中国水产养殖发展与鱼粉使用

China Aquaculture and Fishmeal Consumption

解 绶 启 Shouqi XIE

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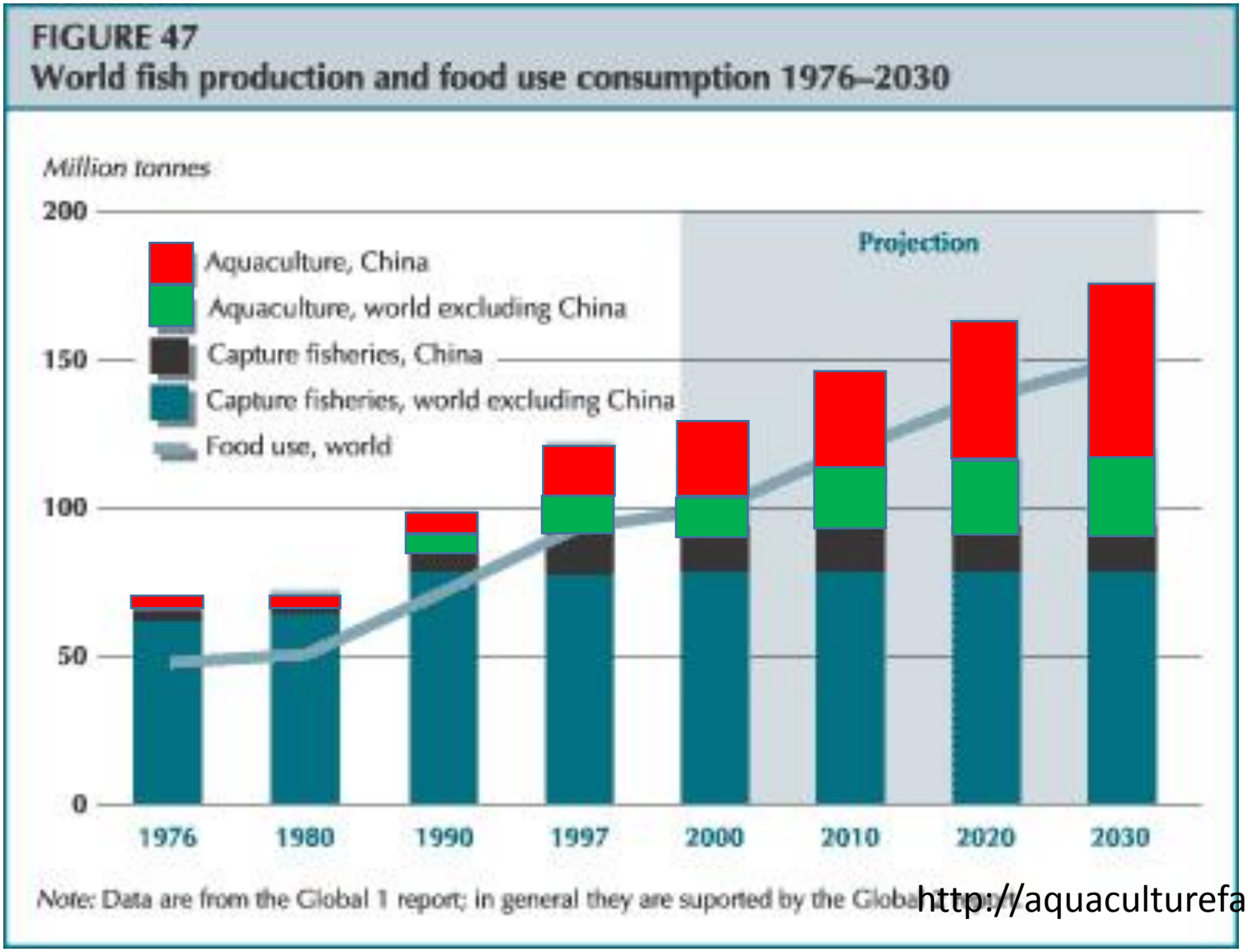
1. Development of aquaculture and demand for protein
2. International fishmeal production is relatively stable
3. Structure and trophic level of cultured breeds in China
4. Feed technology is becoming more mature, alternative source technology has been developed
5. Aquatic products processing ratio increased, more by-products can be reused
6. Nutrient utilization improved and the recycle concept developed
7. Recent industrial development goals

