial meats, are generally leaner and have a lower saturated fat content than terrestrial meats, and are unique in the animal kingdom as being a naturally rich source of heart-healthy long-chain omega-3 polyunsaturated fatty acids (eicosapentaenoic acid [EPA 20:5n-3] and docosahexaenoic acid [DHA 22:6n-3]), and are also generally a richer source of essential minerals and trace elements than most terrestrial meats (including Calcium, Phosphorus, Magnesium, Iron, Potassium, Sodium, Zinc, Copper, Manganese, Selenium, Iodine, Fluorine, and Trivalent chromium), and are also a richer source of several key vitamins than most terrestrial meats (including Vitamin A, Vitamin D, Vitamin E, Vitamin C, Vitamin B_{12}, Folic acid, and Choline).

KEYWORDS

Fish; seafood; FAO; food supply; feed supply; obesity

1. Introduction

According to the FAO (Food and Agriculture Organization of the United Nations), sustainable food and animal feed production systems necessitate that the economic, social and environmental bases used to generate the food or feed for current and future generations are not compromised and are both profitable (economic sustainability), have positive benefits to society (social sustainability), and do not harm the environment (environmental sustainability; FAO. 2014, 2018).

Sadly, for most agricultural and aquacultural food production systems, including the capture (fishing) of wild aquatic food products, profits and economic benefits have usually taken precedence over social or environmental sustainability issues (Willett et al. 2019). The resulting economic focus has resulted in a lack of understanding by the general public and the consumer concerning where the food they consume is produced (country of origin), how it is produced (farming method or fishing practice employed), or concerning the relative nutritional and health attributes of different food products (Gephart et al. 2021; Hambrey 2017; Naylor et al. 2021).

This paper reviews the latest FAO Food Balance sheet for 2019 (FAO 2022a, 2022b) and provides a global, regional and country overview of the major food items produced and consumed, as well as those food products destined for use as animal feed, with a focus on the role of fish and aquatic products[1] in the global food and animal feed basket.

2. A global view

2.1. Fish as food

According to the FAO Food Balance Sheets (FAO 2022a) total global food production was estimated at 5,427,152 thousand tonnes in 2019 (5.43 billion tonnes), and supplied on a daily per capita basis 2,963 calories/day, 83.18 g of protein/day, and 88.04 g of fat/day (Table 1); total food production increasing from 4,655,462 thousand tonnes in 2010 at an average rate of 1.72% per year from 2010 and above the annual population increase of 1.21% per year over the same period (FAO 2022a). On a global basis plant food products constituted 79% of total food production, 78% of total calorie supply, 60.1% of total protein supply, and over 55.8% of total fat

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Table 1. Global food and feed balance sheet for 2019 (FAO 2022a).

Food category	Total production (1000 tonnes)		Per capita food supply/day		
(fresh weight basis)	Food	Feed	Total Calories (kcal)	Protein (g)	Fat (g)
Total global supply	5,427,152	1,416,529	2,963	83.18	88.04
Plant products	4,285,472	1,363,721	2,431	50.02	49.14
Animal products	1,141,680	52,808	532	33.16	38.89
Cereals	1,336,995	987,181	1,312 (1)	32.36 (1)	6.07 (5)
Vegetables	1,080,871	54,385	99 (8)	5.12 (5)	0.84 (10)
Fruits	607,199	2,653	104 (7)	1.22 (10)	0.73
Starchy roots	509,961	166,318	153 (5)	2.32 (9)	0.27
Alcoholic beverages	244,445	–	61	0.3	–
Sugar & sweeteners	199,506	1,933	230 (4)	0.04	0.01
Vegetable oils	86,889	1,118	298 (2)	0.03	33.67 (1)
Oilcrops	63,390	46,689	64	2.94 (8)	4.93 (6)
Pulses	54,528	18,151	67 (9)	4.2 (6)	0.44
Sugar crops	40,022	84,993	5	0.02	0.02
Aquatic plants	19,800	298	3	0.19	0.01
Tree nuts	16,317	–	17	0.44	1.31 (8)
Stimulants	15,002	2	7	0.53	0.44
Spices	10,547	–	12	0.43	0.4
Milk	541,521	27,765	145 (6)	8.6 (3)	7.91 (3)
Meat	330,247	98	240 (3)	14.63 (2)	19.66 (2)
Fish & seafood[1]	152,360	22,517	35	5.47 (4)	1.22 (9)
Eggs	76,745	85	39	3.05 (7)	2.75 (7)
Animal fats	21,760	1,404	64 (10)	0.09	7.12 (4)
Offals	17,845	939	7	1.14	0.22
Other aquatic animals	1,202	–	–	0.02	–

[1]Includes freshwater fish, diadromous fish, pelagic fish, other, other marine fish, crustaceans, cephalopods, other mollusks.

supply in 2019. By contrast, animal food products represented 21% of total global food production on a wet weight basis, providing 40% of total protein supply, and 44.2% of total fat supply (Table 1; FAO 2022a).

Although oceans and water cover over two thirds of our planet, aquatic food products[1] represented less than 3.17% of total global food supply in 2019 (172.16 million tonnes, including aquatic plants on a live weight equivalent basis), compared with 18.2% for terrestrial animal food products[2] (988,118 million tonnes, fresh weight and dressed carcass weight basis; Table 1). Total aquatic food production in 2019 included 60,963 thousand tonnes of freshwater fish, 23,179 thousand tonnes of pelagic fish, 21,284 thousand tonnes of demersal fish, 7,623 thousand tonnes of other marine fish, 15,179 thousand tonnes of crustaceans, 3,461 thousand tonnes of cephlapods, 19,468 thousand tonnes of other mollusks, 1,202 thousand tonnes of other aquatic animals, and 19,800 thousand tonnes of aquatic plants (on a live weight equivalent basis; FAO 2022a).

Moreover, whereas the terrestrial livestock sector supplied 330.2 million tonnes of meat food products in 2019 (poultry meat 36.8%, pig meat 36.2%; bovine meat 20.9%, mutton and goat meat 4.6%, and other meats 1.6% by weight), capture fisheries and aquaculture supplied 109.3 million tonnes of aquatic meat products combined (including finfish 90%, crustaceans 5.0% and mollusks 5.0%); calculated using a live weight to aquatic meat conversion ratio of 1.15 for fish [gutted, head on], 1.5 for cephalopods [edible meat], 2.80 for crustaceans [shrimp meat], and 6.0 for other mollusks [clam & mussel meat]; FAO 2004, FAO 2022a; Tacon and Metian 2013).

