SEAFISH

Fishmeal and fish oil facts and figures

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Compiled by Seafish (with thanks to the Marine Ingredients Organisation (IFFO) for permission to use its data).

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1. Fishmeal and fish oil – summary

MANUFACTURE

Fishmeal is the crude flour obtained after milling and drying fish or fish parts, while fish oil is usually a clear brown/yellow liquid obtained through the pressing of the cooked fish. Many different species are used for fishmeal and fish oil production, with oily fish, especially anchoveta, the main groups of species utilised. A significant, but declining, proportion of world fisheries production is processed into fishmeal and fish oil thereby contributing indirectly to human consumption when they are used as feed in aquaculture and livestock raising.

Fishmeal (FM) and fish oil (FO) are produced mainly from sustainably managed stocks of fish for which there is little or no demand for human consumption. Non official estimates of the contribution of fish by-products and processing waste, rather than whole fish, to the total volume of FM and FO produced indicate it is now about 25-35% and this figure is expected to grow.

These two fish products are manufactured in EU approved dedicated manufacturing plant and through a safety monitored supply chain. FM is never produced in the same factories as meat and bone meal. There are three different products sold as meal:

- High quality - usually for small-scale aquaculture units (trout farms) or marine species.
- LT (low temperature) meal - is highly digestible and used in salmon and piglet production.
- Prime FAQ (fair average quality) - lower protein content feed ingredient for pigs and poultry.

PRODUCTION AND CONSUMPTION

World-wide annual production of FM has been between 4.753 million tonnes (Mt) and 5.861 Mt since 2006. The main producing countries are: Peru, Thailand, China PR, Chile, Vietnam, USA and Denmark. The main species used are:

	Species	**Marketability as food**
Industrial grade forage fish	Gulf menhaden, sandeel, Atlantic menhaden, Norway pout	No market at all as food. Fishery would cease if no fishmeal plants.
Food grade forage fish	Peruvian, Japanese, European and other anchovy. Capelin, blue whiting and European sprat.	Demand often small, localised or niche. Fishmeal plants take what food fish markets cannot absorb.
Food fish rejected by the market	Chilean Jack mackerel, chub mackerel and other species of sardine, mackerel and herring.	Well established food markets. Landings not in demand for food go for fishmeal and fish oil.

USE

Virtually all FM is used as a high protein (60 to 72%) ingredient in feed for farmed land animals and farmed fish. FO is used mainly in the feed of farmed fish and in very small quantities in land animal feed. FM is not fed straight (undiluted) and typical inclusion rates for fishmeal vary.

2. WORLD food and feed fisheries and aquaculture – key figures

WORLD FISHING

Global capture production in 2014 (FAO SOFIA Report 2016)	93.4Mt
Total aquaculture production in 2014 (FAO SOFIA Report 2016)	73.8Mt
Total capture and aquaculture in 2014 (FAO SOFIA Report 2016)	167.2Mt
Of which, caught to produce fishmeal and fish oil in 2014 (FAO SOFIA Report 2016) *(Down from 16.3 Mt in 2012 and 17.9 Mt in 2009. This is a declining trend and well below peak levels of more than 30 Mt in 1994)*	15.8Mt

WORLD FISHMEAL AND FISH OIL PRODUCTION IN 2015

Production

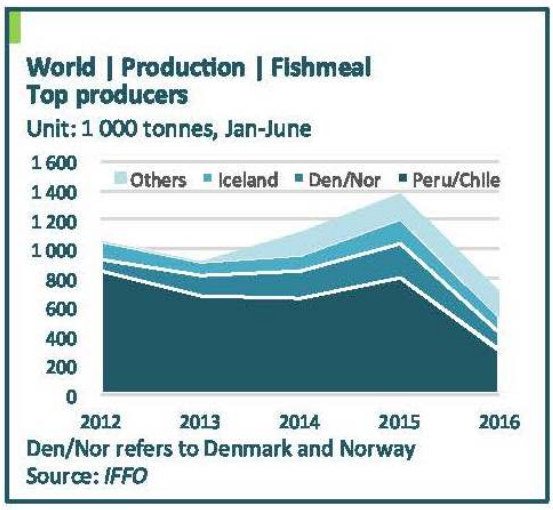
Fishmeal	4.731Mt
Fish oil	0.856Mt

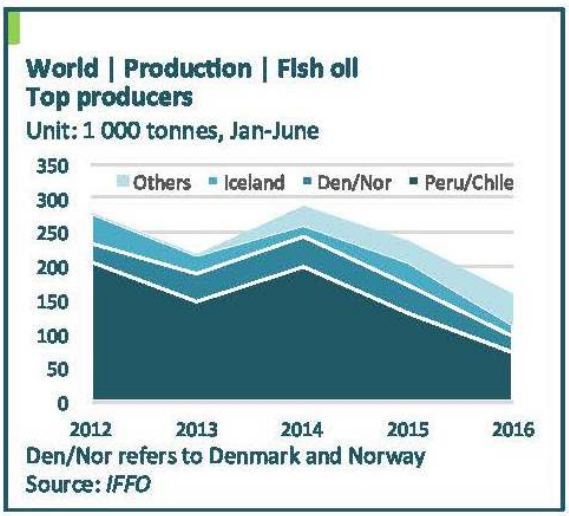
Raw materials used

a) Whole fish	13.9Mt
b) By-product from wild capture	3.75Mt
c) By-product from aquaculture	1.94Mt

Source: Institute of Aquaculture, University of Sterling and IFFO, July 2016.

WORLD FISHMEAL AND FISH OIL PRODUCTION TO 2016





Source: Globefish

3. WORLD production, supply and consumption of fishmeal

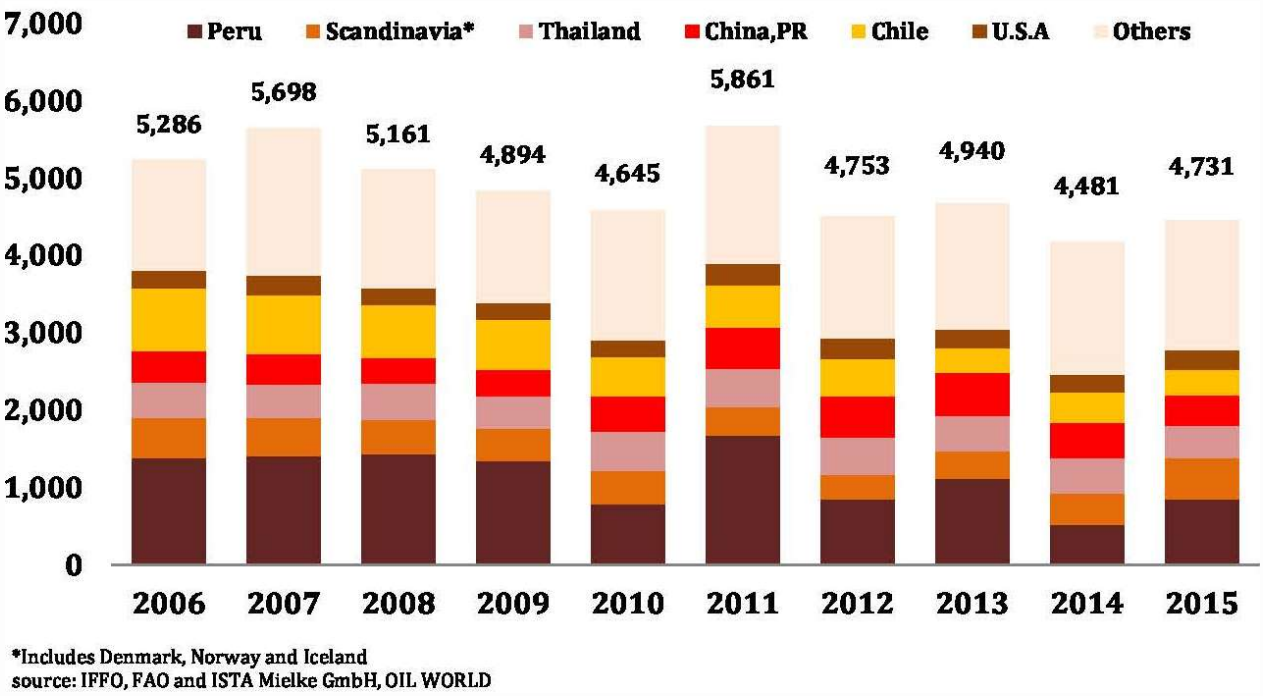
The FAO State of World Fisheries and Aquaculture report 2016 states that global total fisheries production (excluding aquatic plants) reached 167.2 million tonnes (Mt) in 2014, with 93.4 Mt from capture and 73.8 Mt from aquaculture. Global total capture fishery production in 2014 was 93.4 Mt, of which 81.5 Mt was from marine waters (a slight increase on the previous years) and 11.9 Mt from inland waters. World aquaculture production continues to grow and now provides half of all fish for human consumption. Excluding fish destined for non-food uses, a milestone was reached in 2014 when, for the first time ever, the world's population consumed more farmed fish than wild-caught fish.

Fishmeal and fish oil trends

- 21 Mt (22.4% of total catches) was destined for non-food products. Of this 21 Mt 76% (15.8 Mt) was reduced to fishmeal (FM) and fish oil (FO) in 2014, the rest being largely utilised for a variety of purposes including fish for ornamental purposes, culture (fingerlings, fry, etc.), bait, pharmaceutical uses, and as raw material for direct feeding in aquaculture, for livestock and for fur animals.
- This figure of 21 Mt has fallen from 34.2 Mt in 1994. The reasons for this drop range from the increased use for human consumption and a decrease in dedicated fishing for feed production (due to tighter quota setting and additional controls on unregulated fishing). Another factor is the increased use of fish residues and by-products, increasingly replacing whole fish for FM and FO production.
- FM and FO are still considered the most nutritious and digestible ingredients for farmed fish feeds. To offset their high prices, as feed demand increases, the amount of FM and FO used in compound feeds for aquaculture has shown a clear downward trend, with their being more selectively used as strategic ingredients at lower concentrations and for specific stages of production, particularly hatchery, broodstock and finishing diets.
- Owing to the growing demand for FM and FO, in particular from the aquaculture industry, and coupled with high prices, a growing share of FM is being produced from fish byproducts, which previously were often discarded. In industrial fish processing, 30–70% of the fish ends up as by-products, e.g. heads, viscera and backbones. These by-products are usually further processed into FM and FO, and are primarily used for feed purposes.
- Non official estimates of the contribution of by-products and waste, rather than whole fish, to the total volume of FM and FO produced indicate it is now about 25-35% and this figure is expected to grow.
- The amount of FM and FO used in compound feeds for aquaculture has shown a clear downward trend, with their being more selectively used as strategic ingredients at lower levels and for specific stages of production, particularly hatchery, broodstock and finishing diets.

WORLD FM cont'd - production

3.1 World fishmeal production 2006 - 2015 ('000Mt)



Source – IFFO Fishmeal and Fish Oil Statistical Yearbook 2016.

3.2 Total world production of fishmeal 1998 to 2015

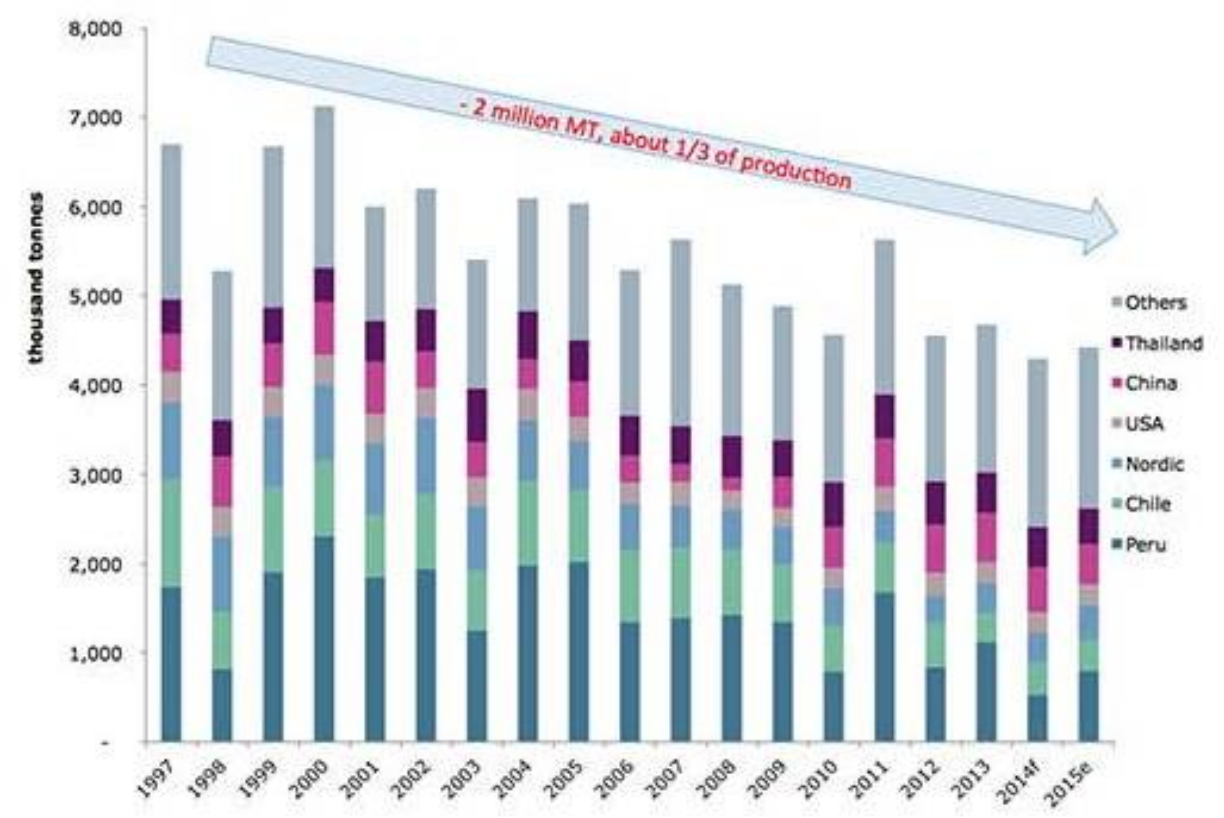
Tonnes

1988	6,837,000	2002	6,201,700
1989	6,875,000	2003	5,401,600
1990	6,380,000	2004	6,274,500
1991	6,448,000	2005	6,022,700
1992	6,263,000	2006	5,286,000
1993	6,514,000	2007	5,698,000
1994	7,441,000	2008	5,161,000
1995	6,833,000	2009	4,894,000
1996	6,912,000	2010	4,645,000
1997	6,617,000	2011	5,861,000
1998	5,208,000	2012	4,753,000
1999	6,670,000	2013	4,940,000
2000	7,125,000	2014	4,481,000
2001	5,997,400	2015	4,731,000

Source – IFFO Fishmeal and Fish Oil Statistical Yearbooks.