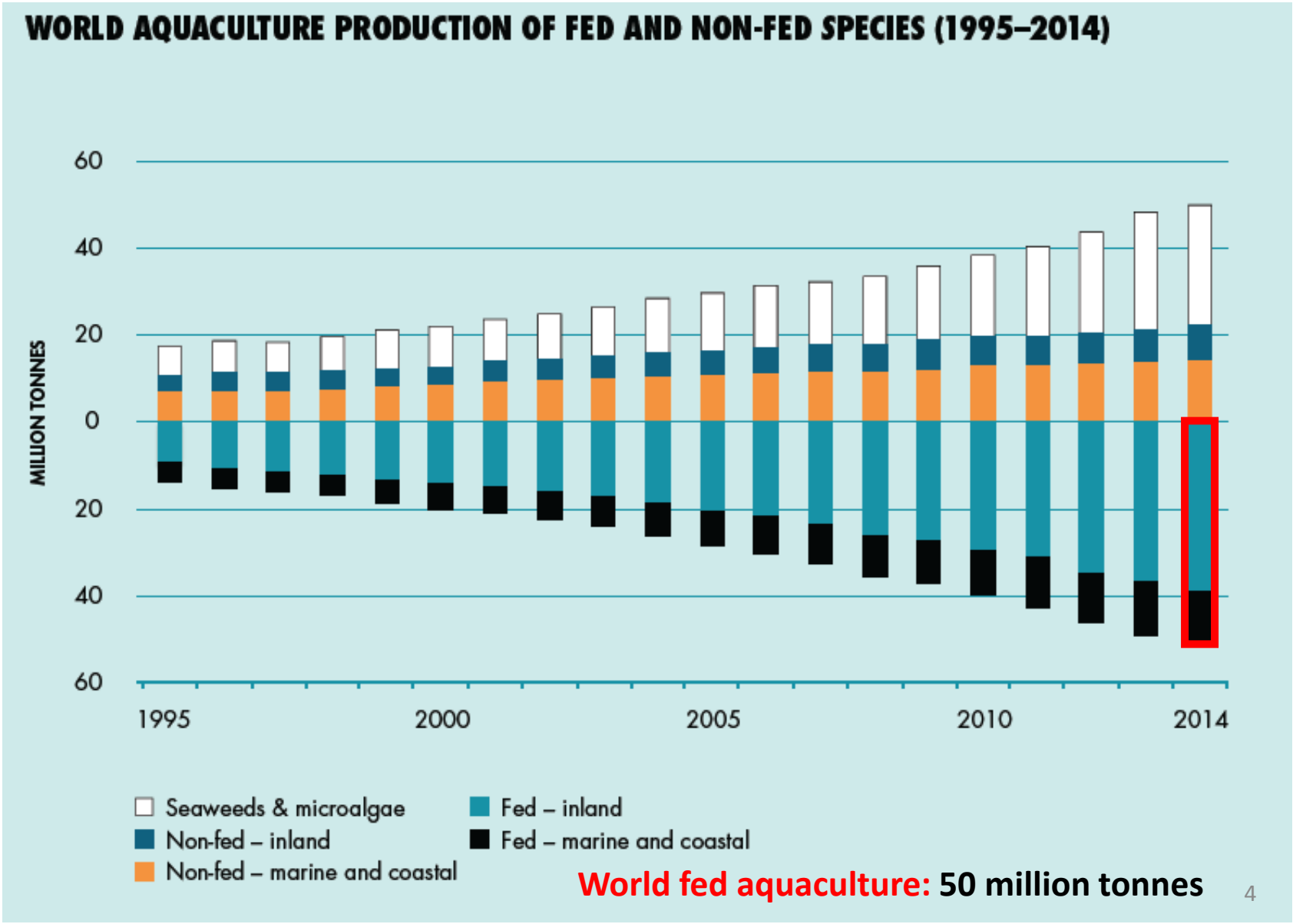
世界水产养殖发展迅速

World aquaculture is developing fast!



http://aquaculturefarm.com/

5000 Million Tons come from Aqua feeding



Farmed food fish production by top 15 producers and main groups of farmed species in 2012