Globally, animal food products supplied 18.0% of total calorie intake, 39.9% of total protein supply, and 44.2% of total fat supply; terrestrial meat represented the largest source of animal protein consumed (44.1% total animal protein intake), followed by milk (25.9%), fish and seafood (16.5%), and eggs (9.2%; Table 1). Fish and seafood supplied 6.6% of total animal calorific supply, 16.5% of total animal protein supply and 3.1% of total animal fat supply on a global basis (Table 1); freshwater fish supplying over 43.0% of total fish and seafood animal protein supply, followed by pelagic fish (20.3%), demersal fish (15.0%), crustaceans (9.1%), other marine fish (6.0%), cephalopods (3.3%), other mollusks (3.3%) and other aquatic animals (0.4%; FAO 2022a).

[1]Includes wild and farmed fish and seafood, including crustaceans, mollusks (including cephalopods), other invertebrate aquatic animals, and aquatic plants;

[2]Includes meats (bovine, mutton & goat, pig, poultry), milk, eggs, offal, and animal fats;

Table 2. Reported global use of fish and fishery products as animal feed 2010-2019 (values given in thousand tonnes; FAO 2022a).

Component	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Freshwater fish	89	195	163	138	221	177	195	267	267	267
Diadromous fish	1,119	1,077	1,023	1,045	1,232	1,345	1,389	1,439	1,439	1,439
Pelagic fish	18,183	19,172	18,408	15,799	16,627	15,918	16,141	19,296	19,296	19,296
Marine fish, other	1,370	994	727	797	768	557	557	988	988	988
Crustaceans	271	292	273	275	317	348	405	489	489	489
Cephalopods	152	93	65	37	140	114	13	14	14	14
Mollusks, other	24	18	15	24	15	24	24	24	24	24
Total Fish & shellfish	21,208	21,841	20,675	18,115	19,320	18,483	18,723	22,517	22,517	22,517
Aquatic plants	318	312	300	312	290	283	300	298	298	298

2.2. Fish as feed

In addition to the direct provision of food inputs, over 22.52 million tonnes of fish and seafood products were reportedly used as animal feed in 2019, including 19.30 million tonnes of pelagic fish (85.7% total), 1.44 million tonnes of diadromous fish, 988 thousand tonnes of other marine fish, 489 thousand tonnes of crustaceans, 267 thousand tonnes of freshwater fish, and 38 thousand tonnes of cephalopods and other mollusks (Table 2); fish destined for feed use mainly being processed into fishmeal and fish oil for use as a feed ingredient, primarily within aquaculture feeds (Boyd et al. 2022; Tacon and Metian 2013).

Although the proportion of fish destined for feed use has remained constant for the past three years (and is almost certainly a statistical anomaly), total fish destined for feed use has remained relatively stable, fluctuating between 18.1 to 22.5 million tonnes, with small pelagic fish representing over 85% of fish destined for reduction (Tacon and Metian 2015).

It is also important to highlight here that over 20.7% of total global food production was destined for use as animal feed in 2019 (1.42 billion tonnes), including 0.987 billion tonnes of cereals, which is in general agreement with the reported global compound animal feed industry estimate of 1.2 billion tonnes in 2019–2021 (Alltech 2022).

2.3. A regional view

2.3.1. Fish as food

The contribution of the major food groups to total energy supply, protein supply, and fat supply within the different major geographical regions of the world is shown in Table 3 and Figures 1–3, respectively. Total per capita calorific supply was highest for the North American region (3,829 calories) and lowest for the African region (2,586 calories; Figure 1). Of particular note was the progressive increasing contribution of animal foods, vegetable oils, and sugars and sweeteners toward total energy supply, increasing from a low of 21.3% for Africa, 31.5% for Asia, 43.6% for Central America, 51.5% for Europe, 51.4% for South America, 53.9% for Oceania, to a high of 62.3% for Northern America.

By contrast, the contribution of fish and seafood consumption to total calorie supply remains low for all regions, ranging from a low of 0.56% in Central America to a high of 1.38% in Europe (Figure 1). Notwithstanding this, the contribution of fish and seafood products to total animal food supply was higher, ranging from 2.27% for South America, 3.16% for Northern America, 3.75% for Central America, 4.77% for Oceania, 4.93% for Europe, to a high of 8.18% for Asia and 9.78% for the African region.

As with total calorific supply, total per capita protein and fat supply was highest for the Northern American region (114.35 g protein & 177.6 g fat) and lowest for the African region (65.15 g protein & 53.91 g fat), respectively (Figures 2 and 3). Moreover, whereas plant foods provided the main source of dietary protein supply within the African and Asian region (78.5% to 64.4%, respectively), animal products supplied the main source of dietary protein within the Northern American region and Oceania (65.1% to 63.7%, respectively; Figure 2). Similarly, in the case of fat supply, vegetable oils provided the main source of dietary lipid for all regions, ranging from 8.5% of total energy supply in the African region to a high of 18.4% in Northern America (Figure 3; FAO 2022a). By contrast, in the case of animal fats, the highest consumption was in Europe (5.4% total energy supply), followed by Oceania (3.8%), Northern America (2.9%), South America (2.3%), Central America (1.9%), Asia (1.8%), and lastly by Africa (0.5%; Figure 3).

Regionally, the Asian region produced over 71.1% of total global food fish production in 2019, followed by Europe (10.5% by weight), Africa (8.0%), Northern America (5.3%), South America (2.7%), Central America (1.4%), and Oceania (0.7%; Table 3). In contrast to the Asian region where fish and seafood supply is mainly derived from increased aquaculture

Table 3. Contribution of fish and aquatic animal products to animal food supply by major geographic region in 2019 (FAO 2022a).