WORLD FM cont'd - production

3.3 Global supply of fishmeal 1997 to 2015 ('000Mt)



Source: The Appeal of Fishmeal: Fishmeal's Transformation from a Commodity to a High-Priced, Strategic Protein. Gorjan Nikolik, Rabobank, GOAL 2015.

3.4 Fishmeal production by top 15 countries 2008 to 2015 (ranked according to 2015 figures) (000Mt)

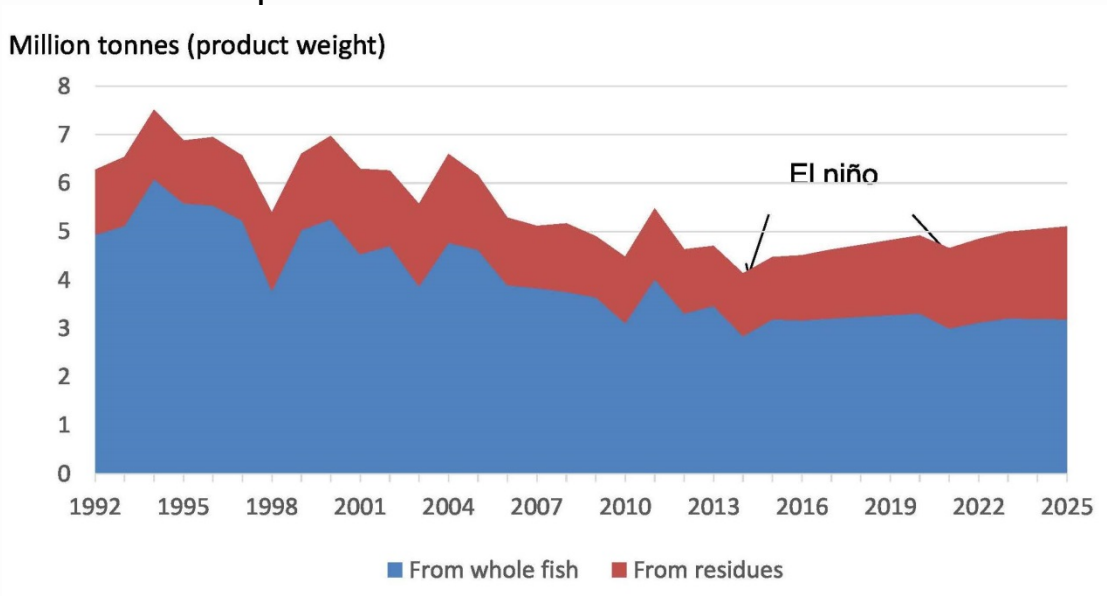
'000 tonnes	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Ave 2011 - 2014**
Peru	1,430	1,347	789	1679	841	1,115	524	852	1,040
Thailand	468	408	500	495	487	450	460	420	473
China PR	141	160	465	530	535	560	450	400	518
Chile	692	639	509	549	483	320	397	322	437
Vietnam	46	56	70	195	245	275	310	285	256
USA	216	214	217	274	259	235	223	263	248
Denmark	163	180	191	163	89	139	165	206	139
Japan	204	205	202	183	186	183	186	184	184
Norway	142	137	153	107	98	96	144	167	111
Iceland	140	103	84	91	133	121	92	153	109
Ecuador	100	98	109	109	116	128	103	125	114
Morocco	77	100	113	99	77	90	135	116	100
India	63	52	53	68	67	76	120	103	82
Russia	75	75	80	77	82	85	84	93	82
Malaysia	44	45	46	109	25	102	109	90	86

Source – 2011 – 2015 figures from IFFO Fishmeal and Fish Oil Statistical Yearbook 2016. 2008 – 2010 figures from IFFO Fishmeal and Fish Oil Statistical Yearbook 2013.

WORLD FM cont'd - production

Nearly 20 Mt of raw material is used annually for the production of FM and FO, of which around 14 Mt comes from the whole fish, nearly half of which is in South America. Around 3.7 Mt of by-product comes from the processing of wild caught fish from Europe producing around 1.2 Mt of this total. An estimated 1.9 Mt comes from aquaculture, of which 0.8 Mt is in Asia, principally Vietnam and Thailand.

3.5 Fishmeal production – overview of raw material used



Source: FAO presentation, EUfishmeal Symposium on future perspectives of fishmeal and fish oil. August 2016.

3.6 Fishmeal production – raw material used (000t)

Region *'000 tonnes*	**Whole fish**	**By-product from wild capture**	**By-product from aquaculture**	**Total Raw material used**
Europe	1,502	1,165	331	2,998
Asia (exc China)	2,577	827	851	4,255
China	1,251	168	367	1,787
M East	188	32	19	240
CIS	260	103	-	364
Africa	650	222	6	877
S. America	6,810	768	331	7,909
N. America	730	427	31	1,188
Oceania	11	42	13	66
Totals	**13,980**	**3,754**	**1,949**	**19,683**

Source: Institute of Aquaculture, University of Sterling and IFFO, July 2016.

WORLD FM cont'd - production

3.7 Fishmeal production – raw material from by-product (000t)

Region *'000 tonnes*	From whole fish	From By-product	Total	% from By-product
Europe	320	381	701	54
Asia (exc China)	580	454	1,034	44
China	281	152	433	35
M East	42	13	55	23
CIS	57	27	84	32
Africa	146	60	206	29
S. America	1,532	289	1,821	16
N. America	170	11	288	41
Oceania	2	14	16	85
Totals	**3,131**	**1,508**	**4,639**	**33**

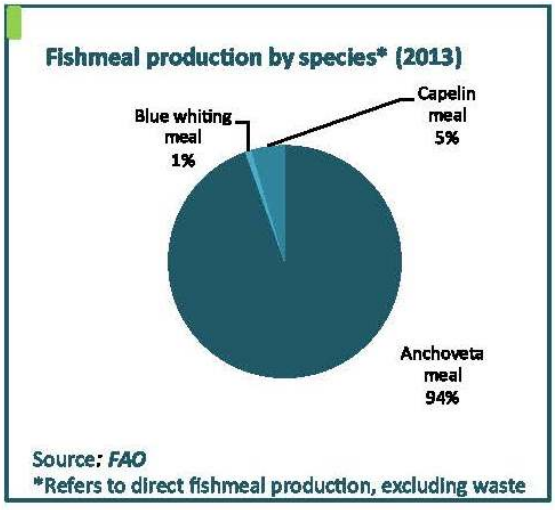
Source: Institute of Aquaculture, University of Sterling and IFFO, July 2016.

3.8 Fishmeal production – main species used

Category	Species	Total %
Fish trimmings and by-products	Herring	11%
	Various species	10%
Fish trimmings and by-products total		21.2%
Forage fish	Anchovy	40%
	Sandeel	9%
	Sprat	8%
	Menhaden	8%
	Various species	14%
Forage fish total		78.4%
Other marine ingredients	Krill	0.4%
Other marine ingredients total		0.4%

Source: EWOS Presentation. IFFO Annual Conference. October 2011.

3.9 Fishmeal production – main species used 2013



Source: Globefish.

WORLD FM cont'd - production

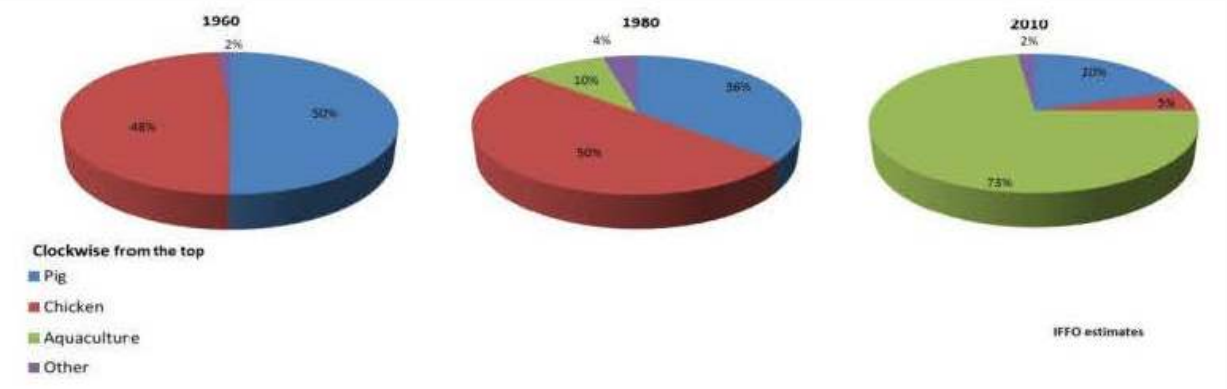
3.10 Key feed manufacturers – species used in fishmeal production – Biomar, Skretting and EWOS, 2015

	Biomar		Skretting	EWOS (FM and FO)
Species	**Volume MT**	**Share %**	**Share %**	**Share %**
Whole forage fish				
Blue whiting	35,149	22	33	12.8
Anchoveta	33,625	21	14	28.2
Sardine	24,862	16		7.2
Capelin	18,005	11	Icelandic 8	6.8
			Barents Sea 3	
Krill	10,114	6		
Lesser sand eel	8,380	5	7	
Sprat	2,661	2	European 11 Baltic 3	4.4
Herring – Icelandic summer spawning		2		
Herring – Norwegian spring spawning		1		
Menhaden	1,996	1		3.3
Other	1,939	1		5.0
Norway pout	1,824	1	2	
Jack mackerel	1,731	1		
Other marine - krill				0.08
Total marine	**159,459**	**87%**	**83%**	**67.7%**
Trimmings				
Herring - Norwegian spring spawning			7	16.3
Herring - Icelandic summer spawning			1	
Capelin			Barents Sea 1	1.1
Unidentified/various			8	3.5
White fish offal				7.8
Hake				1.0
Atlantic mackerel				2.5
Total Trimmings	**19,174**	**12%**	**17%**	**32.2%**
Certification				
IFFO RS approved fisheries		**92%**	**96%**	**93%**

Sources: BioMar Annual Sustainability Report 2015, EWOS Annual Sustainability Report 2015, Skretting Annual Sustainability Report 2015.