Producer	Finfish		Crustaceans	Molluscs	Other species	National total	Share in world total
	Inland aquaculture	Mariculture					
	(Tonnes)			(Tonnes)			(Percentage)
China	23 341 134	1 028 399	3 592 588	12 343 169	803 016	41 108 306	61.7
India	3 812 420	84 164	299 926	12 905	...	4 209 415	6.3
Viet Nam	2 091 200	51 000	513 100	400 000	30 200	3 085 500	4.6
Indonesia	2 097 407	582 077	387 698	...	477	3 067 660	4.6
Bangladesh	1 525 672	63 220	137 174	...	...	1 726 066	2.6
Norway	85	1 319 033	...	2 001	...	1 321 119	2.0
Thailand	380 986	19 994	623 660	205 192	4 045	1 233 877	1.9
Chile	59 527	758 587	...	253 307	...	1 071 421	1.6
Egypt	1 016 629	...	1 109	...	...	1 017 738	1.5
Myanmar	822 589	1 868	58 981	...	1 731	885 169	1.3
Philippines	310 042	361 722	72 822	46 308	...	790 894	1.2
Brazil	611 343	...	74 415	20 699	1 005	707 461	1.1
Japan	33 957	250 472	1 596	345 914	1 108	633 047	1.0
Republic of Korea	14 099	76 307	2 838	373 488	17 672	484 404	0.7
United States of America	185 598	21 169	44 928	168 329	...	420 024	0.6
Top 15 subtotal	**36 302 688**	**4 618 012**	**5 810 835**	**14 171 312**	**859 254**	**61 762 101**	**92.7**
Rest of world	2 296 562	933 893	635 983	999 426	5 288	4 871 152	7.3
World	**38 599 250**	**5 551 905**	**6 446 818**	**15 170 738**	**864 542**	**66 633 253**	**100**

Note: The symbol "..." means the production data are not available or the production volume is regarded as negligibly low.

http://www.fao.org/3/a-i3720e.pdf

未来的食用鱼将更多来自养殖
Future food fish should be from aquaculture!

"Even though the salmon look like fish they are almost more similar to pigs."
— Carlos Duarte

"Consumer demand will be for mass production of food, and not so much for specific elements of quality."
— Carlos Duarte

The only way to meet the increasing demand for fish is through aquaculture.