Region	Total fish food supply 1000 tonnes	Total fish food supply kg/cap/year	Plant/animal food supply kcal/cap/day	Food fish supply kcal/cap/day	Fish protein supply[6] g/cap/day	Fish fat supply g/cap/day
Asia	108,323 (71.1%)	23.65	2,428/489	40 (8.18%)	6.38 (21.9%)	1.31 (3.62%)
Africa	12,269 (8.0%)	9.62	2,402/184	18 (9.78%)	2.85 (20.3%)	0.66 (5.53%)
Europe	16,011 (10.5%)	21.44	2,444/954	47 (4.93%)	6.49 (11.1%)	1.99 (2.79%)
Oceania	1,011 (0.66%)	24.37	2,222/881	42 (4.77%)	6.38 (10.5%)	1.58 (2.49%)
Central America	2,153 (1.4%)	12.12	2,417/613	23 (3.75%)	3.64 (9.14%)	0.82 (1.86%)
Northern America	8,100 (5.3%)	22.10	2,720/1,109	35 (3.16%)	5.39 (7.24%)	1.28 (1.59%)
South America	4,117 (2.7%)	9.64	2,304/747	17 (2.27%)	2.73 (5.58%)	0.61 (1.15%)
World	152,360	19.91	2,431/532	35 (6.6%)	5.47 (16.5%)	1.22 (3.14%)
European Union 27	10,619	23.86	2,462/1,004	50 (4.98%)	7.07 (11.5%)	2.10 (2.76%)
LDC[1]	12,349	12.32	2,246/178	24 (13.5%)	3.76 (28.7%)	0.85 (7.09%)
LLDC[2]	2,256	4.43	2,256/283	9 (2.23%)	1.34 (7.57%)	0.31 (1.59%)
SIDS[3]	763	12.93	2,291/403	26 (6.45%)	3.82 (12.9%)	1.02 (3.81%)
LIFDC[4]	23,516	9.08	2,275/257	16 (6.23%)	2.65 (17.7%)	0.56 (3.23%)
NFIDC[5]	18,812	11.79	2,276/265	23 (8.68%)	3.57 (19.7%)	0.83 (4.70%)

[1]Least developed countries; [2]Land locked developing countries; [3]Small island developing states; [4]Low income food deficit countries; [5]Net food importing developing countries; [6]Values in parenthesis represent % fish and seafood protein as % total daily animal protein intake.

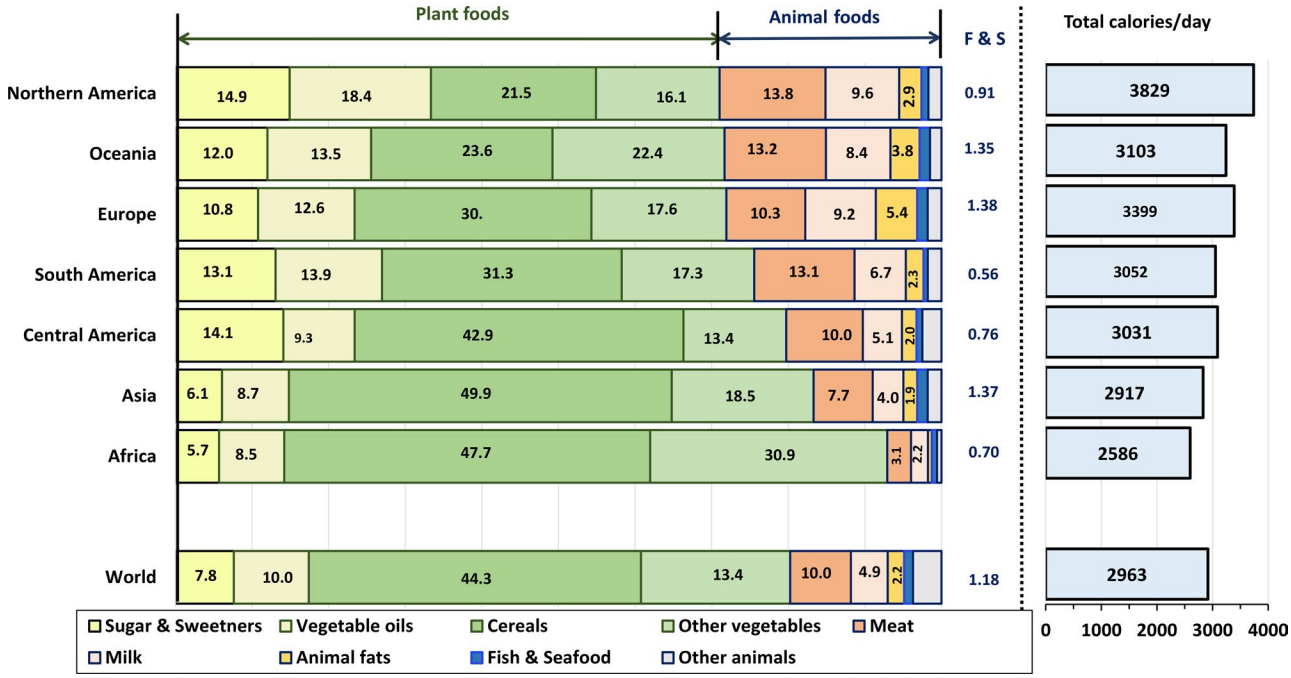

Figure 1. Contribution of the major food groups to total food supply by region. (values expressed as % total calorie supply; FAO 2022a)

production (the Asian region producing over 112.3 million tonnes of farmed aquatic products or 91.6% of total global aquaculture production in 2020), fish and seafood supply within the other regions (includes Africa, the Americas and Europe) is still largely sourced from wild capture fisheries (Table 4; FAO 2022c).

In terms of nutrient supply, within the Asian region fish and seafood supplied over 21.9% of total animal protein supply, 3.6% of total animal fat supply, and 8.2% of total animal calorific supply (Table 3). Moreover, despite low fish production and supply within the African region (8.0% of total food fish supply or 9.6 kg/capita/year), fish and seafood supplied over 20.3% of total animal protein supply, 5.5% of total animal fat supply, and 9.8% of total animal calorific supply (Table 3). By contrast, despite a relatively high per capita fish and seafood supply within Oceania (24.4 kg/cap/year), Northern America (22.1 kg/cap/year), and Europe (21.4 kg/cap/year), fish and seafood supplied only 10.5% of total animal protein supply and 2.5% of animal fat supply within Oceania, 7.2% of total animal protein supply and 1.6% of animal fat supply within Northern America, and 11.1% of total animal protein supply and 2.8% of animal fat supply in Europe, respectively (Table 3).