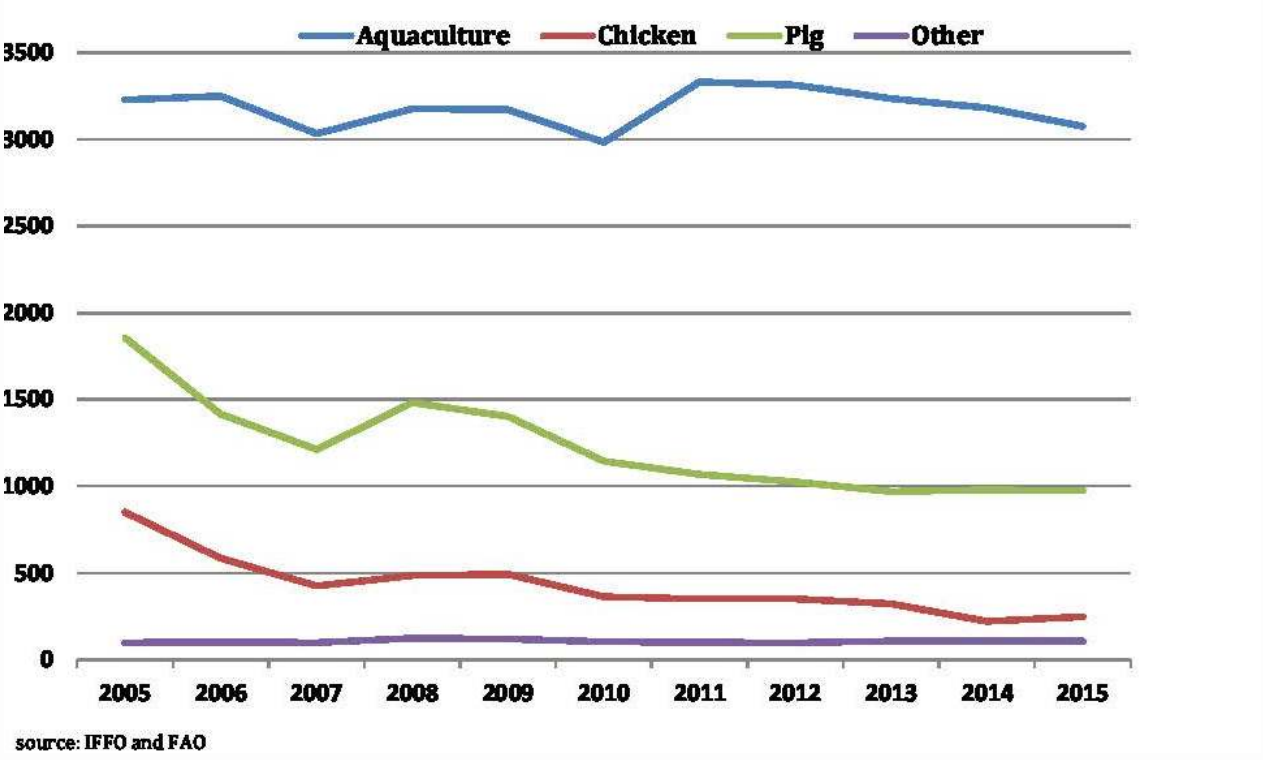
WORLD fishmeal use by sector

3.11 Changing uses of fishmeal from land animal feed to fish feed 1960 to 2010



Source: www.iffo.net

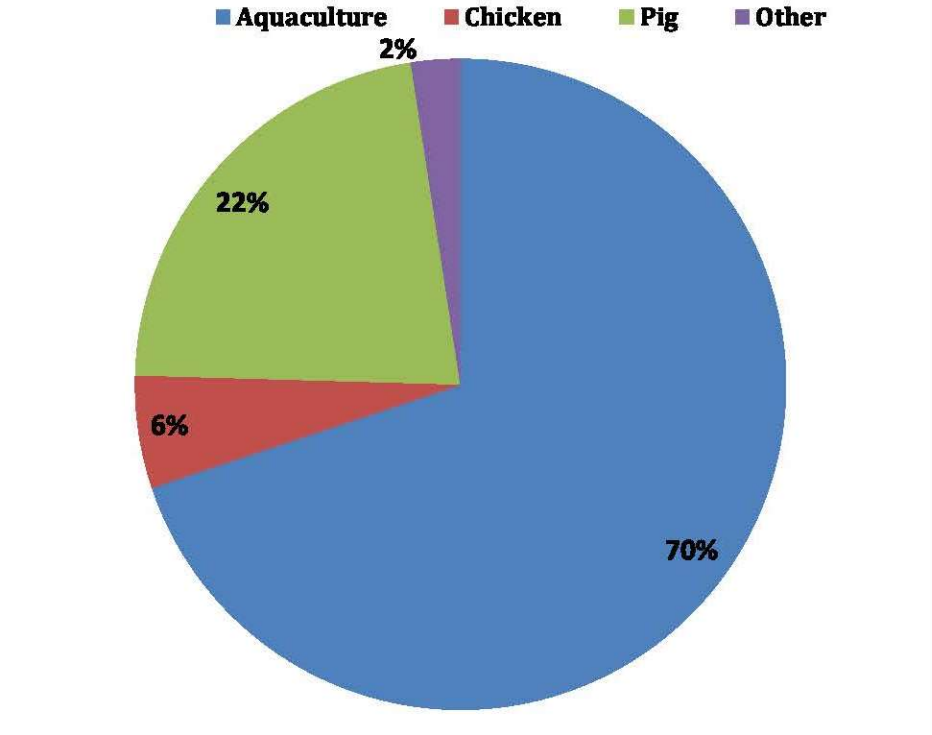
3.12 World fishmeal market use by sector 2005 – 2015 (000Mt)



Source – IFFO Fishmeal and Fish Oil Statistical Yearbook 2016.

WORLD FM cont'd – use by sector

3.13 World fishmeal market use by sector in 2015 (000Mt)



Source – IFFO Fishmeal and Fish Oil Statistical Yearbook 2016.

WORLD FM – imports and exports

3.14 Fishmeal exports by top 15 countries 2008 to 2015 (ranked according to 2015 figures) (000Mt)

'000 tonnes	2008	2009	2010	2011	2012	2013	2014	2015	Ave 2011 - 2014
Peru	1,560	1,538	1,084	1,281	1,328	849	850	705	1,077
Denmark	209	207	208	211	185	197	177	203	192
Chile	521	609	316	331	306	236	255	192	282
Thailand	21	26	110	73	63	126	172	155	108
USA	89	79	77	183	188	149	160	148	170
Germany	20	20	30	197	232	168	203	144	200
Iceland	158	94	70	90	120	121	80	144	103
Morocco	76	92	89	67	72	84	134	110	89
Ecuador	81	91	81	89	93	99	79	70	90
Norway	64	27	22	25	18	21	35	64	25
Russia	46	33	47	51	46	47	50	62	48
S Africa Rep				39	59	18	52	57	42
Mauritania	11	24	33	32	32	29	66	56	40
India	9	14	13	10	11	25	52	48	24
Mexico	80	94	57	62	113	106	73	39	89

Source – 2011 – 2015 figures from IFFO Fishmeal and Fish Oil Statistical Yearbook 2016. 2008 – 2010 figures from IFFO Fishmeal and Fish Oil Statistical Yearbook 2013.

WORLD FM cont'd – imports and exports

3.15 Fishmeal imports by top 15 countries 2008 to 2015 (ranked according to 2015 figures) (000t)

'000 tonnes	2008	2009	2010	2011	2012	2013	2014	2015	Ave 2011 - 2014
China PR	1,349	1,308	1,038	1,212	1,249	980	1,041	1,030	1,102
Japan	310	282	324	236	257	199	253	230	235
Norway	242	328	206	230	249	214	225	182	220
Taiwan	148	180	156	154	183	138	165	143	156
Germany	20	20	30	166	228	167	215	143	184
Vietnam	125	118	93	84	91	81	105	96	91
Denmark	115	95	122	119	153	107	89	87	111
Turkey	55	52	50	44	65	73	81	79	68
Indonesia	68	67	61	100	94	99	79	64	87
Canada	46	45	61	52	51	43	59	63	54
Greece	96	93	70	54	66	65	72	63	64
UK	92	114	101	83	74	65	62	57	68
South Korea	43	48	47	36	44	35	53	49	43
USA	38	34	39	34	43	47	53	49	45
Chile				60	63	65	72	47	61

Source – 2011 – 2015 figures from IFFO Fishmeal and Fish Oil Statistical Yearbook 2016. 2008 – 2010 figures from IFFO Fishmeal and Fish Oil Statistical Yearbook 2013.

WORLD FM – fishmeal composition

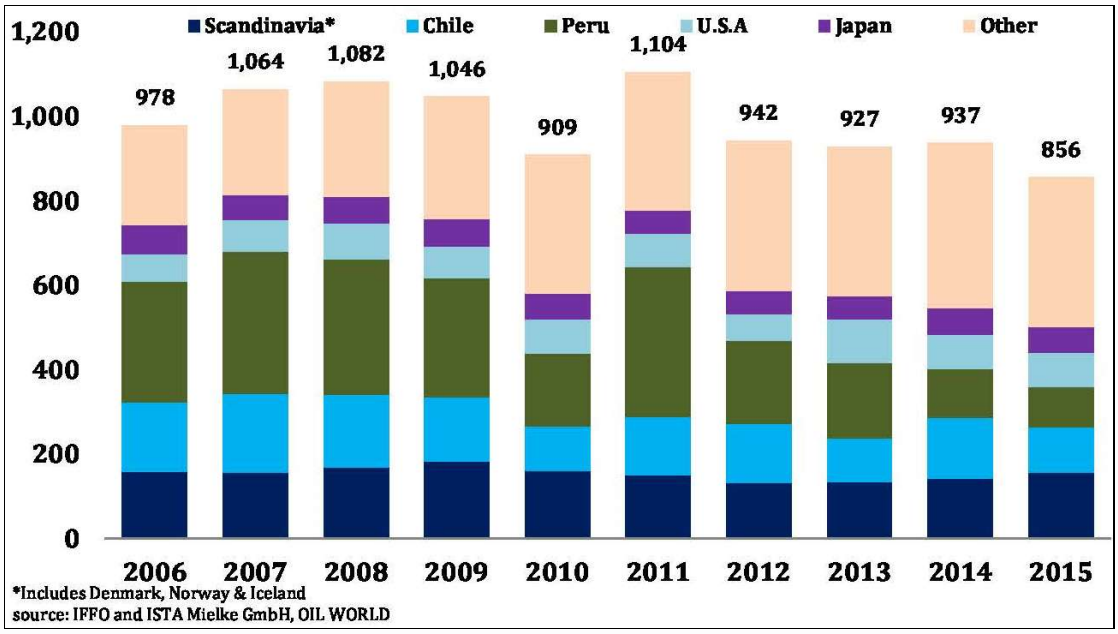
3.16 Composition of 1st, 2nd and 3rd grade fishmeal

Fishmeal	1st Grade	2nd Grade	3rd Grade
Protein (not less than)	60%	55%	50%
Ash (not more than)	26%	28%	30%
Salt (not more than)	3%	3%	3%
Humidity (not more than)	10%	10%	10%
Remaining (not less than)	2%	2%	2%

Source – Oxfam. Mapping shrimp feed supply chain. March 2014.

4. WORLD production, supply and consumption of fish oil

4.1 World fish oil production 2006 - 2015 ('000Mt)



Source – IFFO Fishmeal and Fish Oil Statistical Yearbook 2016

4.2 Fish oil production by top 15 countries 2008 to 2015 (ranked according to 2015 figures) (000Mt)

'000 tonnes	2008	2009	2010	2011	2012	2013	2014	2015	Ave 2011 - 2014
Chile	171	152	105	139	140	103	144	107	126
Peru	320	282	173	354	195	178	115	94	187
USA	86	76	61	79	63	104	80	83	82
Japan	62	64	60	55	55	54	62	60	57
Denmark	56	72	67	54	33	43	51	55	47
Norway	39	42	40	45	41	42	58	51	48
Iceland	72	62	43	49	56	46	32	48	46
Vietnam	26	20	49	28	30	40	53	48	40
China PR	32	38	44	47	45	50	45	40	45
Morocco	25	40	43	22	29	20	35	28	27
Thailand	6	6	8	24	24	22	23	21	23
India	4	5	12	17	23	21	37	20	23
Ecuador	13	10	13	16	17	19	12	16	16
Mauritania				4	12	8	16	14	11
Germany	5	6	6	10	11	12	16	12	12

Source – 2011 – 2015 figures from IFFO Fishmeal and Fish Oil Statistical Yearbook 2016. 2008 – 2010 figures from IFFO Fishmeal and Fish Oil Statistical Yearbook 2013.