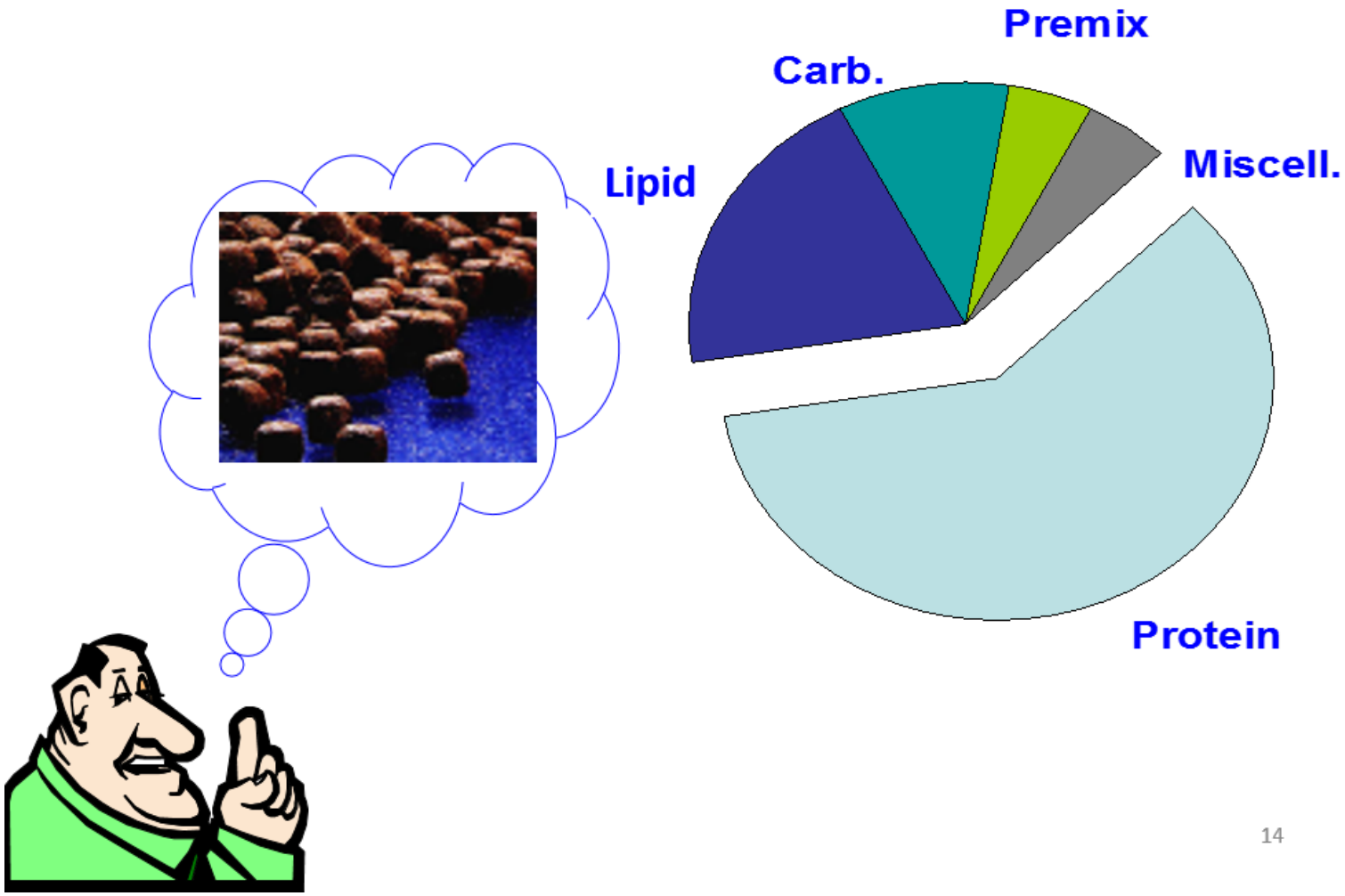
Nature, 458, 2009

The Aquafeed market is big

The global aquafeed market is expected to reach a value of **$123,990.3 million** by 2019, at a CAGR of 12.1% from 2014 to 2019 by revenue, and by consumption value, it is projected to reach 89,479.0 million by 2019, at a CAGR of 10.7% from 2014 to 2019. The aquafeed market size is estimated by segmenting the market into micro-markets, based on the share of each additive, animal species, and geographical region. The market data is available from 2013 to 2019, with a forecasted CAGR from 2014 to 2019.

http://www.marketsandmarkets.com/Market-Reports/aquafeeds-market-1151.html

Protein is the main cost in aquafeed



水产养殖需要饲料蛋白和脂肪

Aquaculture requires more and more proteins and lipids

World fed aquaculture: 50 million tonnes
Diets required: 50-75 million tonnes (FCR=1-1.5)
Dietary protein required: 15-30 million tonnes (30-40% dietary protein)
(25-50 million tonnes fishmeal or 37-75 million tonnes soybean meal)
Dietary lipid required: 5-20 million tonnes (10-30% dietary lipid)

Protein contents

Fishmeal:	**45-70%**
Soybean meal:	**38-43%**
Rapeseed meal:	**42%**
Cotton seed meal:	**42%**