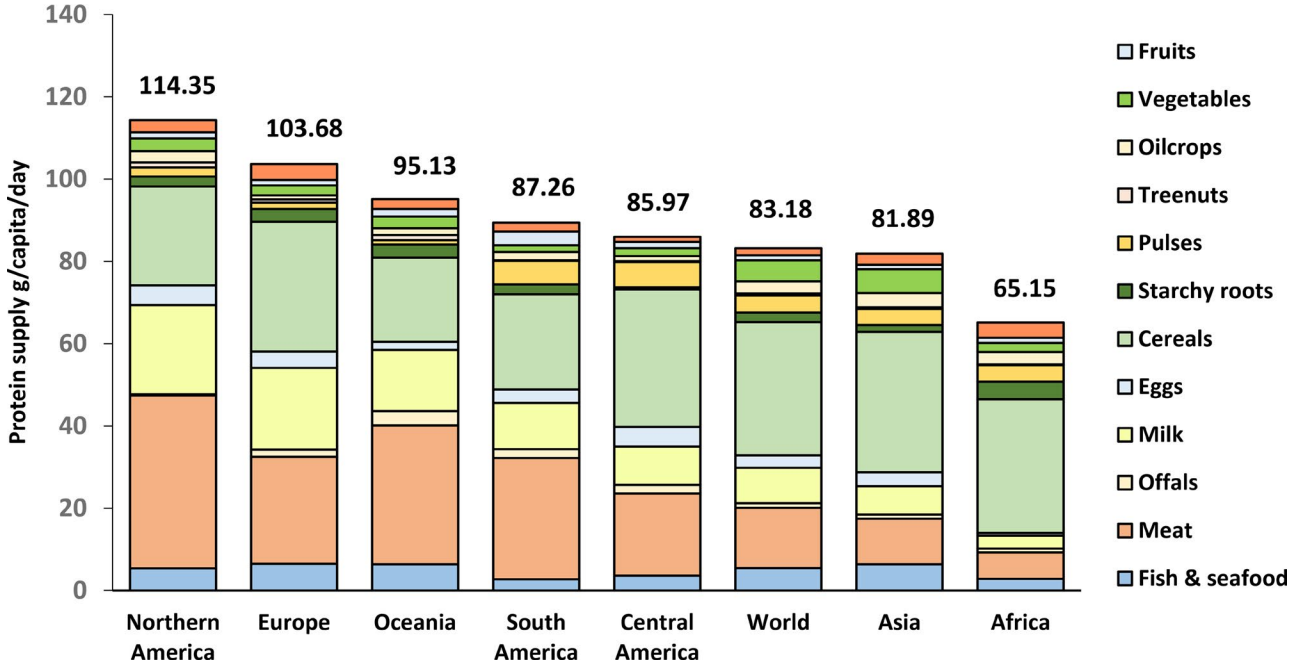

Figure 2. Contribution of the major food groups to total protein supply by region. (values expressed as % total protein supply; FAO 2022a)

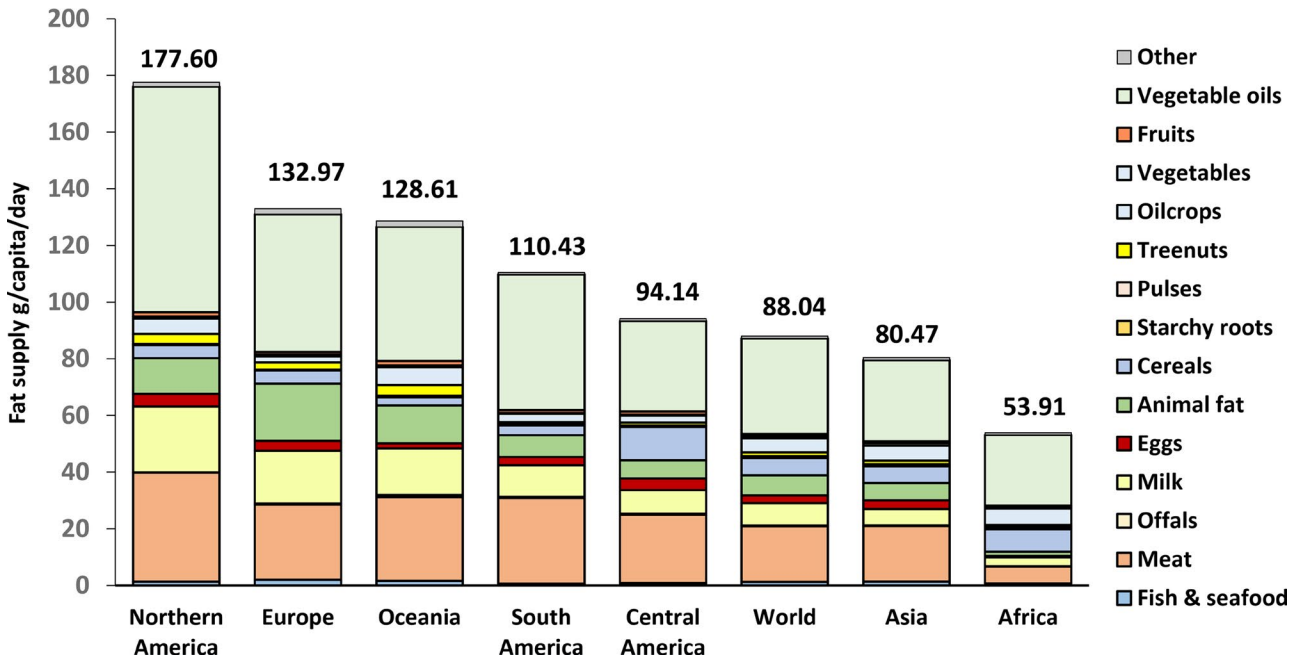

Figure 3. Contribution of the major food groups to total fat supply by region. (values expressed as % total fat supply; FAO 2022a)

Of particular note is the important role played by fish within Least Developed Countries (LDC), where fish and seafood contributed to over 28.7% of total animal protein supply and 7.1% of total animal fat supply. By contrast, Land Locked Developing Countries (LLDCs) displayed the lowest contribution to animal protein supply (7.6%) and animal fat supply (1.6%; Table 3).