WORLD FO contd – production

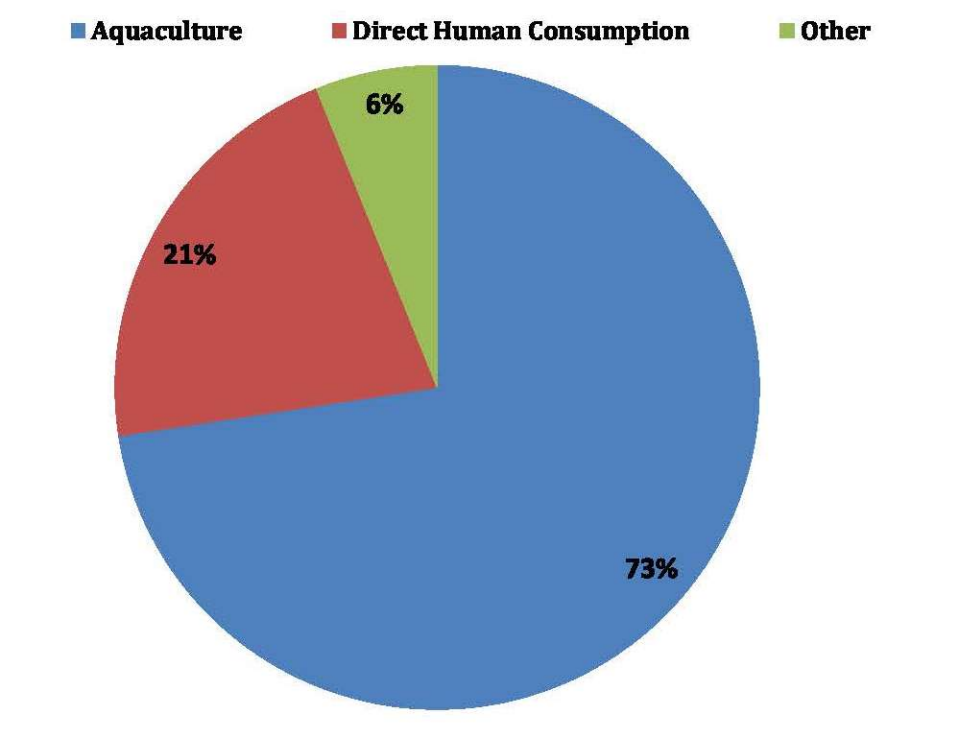
4.3 Key feed manufacturers – species used in fish oil production – Biomar and Skretting, 2015

	Biomar		Skretting
Species	**Volume MT**	**Share %**	**Share %**
Whole forage fish			
Anchoveta	15,120	17	19
Sardine	14,797	17	
Capelin	7,588	8	Icelandic 6 Barents Sea 1
Menhaden	5,168	6	10
Alaska pollock	4,365	5	
Lesser sand eel	4,363	5	10
Blue whiting Sprat	2,061 1,563	2 2	9 North Sea 5 Baltic 4
Herring	1,372	2	Norwegian spring spawning 2
Anchovy	1,279	1	
Other	1,256	1	
Norway pout			1
Total marine	**89,438**	**66**	**67**
Trimmings			
Herring - Norwegian spring spawning			9
Herring – Icelandic summer spawning			2
Capelin			Icelandic 1
Unidentified/various			12
Total Trimmings	**30,506**	**34**	**33**
Certification			
IFFO RS approved fisheries		**86%**	**94%**

Sources: BioMar Annual Sustainability Report 2015, Skretting Annual Sustainability Report 2015.

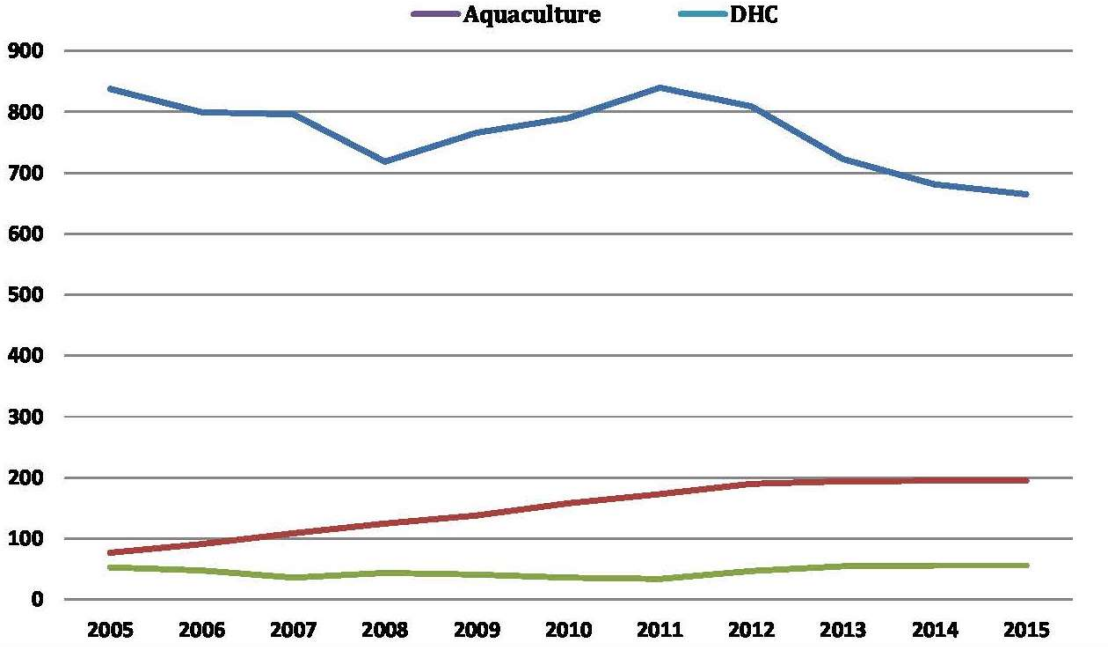
WORLD fish oil – use by sector

4.4 World fish oil market use by sector in 2015 (000Mt)



Source – IFFO Fishmeal and Fish Oil Statistical Yearbook 2016.

4.5 World fish oil market use by sector 2005 – 2015 (000Mt)



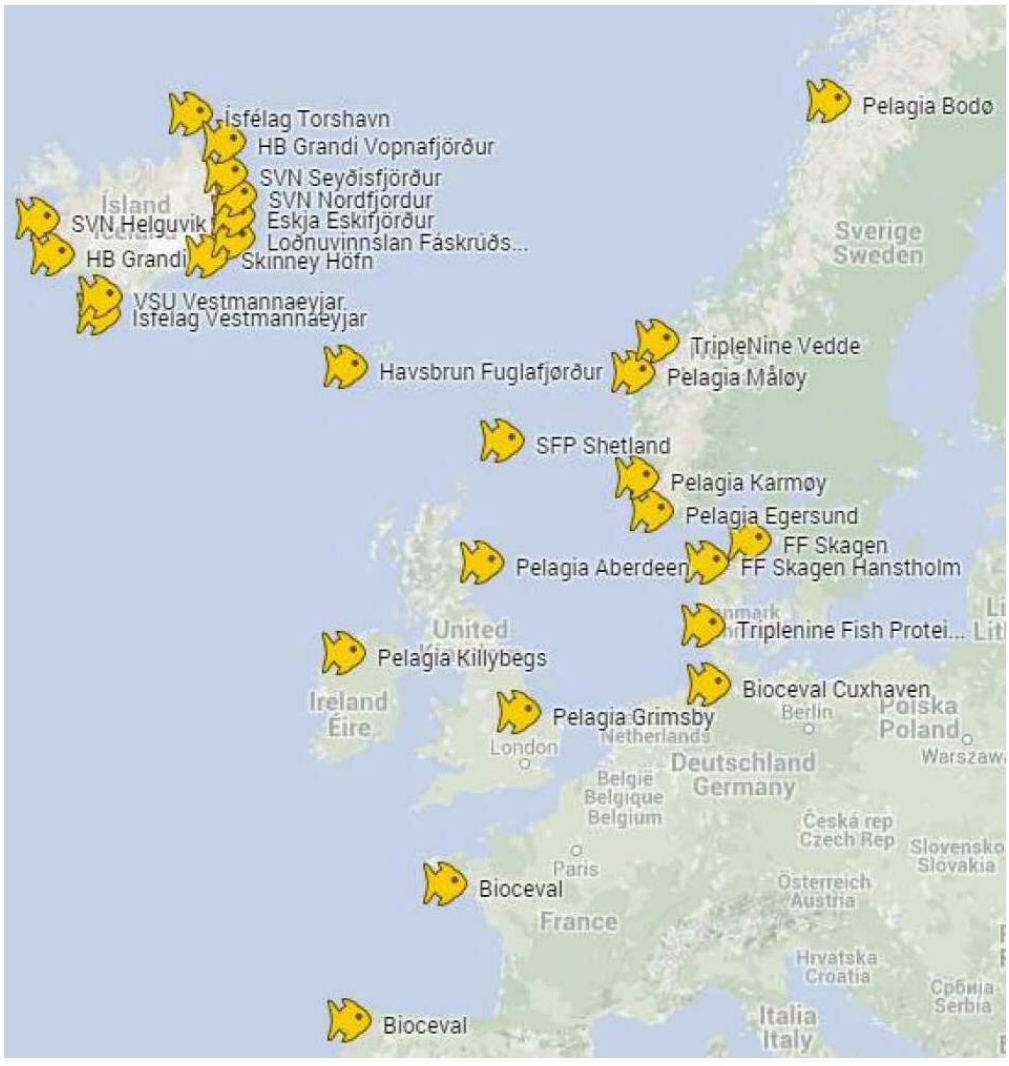
Source – IFFO Fishmeal and Fish Oil Statistical Yearbook 2016.

5. European production, supply and consumption of fishmeal and fish oil

The total European production of fishmeal and fish oil is approximately 500,000 metric tonnes of fishmeal and 190,000 tonnes of fish oil a year and the total value of production is approximately 1,000 million €/year. Exports go to a large variety of countries.

Production is based on landings of small, oily, short-lived species such as blue whiting, capelin, sand eel, Norway pout and sprat as well as by-products (trimmings) from the consumption fish processing sector. Production varies according to the access of raw material but the overall trend over the last 5-10 years has been a fall in production.
Source: EUfishmeal.

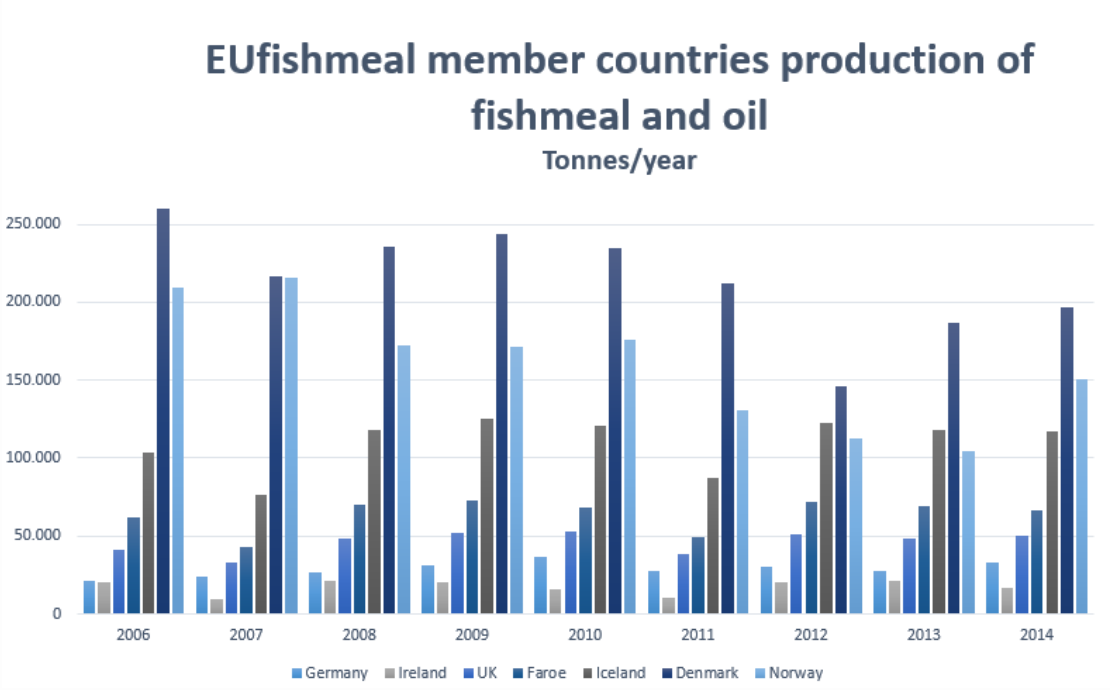
European fishmeal and fish oil factories (20)



Source: EUfishmeal, EUfishmeal Symposium on future perspectives of fishmeal and fish oil. August 2016.

European FM cont'd - production

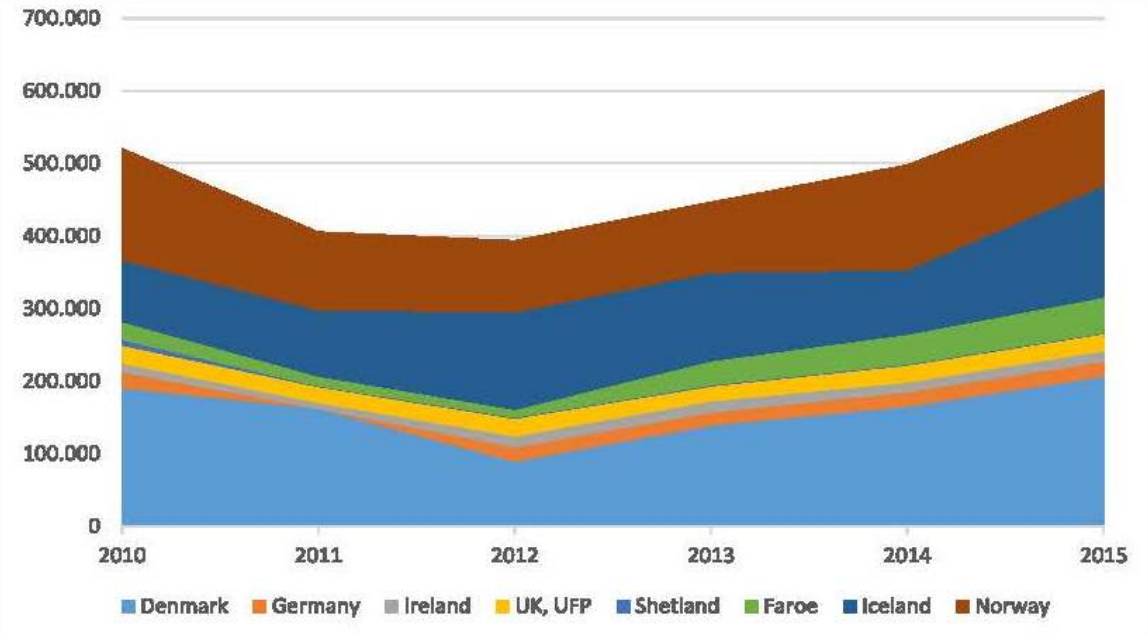
5.1 European fishmeal production 2006 to 2014



Source: EUfishmeal.