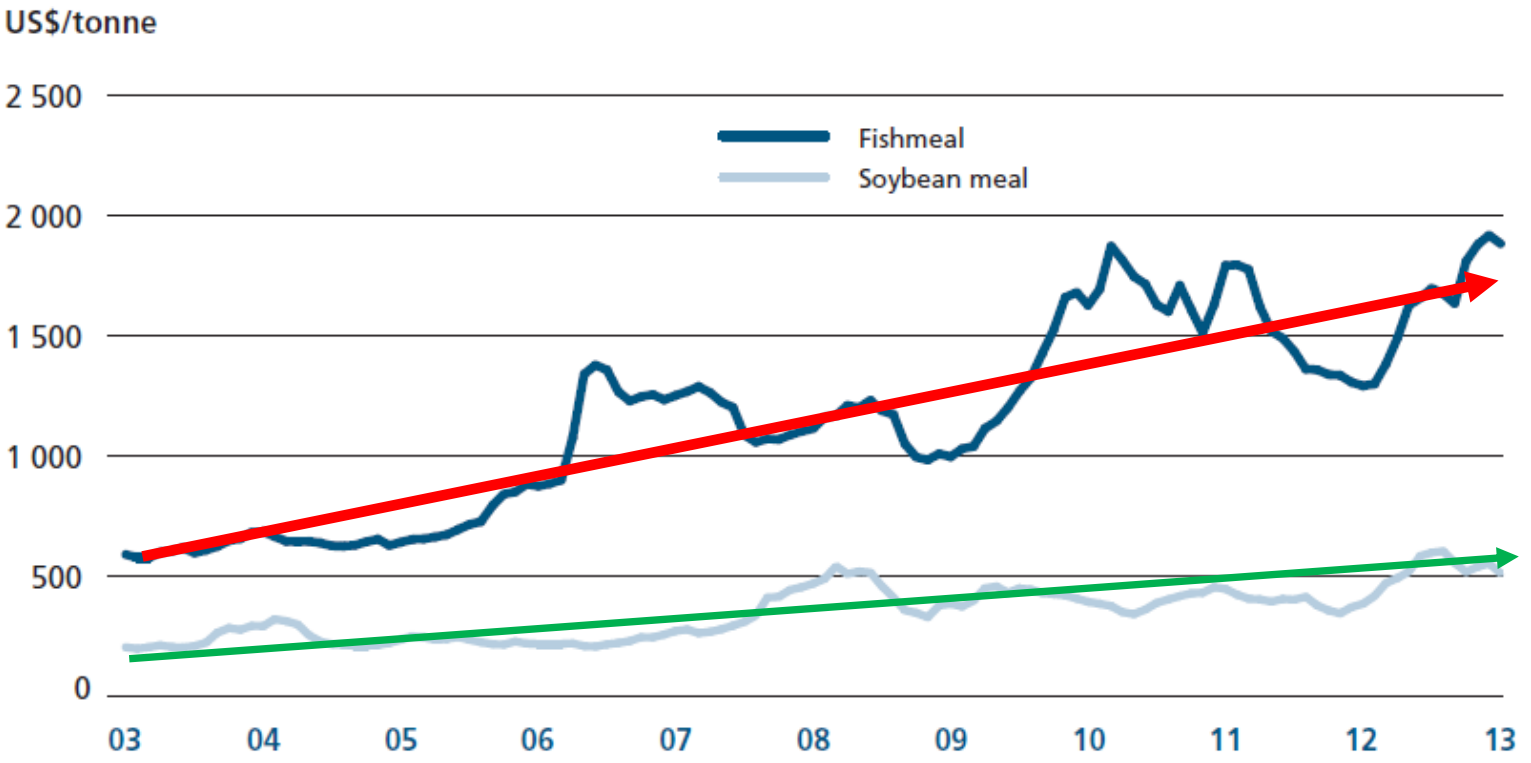
Total world production

Fishmeal:	**6 million**
Fish oil:	**1 million**
Soybean meal:	**150 million**