2.3.2. Fish as feed

Table 5 shows the reported use of fish and fishery products as animal feed from 2010 to 2019. As noted previously at the global level (Table 2), it is not known why values from 2017 to 2019 remained constant, and probably reflects an error in the FAO food balance database for these years. Despite the above anomaly, the Asian region supplied over 16.5 million tonnes of fish and fishery products destined for use as animal feed, followed by Europe (3.5 million tonnes), North America (0.98 million tonnes), and South America (0.78 million tonnes); with pelagic fish species supplying the bulk of the fish species destined for use as animal feed within the Asian, European, and South American region (Table 5).

2.4. A country view

2.4.1. Fish as food

Notwithstanding the above global and regional trends, aquatic animal food products play an essential role in the food and nutrient supply of many Asian and African countries; artisanal processed fish products (including sun dried, salted, fermented, or smoked fish products) usually being one of the cheapest sources of animal protein and essential dietary nutrients available to resource poor consumers (FAO 2022d; Tacon and Metian 2018).

Fish and seafood products have a higher nutritional value and numerous beneficial attributes compared with terrestrial meats and their processed meat products; fish and seafood products having 1) a higher protein content on an edible fresh weight basis (mean 17.3%) than most terrestrial meats (mean 13.8%), 2) are rich dietary sources of methionine and lysine (these essential amino acids usually being limiting within most plant-based diets), 3) are generally leaner and have a lower saturated fat content than terrestrial meats, 4) are unique in the animal kingdom as being a naturally rich source of heart-healthy long-chain omega-3 polyunsaturated fatty acids, namely eicosapentaenoic acid [EPA 20:5n-3] and docosahexaenoic acid [DHA 22:6n-3]), 5) are a richer source of essential minerals and trace elements than most terrestrial meats (including Calcium, Phosphorus, Magnesium, Iron, Potassium, Sodium, Zinc, Copper, Manganese, Selenium, Iodine, Fluorine, and Trivalent chromium), and 6) are also a richer source of several key vitamins than most terrestrial meats (including Vitamin A, Vitamin D, Vitamin E, Vitamin C, Vitamin B_{12}, Folic acid, and Choline; Sargent and Tacon 1999; Tacon and Metian 2013; Tacon et al. 2020).

Moreover, Table 6 shows the relative contribution of fish and seafood products to total animal protein supply within different countries around the world, with fish and seafood contributing the main source of animal protein (over 30% of total animal protein supply) in over 30 countries within the Asian and African region. Within the Asian region the top fish and seafood consumers (in terms of their contribution to total animal protein supply) were Cambodia (69.6% total animal protein supply), followed by Bangladesh (60.1%), Maldives (56.2%), Indonesia (55.6%), Sri Lanka (49.4%), Lao DPR (40.0%), Thailand (38.4%), Malaysia (37.5%), Myanmar (34.0%), Japan (33.9%), Republic of Korea (30.3%), and Viet Nam (29.5%; Table 6). By contrast, within the African region, the top consumers included Sierra Leone (61.3%), Ghana (53.8%), Sao Tome & Principe (49.0%), Mozambique (47.4%), Cote d'Ivoire (44.3%), Gambia (44.0%), Cameroon (41.0%), Nigeria (35.9%), Angola (35.5%), Benin (34.9%), Senegal (34.5%), Togo (33.4%), Malawi (33.3%), Congo DR (32.9%) and Uganda (31.0%; Table 6). A similar trend was also observed for the contribution of fish and seafood to total animal fat supply (including the supply of heart-healthy omega-3unsaturated fatty acids) within these countries (with a few exceptions such as Viet Nam; Table 7).

Table 4. Top aquaculture country producers and capture fisheries landings in 2020 (values given in metric tonnes; FAO 2022c).

Top aquaculture producers	2020	Top capture fisheries landings	2020
China	70,483,538	China	13,445,983
Indonesia	14,845,014	Indonesia	6,989,382
India	8,641,286	Peru	5,675,209
Viet Nam	4,614,692	India	5,522,714
Bangladesh	2,583,866	Russian Federation	5,081,017
Korea Rep	2,327,903	USA	4,253,236
Philippines	2,322,831	Viet Nam	3,421,880
Egypt	1,591,896	Japan	3,215,130
Chile	1,505,486	Norway	2,603,574
Norway	1,490,412	Chile	2,182,768
Total aquaculture production	122,580,187	Total capture fisheries landings	91,420,562

Table 5. Reported regional use of fish and fishery products as animal feed 2010-2019 (values given in thousand tonnes; FAO 2022a).

Component	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Africa										
Freshwater fish	9.71	6.87	6.64	8.44	10.54	16.99	15.02	7.2	7.2	7.2
Diadromous fish	8	5	1	1	2	0	1	2	2	2
Pelagic fish	825	1,088	448	323	385	401	353	324	324	324
Marine fish, other	0	1	0.5	0	0	3.5	3	0	0	0
Total Fish & shellfish	843	1,1001	456	332	397	421	372	333	333	333
Asia										
Freshwater fish	0	0	3.12	85	100	95	135	170	170	170
Diadromous fish	45	34	31	41	22	33	67	35	35	35
Pelagic fish	11,774	12,474	12,846	11,302	12,049	11,861	11,999	15,045	15,045	15,045
Marine fish, other	1,289	931	717	729	744	522	535	973	973	97322
Crustaceans	222	225	211	237	154	151	243	275	275	275
Cephalopods	0	50	40	20	120	100	0	0	0	0
Mollusks, other	24	18	15	24	15	24	24	24	24	24
Total Fish & shellfish	13,354	13,732	13,863	12,438	13,204	12,786	13,003	16,522	16,522	16,522
Aquatic plants	152	152	152	152	130	130	130	130	130	130
Central America										
Diadromous fish	0.88	1.12	0.87	4.78	5.59	4.71	4.54	5.06	5.06	5.06
Pelagic fish	118	136	127	101	85	69	84	97	97	97
Total Fish & shellfish	119	137	128	106	91	74	89	102	102	102
Europe										
Freshwater fish	29	93	75	45	70	65	45	45	45	45
Diadromous fish	681	440	532	550	704	787	758	844	844	844
Pelagic fish	3,379	3,054	3,046	2,753	2,555	2,004	2,226	2,510	2,510	2,510
Marine fish, other	32	1.4	2.25	2.16	12	17	1.3	3.37	3.37	3.37
Crustaceans	1.5	1	1	1	141	131	121	121	121	121
Total Fish & shellfish	4,122	3,590	3,656	3,351	3,483	3,003	3,151	3,523	3,523	3,523
Aquatic plants	166	160	148	160	160	153	170	167	167	167
North America										
Diadromous fish	269	341	335	355	389	424	442	447	447	447
Pelagic fish	752	858	590	424	463	642	568	437	437	437
Crustaceans	4.02	3.02	5.33	3.46	1.67	4.13	2.30	86.92	86.92	86.92
Cephalopods	11.63	10.98	11.47	13.45	12.63	13.42	13.07	13.71	13.71	13.71
Total Fish & shellfish	1,037	1,213	942	795	867	1,083	1,026	985	985	985
Oceania										
Diadromous fish	68	60	42	35	60	70	45	45	45	45
Pelagic fish	274	232	275	200	299	237	247	213	213	213
Total Fish & shellfish	342	292	317	235	359	307	292	258	258	258
South America										
Freshwater fish	50	95	78	0	40	0	0	45	45	45
Diadromous fish	46	195	81	59	48	26	71	61	61	61
Pelagic fish	1,059	1,325	1,071	690	784	699	657	664	664	664
Marine fish, other	35	50	0	57	1.7	3.43	5.8	0.77	0.77	0.77
Crustaceans	44	62	55	34	20	62	39	6.61	6.61	6.61
Cephalopods	140	32	13.6	3.21	7.54	0.26	0.12	0.09	0.09	0.09
Total Fish & shellfish	1,374	1,760	1,299	843	901	791	772	778	778	778