5.2 European fishmeal production 2010 to 2015

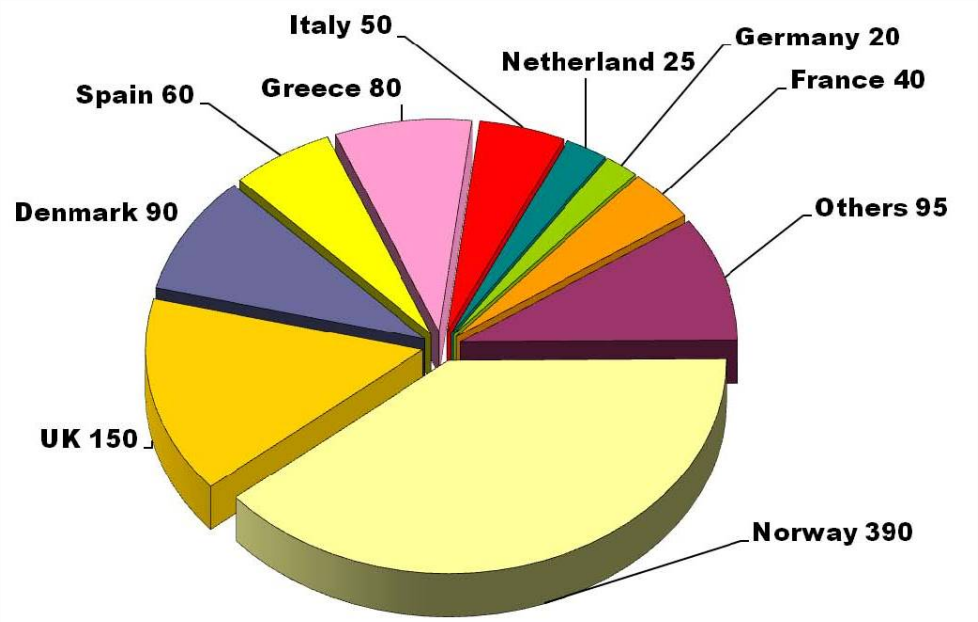
Tonnes



Source: EUfishmeal, EUfishmeal Symposium on future perspectives of fishmeal and fish oil. August 2016.

European FM cont'd – use by country

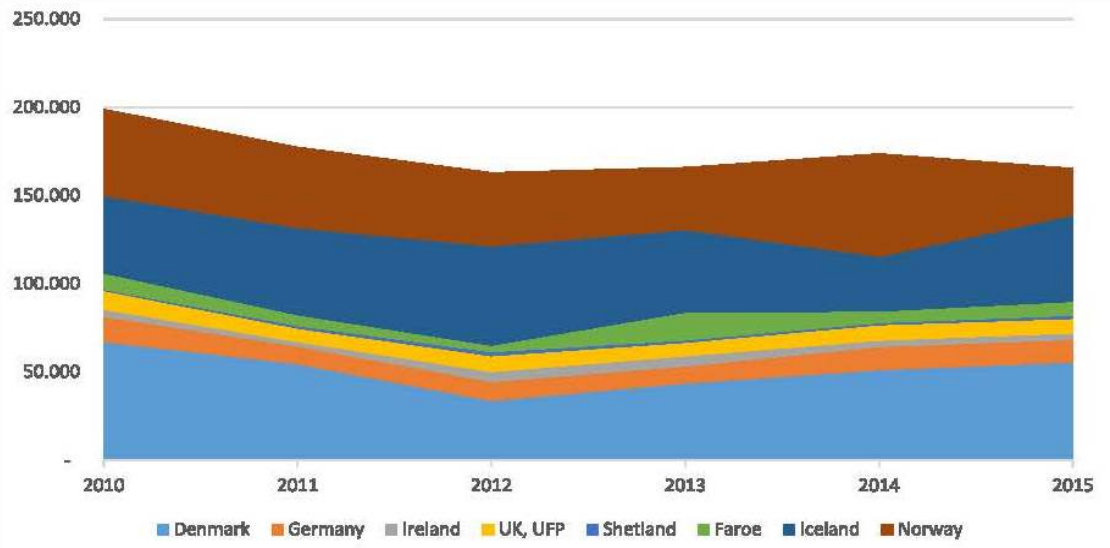
5.3 European fishmeal consumption 2009 (EU-27 + Norway) (1,000,000 Mt)



Source: Resource supply from sustainably managed sources - using the example of fishmeal. Michael Lutz, Koster Marine Proteins. 2010.

European fish oil – production

5.4 European fish oil production 2010 to 2015 (Tonnes)

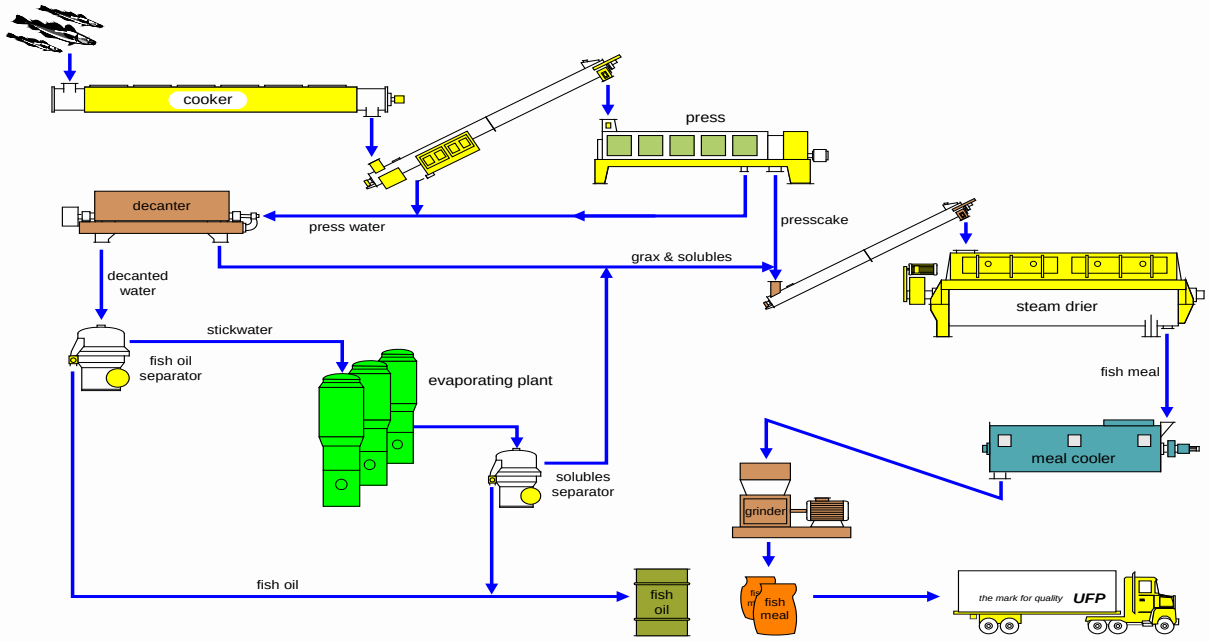


Source: EUfishmeal, EUfishmeal Symposium on future perspectives of fishmeal and fish oil. August 2016.

6. UK production, supply and use of fishmeal and fish oil

UFI Grimsby – production process

UFI is part of Pelagia AS, a leading producer of pelagic fish products for human consumption, and an important supplier of essential ingredients in all kinds of fish and animal feed including protein concentrate, fishmeal, and fish oil. The company operates 26 factories in Norway, Denmark, the UK and Ireland. There are UFI facilities in Aberdeen, Killybegs and Grimsby. UFI Grimsby predominantly processes trimmings from cod, haddock and salmon and can process up to 300 tonnes per day.



6.1 Summary of UK fishmeal imports – 2009 to 2015

'000 tonnes	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Norway	2.6	3.7	3.1	0.1	5.6	11.6	12.7
Ireland	22.1	11.2	2.6	9.7	12.5	9.9	10.6
Peru	53.1	33.3	28.6	24.2	11.9	14.6	2.3
Germany	2.5	14.9	14.9	10.4	7.3	1.2	5.5
Denmark	19.1	29.7	23.7	10.3	11.2	11.4	11.6
Chile	4.7	1.2	1.5	1.9	2.9	2.0	0.3
Spain	0.0	0.0	0,1	0.4	1.4	9.7	2.4
Iceland	1.6	2.8	3.5	7.3	5.7	2.3	
France	1.2	1.1	1.8	1.4	1.8	1.1	
Netherlands			0.3	0.1	0.5	1.4	0.1
Sub total			**74.8**	**57.1**	**53.4**	**61.9**	**45.4**
Others	7.6	3.5	9.2	16.9	11.7	1.8	12.5
Total	**114.5**	**101.4**	**83.9**	**74.0**	**65.1**	**63.7**	**57.9**

Source: 2009 and 2010 Globefish; 2011 – 2015 IFFO Fishmeal and Fish Oil Statistical Yearbook 2016.

UK FM cont'd – production and imports

6.2 Summary of UK fishmeal supply – 2002 to 2008

000 tonnes	2002	2003	2004	2005	2006	2007	2008
UK Consumption	c237.8	c231.2	184.2	187.6	168.8	122.5	115.1
Imports from EU	33.3	30.5	48.8	57.1	62.2	39.8	40.5
Imports from non-EU	154.5	150.7	91.1	87.8	74.4	45.3	46.8
UK production	50	50	50	53	44	44	42
UK exports			5.7	10.3	11.8	6.6	14.2

Source – Trade sources.

6.3 Sources of UK fishmeal imports 2000 to 2008

000 t	2000	2001	2002	2003	2004	2005	2006	2007	2008
Imports from non EU									
Peru	70.1	54.7	28.9	47.0	19.4	23.2	37.6	21.2	24.6
Iceland	57.5	52.5	64.2	49.1	42.5	34.6	13.6	3.8	10.3
Norway	32.1	28.0	35.6	16.5	9.5	3.7	7.9	9.9	3.8
Chile	13.6	18.9	11.6	21.4	6.5	12.6	10.9	5.1	0.2
Faroe Is	8.7	11.7	14.2	9.7	11.5	10.9	2.3	3.4	7.9
M'rocco	4.5	4.8	0	7.0	1.7	2.8	2.1	1.9	0
Sub tot	**186.5**	**172.6**	**154.5**	**150.7**	**91.1**	**87.8**	**74.4**	**45.3**	**46.8**
Imports from EU									
Denm'k	6.1	9.6	17.8	14.3	24.7	16.1	25.2	12.9	22.0
G'many	33.8	26.0	9.6	8.6	8.2	25.4	30.8	13.5	8.3
Eire	14.2	19.9	5.9	6.0	15.1	11.7	6.1	11.6	9.2
N'Lnds	0	1.7	0	1.6	0.8	3.9	0.1	1.8	1.0
Sub tot	**14.1**	**57.2**	**33.3**	**30.5**	**48.8**	**57.1**	**62.2**	**39.8**	**40.5**
Others	**2.1**	**3.2**	**4.5**	**2.2**	**2.5**	**3.0**	**2.9**	**2.6**	**3.6**
Total	**242.7**	**233.0**	**192.3**	**183.4**	**142.5**	**148.0**	**139.4**	**87.7**	**91.0**

Trade sources.

6.4 Fishmeal consumption and imports - UK 1996 to 2008

000' tonnes	UK consumption	UK imports	From EU	From non EU
1996	272,000	241,995	*Na*	*Na*
1997	330,000	284,788	34,289	250,499
1998	260,000	238,602	34,968	203,634
1999	270,000	221,056	41,260	19,796
2000	290,000	240,951	50,226	190,725
2001	280,000	232,765	60,183	172,582
2002	240,000	191,990	36,473	155,517
2003	233,000	183,442	31,486	151,956
2004	192,000	142,492	51,227	91,265
2005	187,000	136,892	48,770	88,122
2006	189,000	138,973	62,634	76,339
2007	134,800	90,800	44,500	46,300
2008	134,100	92,100	40,200	51,900

Source: Trade sources.