Much less than required!

FM, SBM Price Increasing

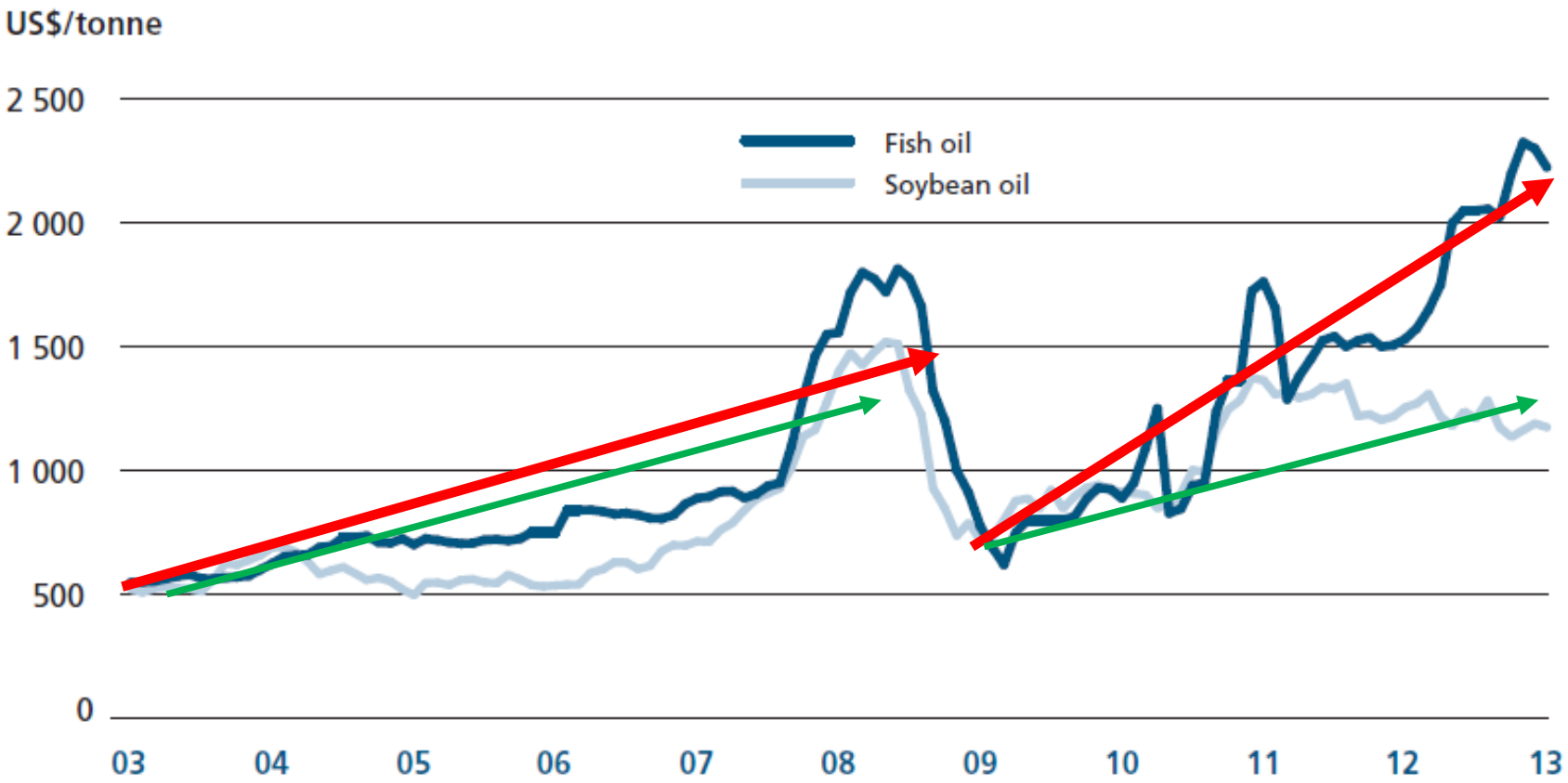
Trends in the price of fishmeal and soybean meal