Within the European countries, the top consumers of fish and seafood (in terms of their contribution to total animal protein supply) included Norway (22.6%), Portugal (20.6%) and Spain (18.0%), and the lowest surprisingly being Turkey (3.2%, despite being the largest marine finfish aquaculture producer in the European Union; FAO 2022c).

In addition to their important contribution to animal protein and fat supply, fish and seafood also serve as important dietary sources of energy; supplying over one fifth of total animal calorie supply in many African and Asian countries, including Sierra Leone (43.5%), Ghana (42.7%), Cambodia (40.9%), Cote d'Ivoire (37.5%), Indonesia (36.7%), Bangladesh (36.6%), Sri Lanka (29.6%), Cameroon (24.5%), Japan (22.1%), and Nigeria (20.5%; Table 7).

It is important to mention here that within those countries where fish and seafood currently play a relatively minor role in animal protein supply (<10% total animal protein supply), there is generally an over consumption of terrestrial animal food products and processed foods; obesity and diabetes being a major health risk and cause of death within many of these countries (Tacon et al. 2020; Willett et al. 2019), with sugars and sweeteners supplying over 10% of total calorific supply within these countries (Table 7). The top apparent consumers of sugars and sweeteners in 2019 included Guatemala (sugars and sweeteners supplying 18.0% of total energy supply), followed by New Zealand (17.4%), Thailand (16.0%), USA (15.3%), Cuba (15.0%), Denmark (14.4%), Chile (14.3%), Mexico (13.5%), Republic of Korea and Belgium (13.3%), and Argentina, and Australia (13.1%; Table 7).

Table 6. Contribution of fish and shellfish to total animal protein supply in 2019 (FAO 2022a).

Country	%	Country	%	Country	%
Cambodia	69.6%	Mozambique	47.4%	Senegal	34.5%
Kiribati	65.5%	Cote d'Ivoire	44.3%	Myanmar	34.0%
Sierra Leone	61.3%	Gambia	44.0%	Togo	33.4%
Bangladesh	60.1%	Cameroon	41.0%	Malawi	33.3%
Solomon Islands	58.8%	Lao DPR	40.0%	Vanuatu	34.0%
Maldives	56.2%	Thailand	38.4%	Japan	33.9%
Indonesia	55.6%	Malaysia	37.5%	Congo DR	32.9%
Ghana	53.8%	Nigeria	35.9%	Uganda	31.0%
Sri Lanka	49.4%	Angola	35.5%	Korea Rep	30.3%
Sao Tome & Principe	49.0%	Benin	34.9%	Viet Nam	29.5%
Rwanda	28.8%	Burkina Faso	22.6%	Guyana	18.4%
Korea DPR	28.4%	Norway	22.6%	Jamaica	18.4%
Iceland	28.3%	Morocco	22.3%	Mauritius	18.3%
Philippines	28.0%	French Polynesia	22.2%	Madagascar	18.2%
Antigua & Barbuda	28.0%	Fiji	21.9%	Spain	18.0%
Egypt	27.3%	China	21.7%	Dominica	18.0%
Guinea	25.1%	Gabon	21.3%	Oman	17.8%
Barbados	24.9%	Portugal	20.6%	Malta	16.6%
Zambia	24.3%	Tanzania	19.0%	Peru	16.5%
Samoa	24.0%	United Arab Emirates	18.8%	Namibia	16.3%
Trinidad & Tobago	15.5%	Denmark	12.9%	Moldova Rep	11.8%
Italy	15.4%	New Caledonia	12.4%	Liberia	11.7%
Suriname	14.6%	Finland	12.3%	Poland	11.5%
Cyprus	14.5%	Costa Rica	12.3%	Cape Verde	11.2%
Lithuania	14.5%	Sweden	12.2%	Croatia	11.2%
Latvia	13.7%	Luxembourg	12.1%	Chad	11.1%
France	13.5%	Tunisia	11.9%	Central African Rep	11.0%
Venezuela	13.4%	New Zealand	11.8%	Ireland	10.7%
Iran	13.0%	Russian Federation	11.8%	Panama	10.4%
India	12.9%	Mali	11.8%	Belgium	10.0%
UK	10.0%	Nicaragua	8.4%	Zimbabwe	7.1%
Belize	9.5%	Israel	8.3%	Switzerland	7.0%
Netherlands	9.7%	Saudi Arabia	8.2%	Slovakia	6.9%
Mexico	9.5%	Iraq	8.0%	Germany	6.8%
Greece	9.2%	El Salvador	7.9%	Dominican Rep	6.6%
Canada	9.1%	Mauritania	7.9%	Nepal	6.6%
Lebanon	9.0%	Georgia	7.8%	Belarus	6.4%
Australia	8.7%	Ukraine	7.1%	Slovenia	6.2%
Yemen	8.6%	Chile	7.1%	Jordan	6.1%
Kuwait	8.4%	USA	7.1%	Austria	6.1%
Estonia	5.7%	Guatemala	4.5%	Turkey	3.2%
Kenya	5.5%	Cuba	4.5%	Argentina	3.0%
Uruguay	5.5%	Brazil	4.4%	Lesotho	3.0%
Bulgaria	5.5%	Serbia	4.3%	Botswana	2.8%
Niger	5.4%	Guinea-Bissau	4.2%	Azerbaijan	2.5%
Colombia	5.3%	Romania	4.1%	Ethiopia	2.5%
Czechia	5.2%	Albania	4.1%	Turkmenistan	2.3%
South Africa	4.9%	Hungary	3.6%	Bolivia	2.1%
Algeria	4.7%	Honduras	3.5%	Uzbekistan	1.8%
Paraguay	4.6%	Armenia	3.2%	Pakistan[1/]	1.8%