UK FM cont'd – use and stock status

6.5 Feed grade fish stocks used to produce fishmeal and fish oil

Trade Sources:	% of FM used in UK			How stock is used	Status of fish stocks at June and Oct 2016
	2007	2011	2013		
EUROPE AND THE ANTARTIC – *Source ICES and FishSource*					
Sandeel *Ammody-tidae*	Less than 3%	8%	2.2%	Not used for human consumption (HC)	**Main North Sea:** Adult stock is large enough to ensure an optimal use in the long term. However fishing pressure is unknown. Improvement in Spawning Stock Biomass (SSB).
Sprat *Sprattus Sprattus*	3%	8%	1.1%	Potential uses for HC but mainly used for fishmeal (FM).	**North Sea:** Adult stock size is large enough and fishing pressure is low enough to ensure a sufficient amount of offspring can be produced. SSB has declined.
Capelin *Mallotus villosus*	Less than 1%	2%	5.3%	Roe used for HC. Frozen capelin for specific limited markets. Mainly used for FM.	**Barents Sea:** Estimate of the 2015 year class at age 1, found to be well below the long-term average. **Icelandic:** Adult stock size is too small to produce a sufficient amount of offspring to maintain the stock. Fishing pressure is unknown.
Norway pout	Less than 1%	2%	2.0%	Not used for HC.	Stock size has increased and is above precautionary levels. Fishing mortality has been below the long-term average since 1995.
Blue Whiting *Micromes-istius Poutassou*	21%	1%	3.6%	Mainly used for FM. Limited use for HC due to processing difficulties.	SSB has increased from 2010 and is above the MSY biomass trigger. Large 2013 and 2014 year classes - much more abundant than assumed in 2015.
Herring *Clupea harengus*	3%	1%	0.2%	Primarily HC, but non-food grade fish and trimmings may be used for FM.	**Icelandic:** Adult stock size is large enough, but fishing pressure has been increasing. **Norwegian:** Stock is declining and estimated close to MSY biomass trigger.
Mackerel *Scomber scombrus*	n/a	n/a	4.1%	Primarily HC, but non-food grade fish and trimmings may be used for FM.	**NEA:** SSB has been above MSY Biomass trigger since 2009. Fishing mortality (F) declining but above MSY.
Boar fish *Capros aper*	n/a	n/a	5.9%	Currently for FM but HC market underway.	Stock status is currently unknown. Stock has declined sharply since the peak in 2010–2013 and is currently at a historic low.
Krill	n/a	n/a	1.1%	Mostly used for FM.	No recent stock assessment for *Euphausia superba.*
Trimmings	**38%**	**35%**	**50%**	**Generally small pelagic species (e.g mackerel, capelin, herring) and trimmings from the white fish processing sector (e.g. cod).**	
SOUTH AMERICA/GULF – *Source FishSource*					
Anchovy *Engraulis ringens*	28%	38%	19.6 %	Very small amount used for HC. Majority used for FM.	Cumulative adverse environmental conditions have affected the stock since late 2013 with drastic changes in population dynamics. Surveys show the ability of this stock to recover rapidly.
Jack mackerel *Trachurus murphyi*	1%	3%		50% of Chilean jack mackerel used for HC and 50% for FM.	The stock is determined to still be at low levels but the population trend is estimated to be increasing.
Sardine *Strangome ra bentincki*	Less than 1%	1%	4.2%	Used for HC and FM	This stock is not considered to be overfished, nor is overfishing occurring. Recruitment has been oscillating in recent years, with a weak 2012-2013 class.
Gulf Menhaden *Brevoortia patronus*	n/a	1%	0.6%	Mostly used for FM and FO.	The stock is not overfished and overfishing is not occurring. Population fecundity well above benchmarks/fishing mortality well below benchmarks. Stock appears in very good shape.

UK fish oil production and imports

6.6 Summary of UK fish oil imports – 2011 to 2015

'000 tonnes	**2011**	**2012**	**2013**	**2014**	**2015**
Peru	2.4	8.0	1.5	2.3	12.3
France	1.9	1.3	1.8	3.1	3.6
Belgium	0.0	4.3	1.2	2.4	1.2
Ireland	1.2	2.1	0.8	1.2	1.0
Thailand	0.9	1.6	0.6	0.5	0.5
Iceland	3.9	2.2	0.7	0.5	0.5
Netherlands	0.2	2.8	0.1	0.1	0.3
China	0.0	0.0	0.0	0.1	0.2
Sweden	0.0	0.0	0.0	0.1	0.0
Sub Total	**10.5**	**22.5**	**6.8**	**10.3**	**19.7**
Other	**9.2**	**1.3**	**5.1**	**0.1**	**6.1**
Total	**19.7**	**23.8**	**11.8**	**10.4**	**25.8**

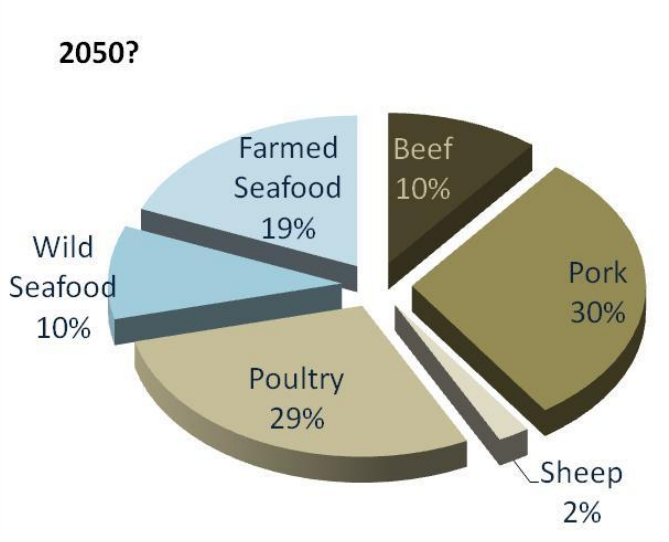
Source: IFFO Fishmeal and Fish Oil Statistical Yearbook 2016.

7a. Feeding fishmeal and oil to farmed land animals

Fishmeal as an ingredient is particularly suited to meet the demands of the contemporary food chain.

Fishmeal is primarily used in aquaculture feed, but is also used in used in poultry and pig diets and other markets (mainly pet food). Use in ruminant feed, which had been about 5-10% of the EU market, is zero, due to the precautionary EU ban on its use in ruminant feed as part of BSE controls.

- Fishmeal is fed to farm animals, not only to improve productivity, but also to protect health and welfare and reduce dependence on antibiotics and other drugs.
- Fishmeal has low antigenicity, making it easy for young animals to digest.
- Fishmeal has anti-inflammatory properties which improve animal's disease resistance.
- Fishmeal and fish oil are "functional feeds" – offering, through their high omega-3 content, specific health and welfare benefits to both farmed livestock and to the human population eating the animal products.



- *Assumes no growth in wild caught seafood*
- *Assumes similar relative seafood demand (29%)*
- *Assumes meat and seafood demand of 600 million tonnes*
- *Farmed seafood is roughly double 2006 production.*

Source: WWF presentation at Humber Seafood Institute Summit. September 2011.

Feeding FM and FO to farmed land animals cont'd

7a.1 Comparison of basic nutritive characteristics of various protein concentrates

	Crude Protein g/kg	Crude fat g/kg	Energy MJ DE/kg	Calcium g/kg	Phosphorus g/kg
Fishmeal (herring	720	100	11.0	55	33
White fishmeal	620	40	10.8	75	36
Skimmed milk	330	5	11.3	12.5	10.1
Low lactose whey	170	10	12.1	15	12
Whey	120	7	14.0	8.7	7
Dried blood	800	10	8.49	2.8	2.2

Source: IFFO 2002.

7a.2 Recommended rates of inclusion in diets for optimum benefit (pig and poultry feed)

Pig	**% inclusion**
Creep	5-10
Weaner	5-10
Grower	3-5
Finisher	3
Sow	3
Poultry	**% inclusion**
Chick rearing	Up to 3
Broiler	2-5
Layer	2
Breeder	1-5
Turkey	3-10
Pheasant/game	3-7
Dairy Cattle	
Late pregnancy	2.5-10
Lactating	5-10
Calves	2.5-10
Sheep	
Breeding ewes	
Pregnant	2-7.5
Lactating	5-10
Growing lambs	
Early weaned/ Intensively reared	2.5-7.5
Finishing lambs/ On forage diets	2.5-7.5
Reduce body fat/ On overfat lambs	5-10

Source: Nutritional advice in 2002.

Feeding FM and FO to farmed land animals cont'd

7a.3 Amino acid composition fishmeal/other protein sources

g/kg	Fishmeal	Soya bean	Barley (42)
Lysine	48	27	5
Methionine	16	6	2
Cystine	5	6	3
Threonine	25	17	4
Tryptophan	6	7	2
Leucine	43	38	8
Iso-leucine	25	28	4
Valine	28	22	6
Phenylalanine	23	21	6
Arginine	35	32	5
Histidine	17	11	2

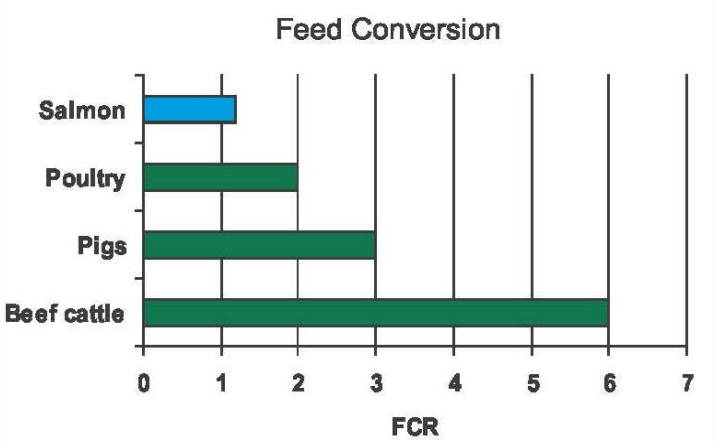
Source: IFFO 2002.

7a.4 A comparison of fishmeal with other protein sources

Feed Ingredient As received %	Fishmeal Chilean	Fishmeal Herring	*Fishmeal* White	Soyabean Meal – hipro	Milk Pwd – skimmed
Crude protein	66	71	66	48	34
Digestible CP	63	66	63	46	31
Essential amino acids:					
Total lysine	5.0	5.6	4.4	2.7	2.3
Available lysine	4.8	5.4	4.2	2.5	2.2
Methionine + cysteine	2.5	2.6	2.4	1.3	1.2
Tryptophan	0.8	0.8	0.6	0.8	0.4

Source: Reprinted in Fishmeal for Pigs from The Feeds Directory.

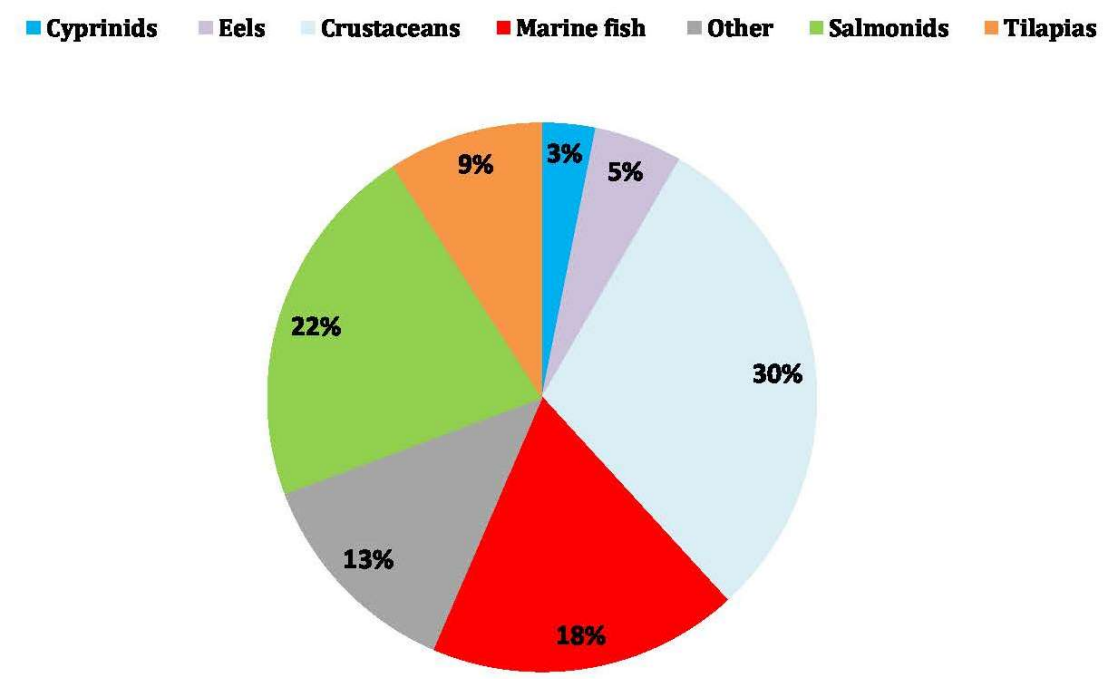
7a.5 Feed conversion comparison



Source: EWOS. 7th NSAF 'Outlook for global salmon supply, trade and prices'. March 2012.