Source: FAO. 2013. FAO Fisheries and Aquaculture Information and Statistics Branch. Rome.

Fishoil, Soybean oil Price Increasing

Trends in the price of fish oil and soybean oil



Source: FAO. 2013. FAO Fisheries and Aquaculture Information and Statistics Branch. Rome.

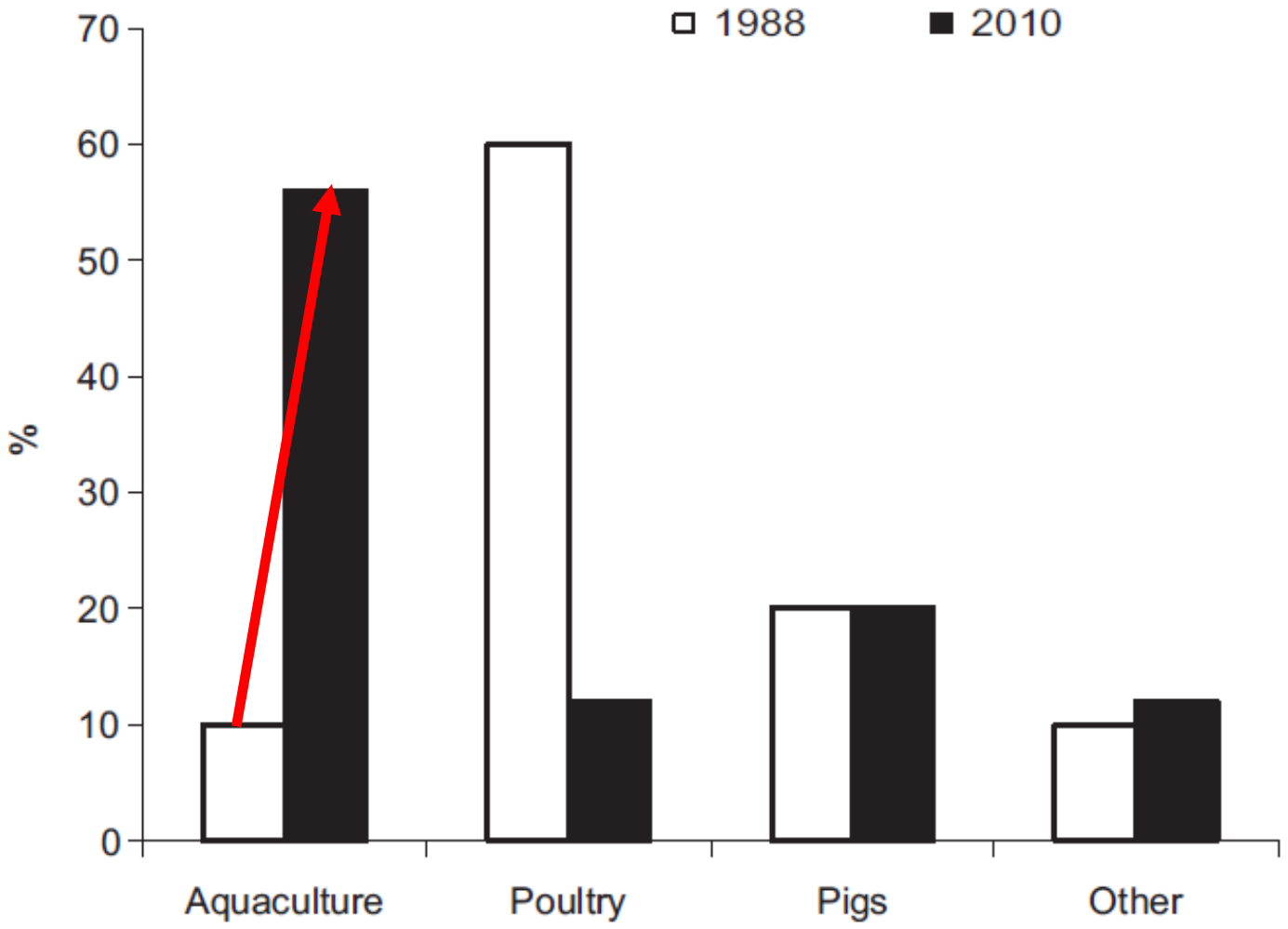
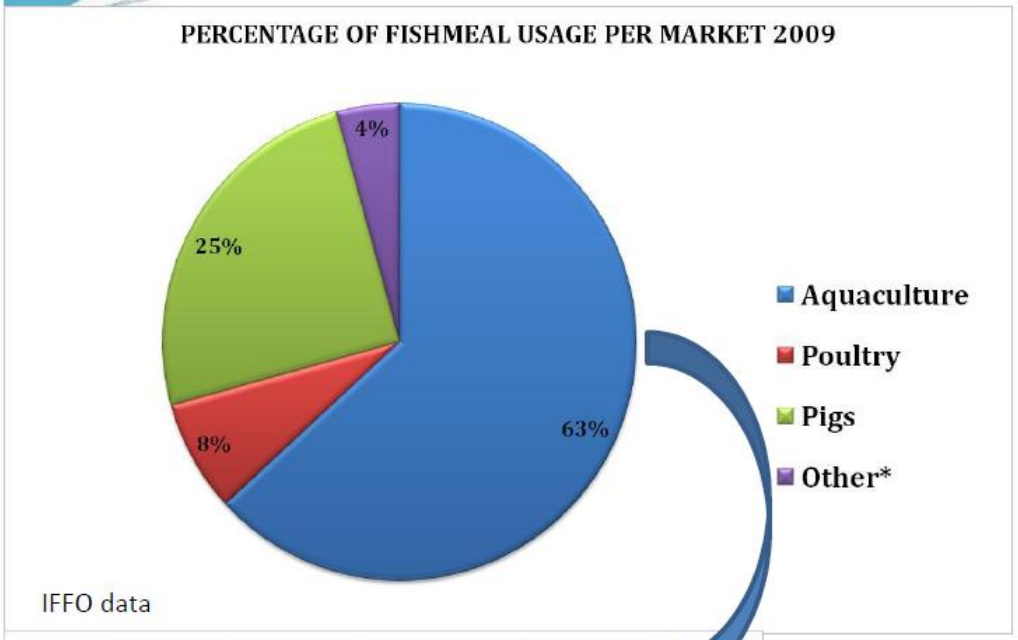
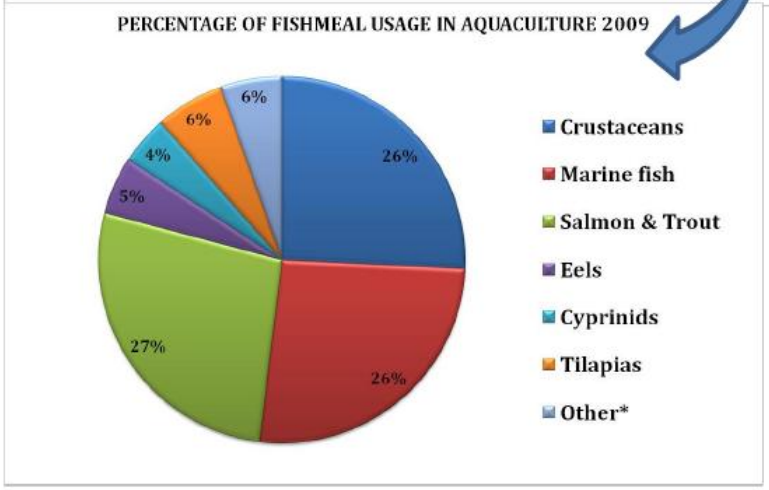