[1/]Others: Sudan 1.6%, Kazakhstan 1.4%, Kyrgyzstan 0.94%, Tajikistan 0.47%, Afghanistan 0.68% & Mongolia 0.23% (FAO 2022a).

2.4.2. Fish as feed

As expected, the major producers and users of fish and seafood products for use as animal feed in 2019 were also the largest aquaculture producers, including China (10.49 million tonnes [Mt] or 46.6% of the total global use of 22.52 Mt of fish as feed; Table 1), followed by Japan (1.53 Mt), Norway (1.52 Mt), Viet Nam (1.08 Mt), Turkey (0.70 Mt), USA (0.70 Mt), Chile (0.63 Mt), Thailand (0.44 Mt), India (0.38 Mt), Greece (0.35 Mt), Indonesia (0.35 Mt), Russian Federation (0.29 Mt), Canada (0.28 Mt), Republic of Korea (0.28 Mt), UK (0.23 Mt), Iran (0.20 Mt), Bangladesh (0.18 Mt), Philippines (0.18 Mt), Spain (0.17 Mt) and Cambodia (0.15 Mt): these twenty countries accounting for 89.5% of total reported global production in 2019 (FAO 2022a). It is not known why the contribution of Peru to total fish feed supply was only reported as 9,000 tonnes, whereas exports from Peru were reported as 4.83 Mt in 2019 (Peru being the largest country producer of fishmeal and fish oil in 2019 and 2020 (FAO 2022c, 2022d). According to FishStat Peru produced 810,530 tonnes and 1,048,514 tonnes of anchoveta meal in 2019 and 2020 respectively, and 105,008 tonnes and 169,408 tonnes of anchoveta oil in 2019 and 2020 respectively (FAO 2022c).

Table 7. Total calorific, animal protein and animal fat supply and contribution of fish and seafood (FAO 2022a).