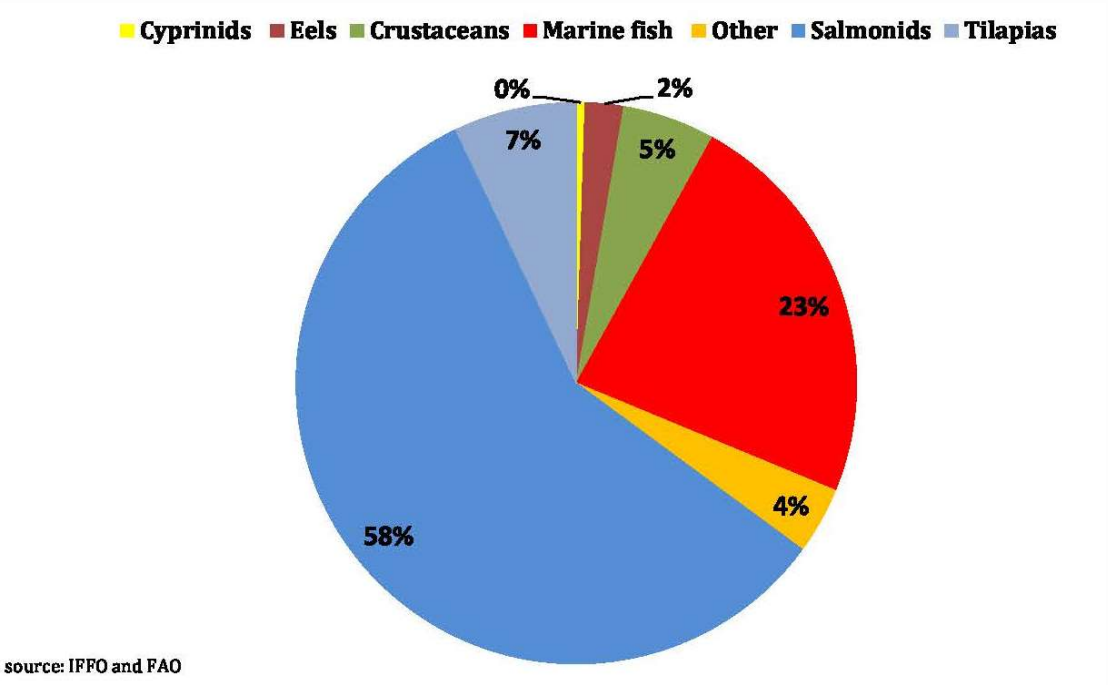
7b. Feeding fishmeal and fish oil to farmed fish – inclusion rates

7b.1 Use of fishmeal in aquaculture in 2015



Source: IFFO Fishmeal and Fish Oil Statistical Yearbook 2016.

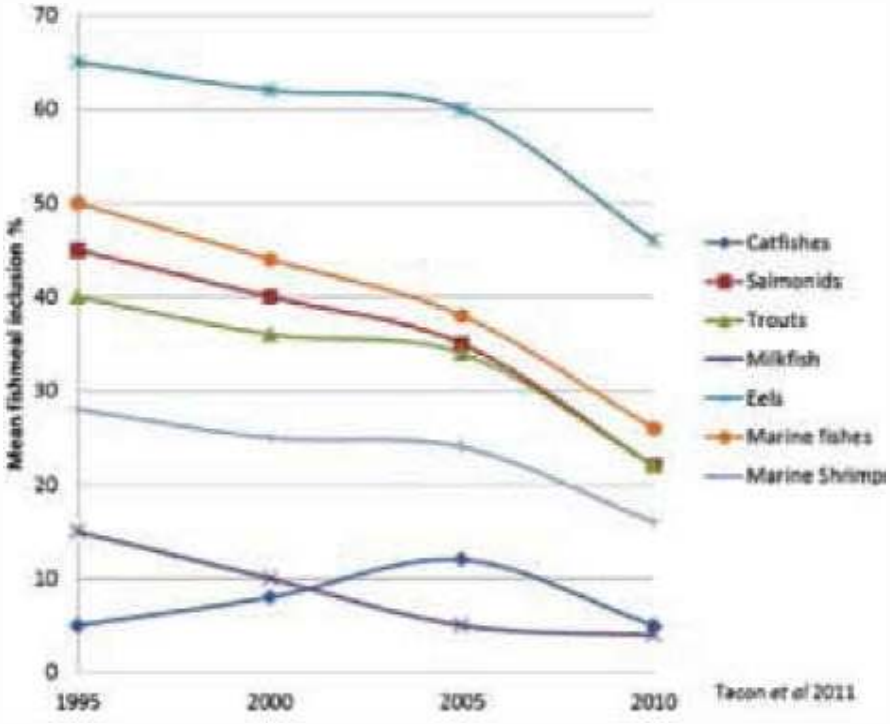
7b.2 Use of fish oil in aquaculture in 2015



Source: IFFO Fishmeal and Fish Oil Statistical Yearbook 2016.

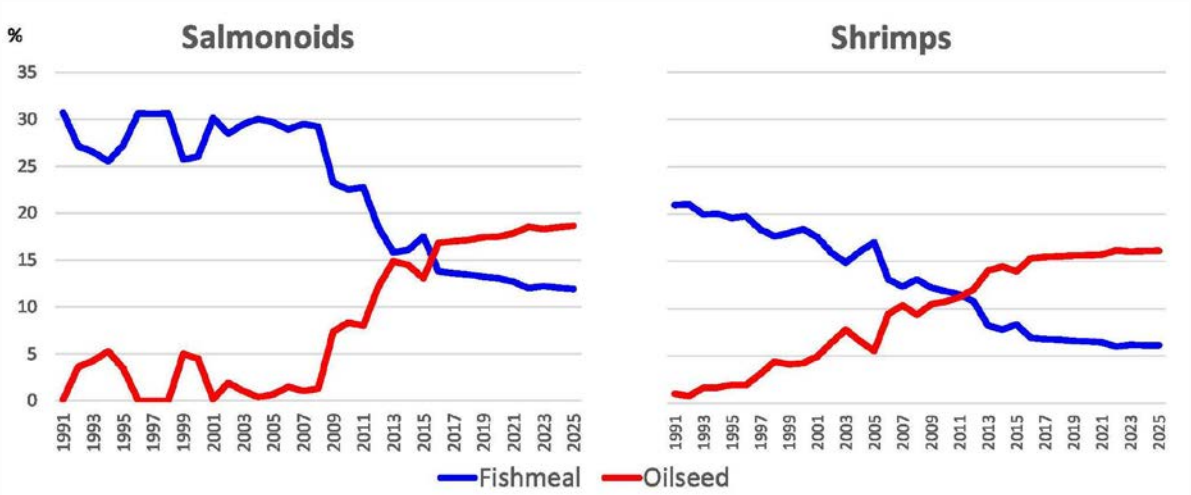
Feeding FM and FO to farmed fish contd – inclusion rates

7b.3 Dietary inclusion of fishmeal (%) in aquaculture feeds 1995 – 2011



Source: IFFO article. International Aquafeed. October 2012.

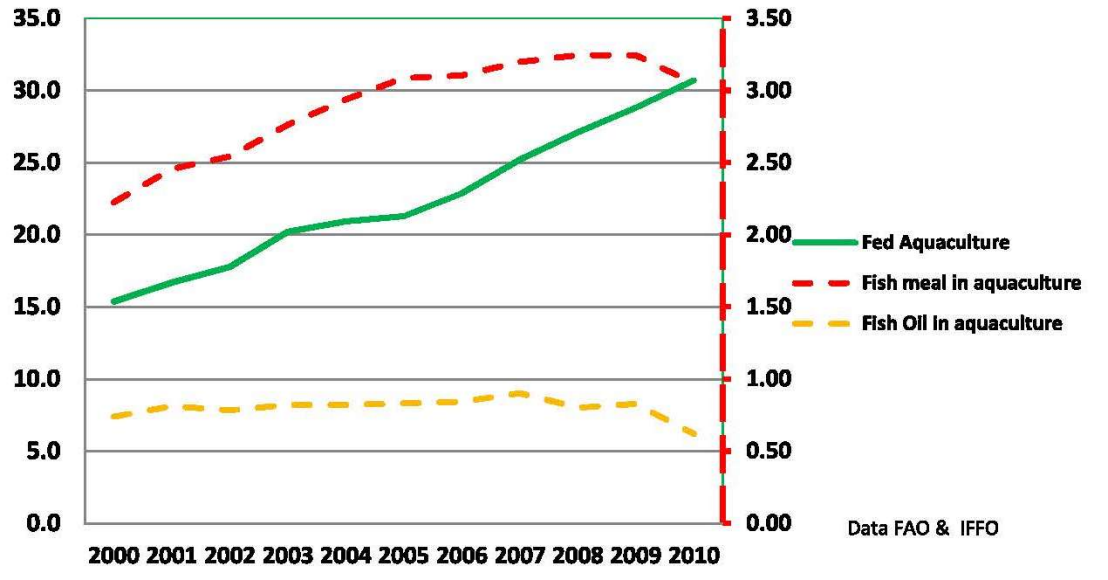
7b.4 Share of fishmeal in feed ratio- world average 1991-2025



Source: FAO presentation, EUfishmeal Symposium on future perspectives of fishmeal and fish oil. August 2016.

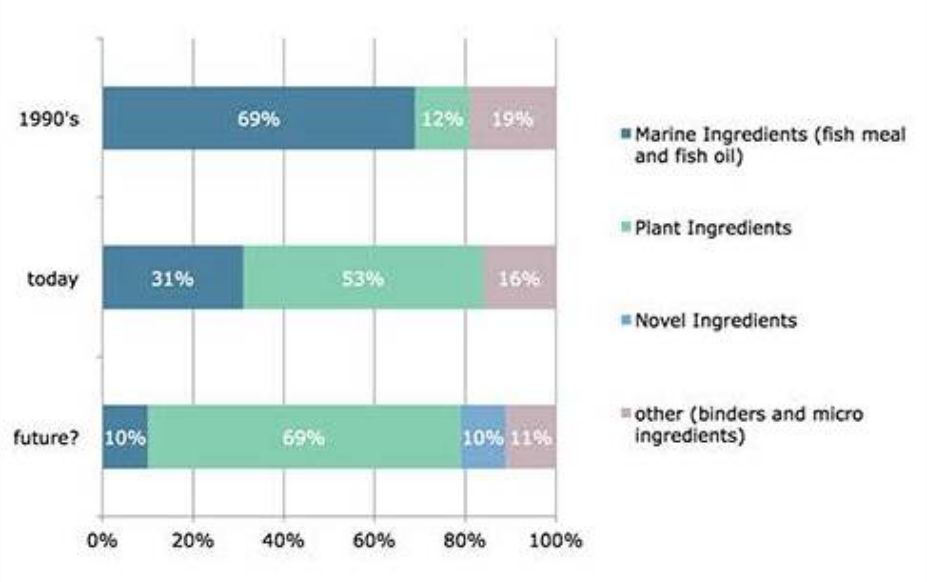
Feeding FM and FO to farmed fish contd – inclusion rates

7b.5 Fishmeal and fish oil consumption relative to growth of 'fed' aquaculture 2000 - 2010



Source: IFFO Positional Paper. February 2013. Is aquaculture growth putting pressure on feed fish stocks? And is the growth of aquaculture being restricted by finite supplies of fishmeal and fish?

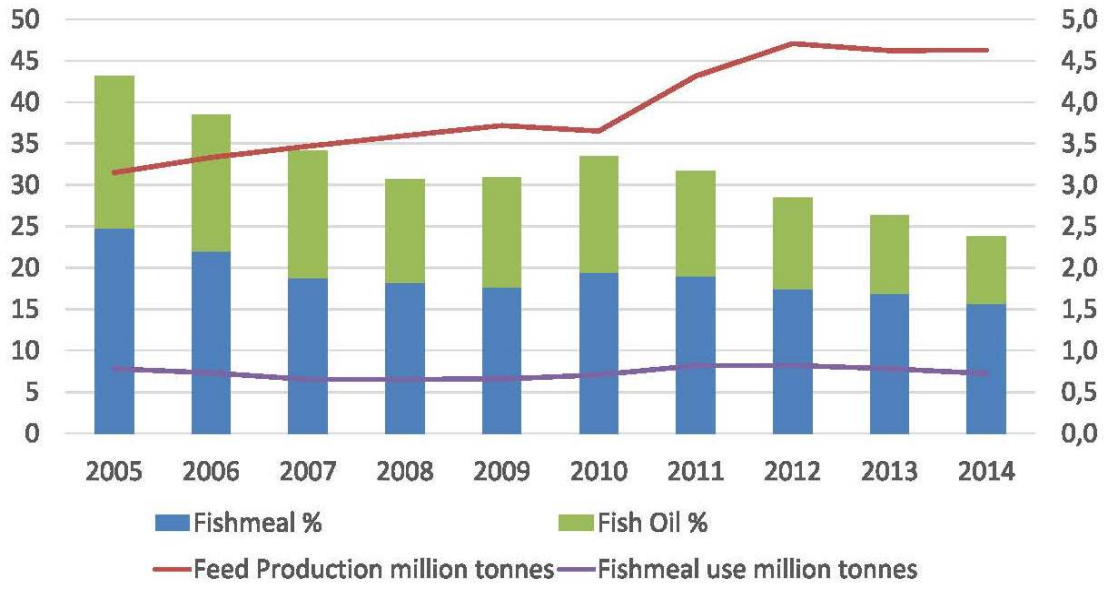
7b.6 Declining fishmeal inclusion rates in salmon diets



Source: The Appeal of Fishmeal: Fishmeal's Transformation from a Commodity to a High-Priced, Strategic Protein. Gorjan Nikolik, Rabobank, GOAL 2015.