	Total food supply per capita per day					Fish & seafood food supply/capita/day		
Country	Total calories (kcal)	Animal calories (kcal)	Animal protein (g)	Animal fat (g)	Sugar & sweeteners (kcal)	Calories	Protein g	Fat g
Korea DPR	2,097	132 (6.3%)	10.21	9.48	46 (2.2%)	16 (12.1%)	2.90 (28.4%)	0.43 (4.5%)
Uganda	2,156	154 (7.1%)	10.11	10.48	117 (5.4%)	20 (13.0%)	3.13 (31.0%)	0.72 (6.9%)
Haiti	2,159	169 (7.8%)	10.94	10.46	251 (11.6%)	12 (7.1%)	1.83 (16.7%)	0.48 (4.6%)
Guinea-Bissau	2,230	146 (6.5%)	8.40	10.92	41 (1.8%)	3 (2.0%)	0.35 (4.2%)	0.14 (1.3%)
Sierra Leone	2,332	92 (4.0%)	11.11	4.63	76 (3.2%)	40 (43.5%)	6.81 (61.3%)	1.20 (25.9%)
Bolivia	2,464	546 (22.2%)	35.61	41.20	276 (11.2%)	5 (0.9%)	0.74 (2.1%)	0.20 (0.5%)
Namibia	2,474	307 (12.4%)	22.95	20.12	239 (9.7%)	24 (7.8%)	3.73 (16.3%)	0.86 (4.3%)
Guatemala	2,556	285 (11.1%)	21.82	18.84	459 (18.0%)	6 (2.1%)	0.98 (4.5%)	0.21 (1.1%)
Ecuador	2,563	570 (22.2%)	32.68	43.15	269 (10.5%)	14 (2.4%)	2.32 (7.1%)	0.48 (1.1%)
Nigeria	2,565	78 (3.0%)	7.01	4.94	100 (3.9%)	16 (20.5%)	2.52 (35.9%)	0.56 (11.3%)
India	2,581	298 (11.5%)	15.44	19.73	215 (8.3%)	12 (4.0%)	1.99 (12.9%)	0.42 (2.1%)
Bangladesh	2,626	123 (4.7%)	12.22	6.69	77 (2.9%)	45 (36.6%)	7.35 (60.1%)	1.54 (23.0%)
Gabon	2,633	366 (13.9%)	37.59	20.86	169 (6.4%)	54 (14.7%)	8.01 (21.3%)	2.18 (10.4%)
Japan	2,691	569 (21.1%)	49.17	35.74	249 (9.2%)	126 (22.1%)	16.68 (33.9%)	5.76 (16.1%)
Cambodia	2,700	210 (7.8%)	18.72	13.84	285 (10.5%)	86 (40.9%)	13.03 (69.6%)	3.09 (22.3%)
Sri Lanka	2,719	206 (7.6%)	18.96	10.77	287 (10.5%)	61 (29.6%)	9.37 (49.4%)	2.21 (20.5%)
Cameroon	2,770	114 (4.1%)	11.01	6.66	101 (3.6%)	28 (24.5%)	4.51 (41.0%)	0.92 (13.8%)
Peru	2,786	459 (16.5%)	42.94	26.57	214 (7.7%)	48 (10.4%)	7.07 (16.5%)	1.88 (7.1%)
Thailand	2,808	358 (12.7%)	26.21	25.10	450 (16.0%)	65 (18.1%)	10.08 (38.4%)	2.30 (9.2%)
Philippines	2,809	417 (14.8%)	26.25	32.59	226 (8.0%)	45 (10.8%)	7.34 (28.0%)	1.51 (4.6%)
Cote d'Ivoire	2,841	112 (3.9%)	14.32	5.18	109 (3.8%)	42 (37.5%)	6.35 (44.3%)	1.62 (31.3%)
Myanmar	2,847	638 (22.4%)	46.24	46.93	190 (6.7%)	107 (16.8%)	15.73 (34.0%)	3.92 (8.3%)
Guinea	2,849	141 (4.9%)	11.85	8.82	125 (4.4%)	19 (13.5%)	2.97 (25.1%)	0.67 (7.6%)
Indonesia	2,879	226 (7.8%)	24.54	12.31	246 (8.5%)	83 (36.7%)	13.64 (55.6%)	2.72 (22.1%)
South Africa	2,898	466 (16.1%)	35.13	33.49	308 (10.6%)	11 (2.4%)	1.71 (4.9%)	0.44 (1.3%)
Viet Nam	2,939	619 (21.1%)	34.36	50.38	104 (3.5%)	60 (9.7%)	10.15 (29.5%)	1.73 (3.4%)
Chile	3,078	792 (25.7%)	49.55	58.35	442 (14.3%)	24 (3.0%)	3.53 (7.1%)	0.90 (1.5%)
Ghana	3,114	124 (4.0%)	14.61	6.15	113 (3.6%)	53 (42.7%)	7.86 (53.8%)	2.13 (34.6%)
Mexico	3,163	700 (22.1%)	44.89	51.00	426 (13.5%)	27 (3.9%)	4.28 (9.5%)	0.92 (1.8%)
Sweden	3,184	1,048 (32.9%)	69.35	74.38	353 (11.1%)	59 (5.6%)	8.44 (12.2%)	2.34 (3.1%)
New Zealand	3,228	968 (30.0%)	55.63	78.35	563 (17.4%)	42 (4.3%)	6.59 (11.8%)	1.48 (1.9%)
Brazil	3,246	875 (27.0%)	54.86	62.76	405 (12.5%)	15 (1.7%)	2.43 (4.4%)	0.46 (0.7%)
Argentina	3,304	1,017 (30.8%)	67.89	73.78	433 (13.1%)	13 (1.3%)	2.06 (3.0%)	0.38 (0.5%)
Egypt	3,307	267 (8.1%)	23.68	16.88	268 (8.1%)	41 (15.3%)	6.47 (27.3%)	1.44 (8.5%)
Finland	3,320	1,277 (38.5%)	73.01	101.6	305 (9.2%)	63 (4.9%)	8.98 (12.3%)	2.61 (2.6%)
China	3,340	754 (22.6%)	41.62	60.91	76 (2.3%)	55 (7.3%)	9.05 (21.7%)	1.57 (2.6%)
Spain	3,348	872 (26.0%)	68.32	58.46	323 (9.6%)	85 (9.7%)	12.32 (18.0%)	3.23 (5.5%)
Netherlands	3,353	1,156 (34.5%)	69.57	85.85	384 (11.4%)	44 (3.8%)	6.76 (9.7%)	1.57 (1.8%)
Russian Fed.	3,363	871 (25.9%)	55.87	62.60	397 (11.8%)	47 (5.4%)	6.61 (11.8%)	2.07 (3.3%)
Morocco	3,365	335 (9.9%)	27.91	21.31	333 (9.9%)	41 (12.2%)	6.22 (22.3%)	1.63 (7.6%)
Cuba	3,375	528 (15.6%)	34.21	37.56	505 (15.0%)	10 (1.9%)	1.54 (4.5%)	0.38 (1.0%)
UK	3,395	985 (29.0%)	58.86	73.38	309 (9.1%)	47 (4.8%)	5.91 (10.0%)	2.34 (3.2%)
Greece	3,396	843 (24.8%)	62.51	58.24	286 (8.4%)	34 (4.0%)	5.74 (9.2%)	0.99 (1.7%)
Australia	3,417	1,099 (32.2%)	72.91	79.07	447 (13.1%)	41 (3.7%)	6.34 (8.7%)	1.46(1.8%)
Denmark	3,421	1,244 (36.4%)	76.72	95.24	493 (14.4%)	75 (6.0%)	9.93 (12.9%)	3.42 (3.6%)
Norway	3,449	1,100 (31.9%)	64.41	85.20	281 (8.1%)	104 (9.4%)	14.54 (22.6%)	4.53 (5.3%)
Korea Rep.	3,453	691 (20.0%)	53.86	47.07	460 (13.3%)	112 (16.2%)	16.30 (30.3%)	4.36 (9.3%)
Portugal	3,458	1,045 (30.2%)	75.25	72.01	244 (7.1%)	95 (9.1%)	15.52 (20.6%)	3.00 (4.2%)
Italy	3,505	842 (24.0%)	55.60	63.20	321 (9.2%)	59 (7.0%)	8.57 (15.4%)	2.33 (3.7%)
France	3,532	1,117 (31.6%)	64.53	88.35	363 (10.3%)	63 (5.6%)	8.72 (13.5%)	2.75 (3.1%)
Canada	3,539	960 (27.1%)	61.12	72.39	407 (11.5%)	36 (3.7%)	5.59 (9.1%)	1.21 (1.7%)
Germany	3,559	1,057 (29.7%)	62.70	78.55	441 (12.4%)	37 (3.5%)	4.26 (6.8%)	2.06 (2.6%)
Turkey	3,734	611 (16.4%)	39.73	39.07	308 (8.2%)	9 (1.5%)	1.29 (3.2%)	0.33 (0.8%)
Belgium	3,800	1,257 (33.1%)	60.58	103.1	505 (13.3%)	44 (3.5%)	6.04 (10.0%)	1.91 (1.8%)
USA	3,862	1,126 (29.1%)	75.93	81.11	591 (15.3%)	36 (3.2%)	5.40 (7.1%)	1.29 (1.6%)

2.5. Concluding remarks

Fish and seafood needs to be viewed by policy makers and governments alike as a major contributor to the global food basket, and the increased consumption of fish and seafood products actively promoted as a heart-healthy alternative to processed foods and terrestrial animal food products; the latter being most relevant for those countries suffering from a high incidence of obesity, coronary heart disease, diabetes and associated ailments where fish and seafood play a relatively minor role, supplying less than 10% of total animal protein supply (Table 6; Boyd et al. 2020; Farmery et al. 2022; Tacon et al. 2020; Willett et al. 2019).

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