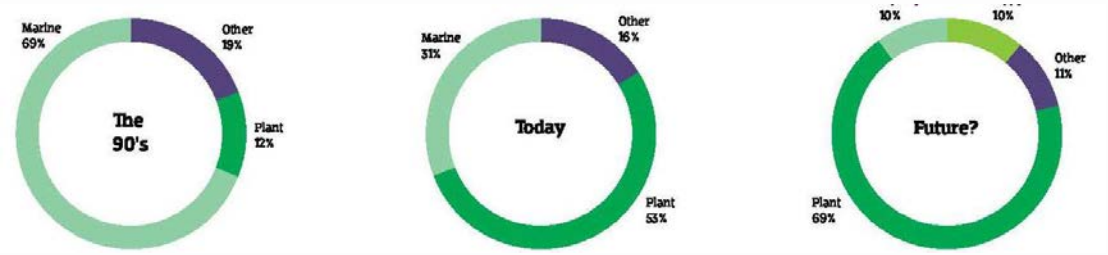
Feeding FM and FO to farmed fish contd – inclusion rates

7b.7 Marine ingredient inclusion in salmonid diets



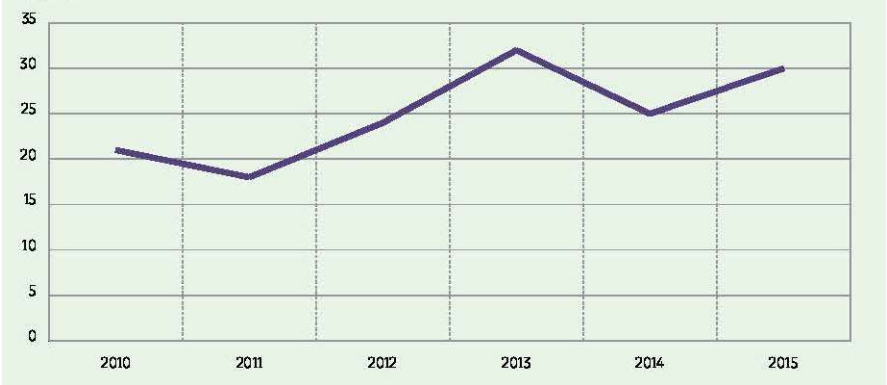
Source: IFFO presentation, EUfishmeal Symposium on future perspectives of fishmeal and fish oil. August 2016.

7b.8 Salmonid feed moving forward



Source: EWOS Annual Sustainability Report 2015.

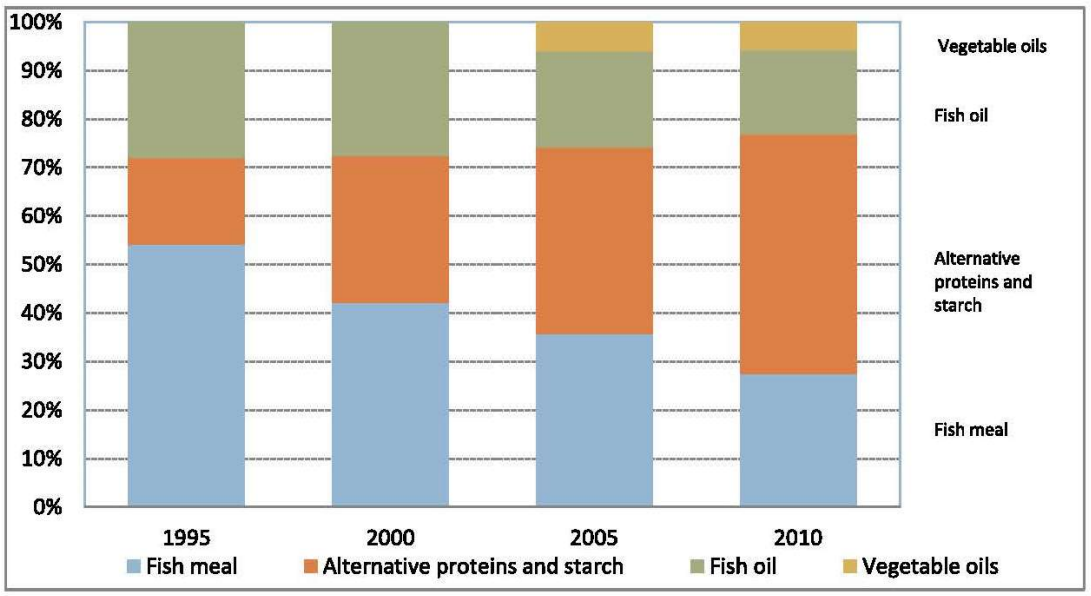
7b.9 Share of trimmings and byproducts in EWOS fishmeal and fish oil in salmon diets



Source: EWOS Annual Sustainability Report 2015.

Feeding FM and FO to farmed fish contd – inclusion rates

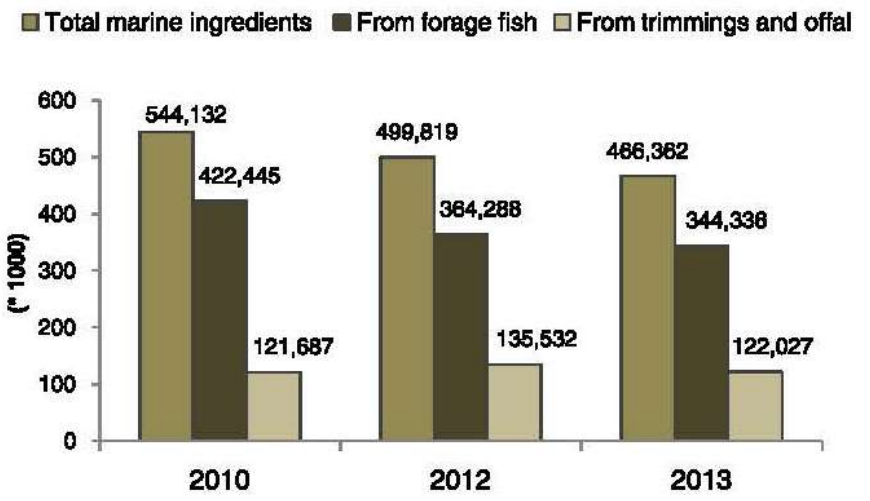
7b.10 Changing composition of salmon feeds – fishmeal and fish oil substitution



(UPDATE: For 2013 inclusion is 15 % fishmeal and the oil content is 1/3 fish oil and 2/3 vegetable oil . Some major producer grower diets are down to 10 % fishmeal.)

Source: IFFO Positional Paper. February 2013. Is aquaculture growth putting pressure on feed fish stocks? And is the growth of aquaculture being restricted by finite supplies of fishmeal and fish?

7b.11 Use of marine ingredients in Norwegian salmon feed 2010 – 2013 (Tonnes)



Source: Research article. Utilisation of feed resources in production of Atlantic salmon (Salmo salar) in Norway. June 2015.

Feeding fishmeal and fish oil to farmed fish – conversion efficiency

The fish in:fish out ratio (FIFO) indicates the overall quantity of wild caught fish used per quantity of cultured fish produced. The fish in/fish out ratio (FIFO) measures the amount of fishmeal and fish oil that is used to produce one weight equivalent of farmed fish back to wild fish weight equivalents, and the forage fish dependency ratio (FFDR) is the amount of wild caught fish used to produce the amount of fish meal and fish oil required to produce 1 kg of salmon.

According to the Aquaculture Stewardship Council standards, this measure is referred to as the feeder (forage) fish dependency ratio (FFDR), and should be calculated for both fishmeal and fish oil, using the inclusion levels of marine meals and marine oils in the feed recipe, multiplied by the feed conversion ratio and divided by their corresponding contribution factors.

7b.12 BioMar, Skretting and EWOS FFDR

	BioMar	Skretting	EWOS
FFDR fishmeal	0.68	0.6	0.33 Optiline range/0.51 Premium range
FFDR fish oil	1.05	1.7	1.07 Optiline range/1/05 Premium range
The Aquaculture Stewardship Council criteria for the FFDR for fishmeal is <1.35 and the FFDR for fish oil is < 2.95. Forage fish dependency ratios vary between countries due to customer preferences regarding marine ingredient composition of the feed, and also the sourcing capabilities for byproducts and trimmings.			

Sources: BioMar Annual Sustainability Report 2015, Skretting Annual Sustainability Report, 2015EWOS Annual Sustainability Report 2015

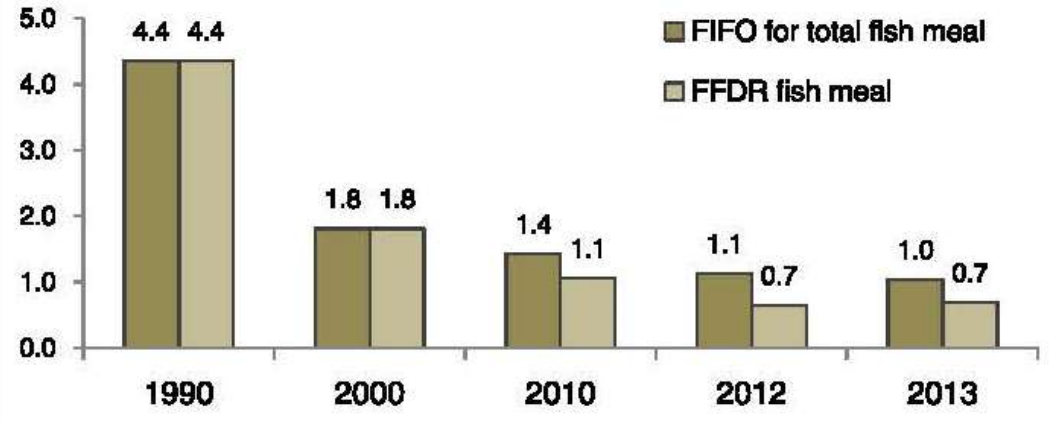
7b.13 Estimated changes to Whole fish in: whole fish out (FIFO) ratios based on mass balance

Farmed fed category	2000	2010
Eels	3.0	1.8
Salmonids (including trout	2.6	1.4
Marine fish	1.5	0.9
Crustacea including shrimps and crabs	0.9	0.4
Tilapia	0.3	0.2
Other fed freshwater fish (e.g. catfish and pangasius	0.6	0.2
Fed cyprinids	0.1	0.1
Total for fed aquaculture	**0.6**	**0.3**

Source: IFFO Positional Paper. February 2013. Is aquaculture growth putting pressure on feed fish stocks? And is the growth of aquaculture being restricted by finite supplies of fishmeal and fish?

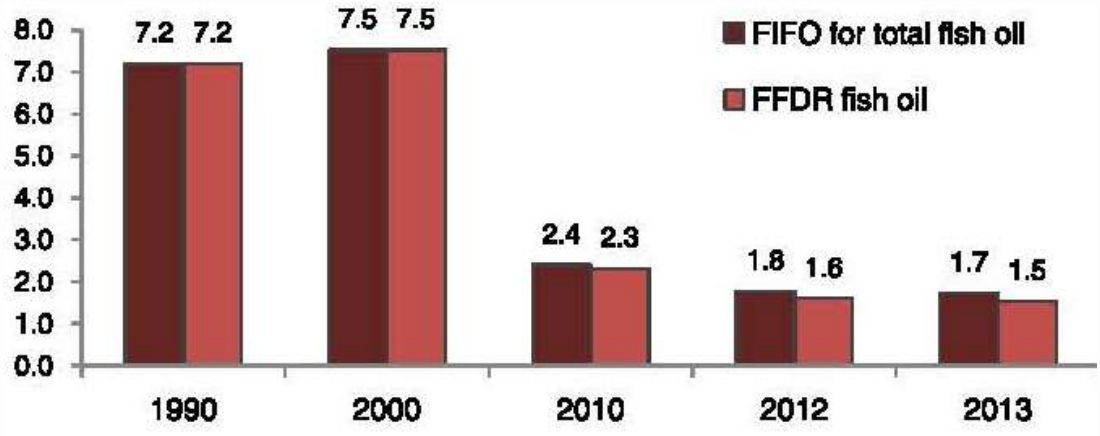
Feeding FM and FO to farmed fish contd – conversion efficiency

7b.14 Development of FIFO and FFDR values for fishmeal in Norwegian salmon farming 1990-2013.



Source: Research article. Utilisation of feed resources in production of Atlantic salmon (Salmo salar) in Norway. June 2015.

7b.15 Development of FIFO and FFDR values for fish oil in Norwegian salmon farming 1990-2013.



Source: Research article. Utilisation of feed resources in production of Atlantic salmon (Salmo salar) in Norway. June 2015.