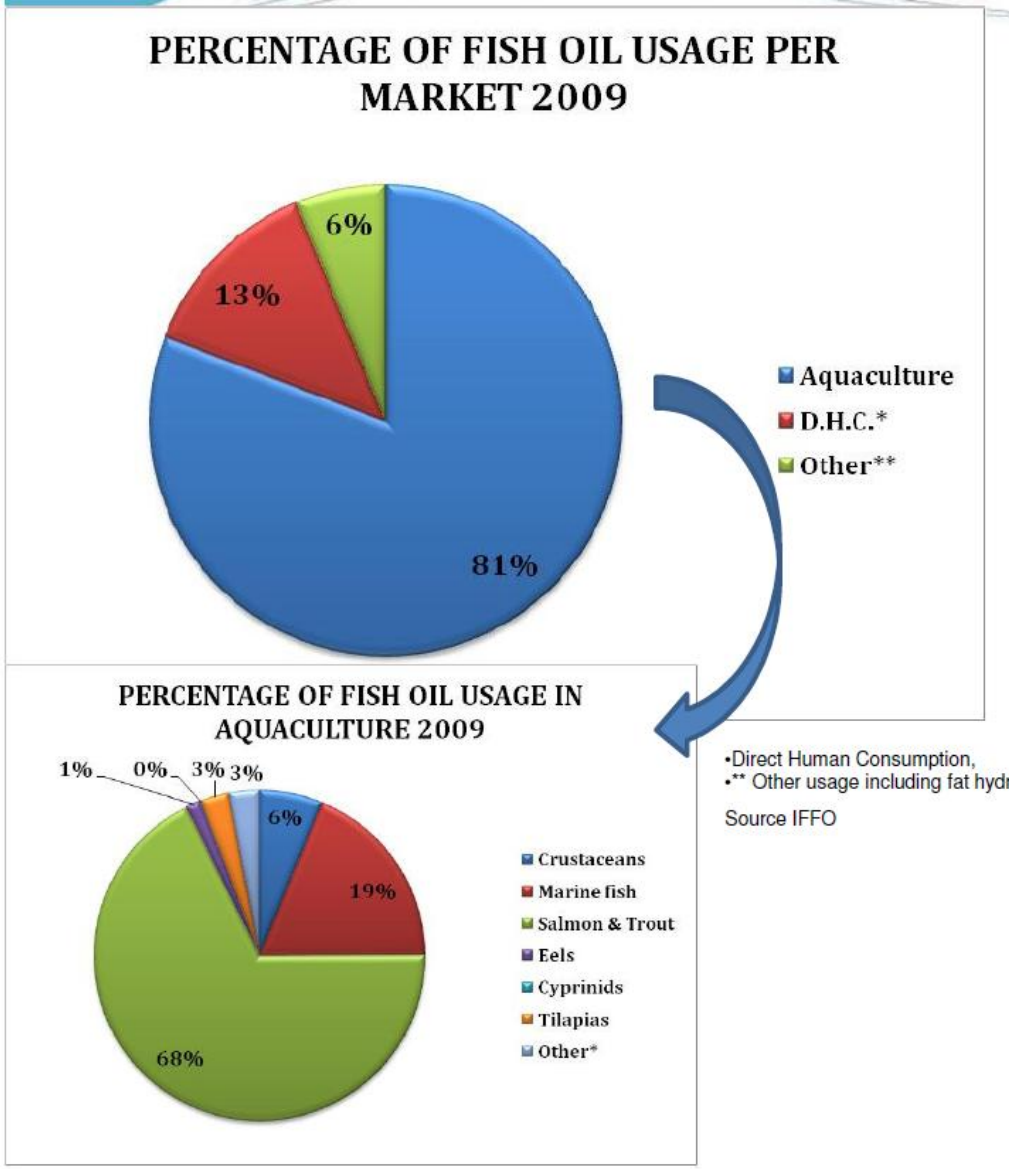


Fig. 2. Estimated use of available fishmeal in compound feed in different sectors. Data for 1988 from New and Csavas (1995) and for 2010 from Huntington and Hasan (2009).





We estimate that in 2009 63% of global fishmeal production went to aquaculture and that was split almost equally between salmonids, marine fish, crustacean and others.

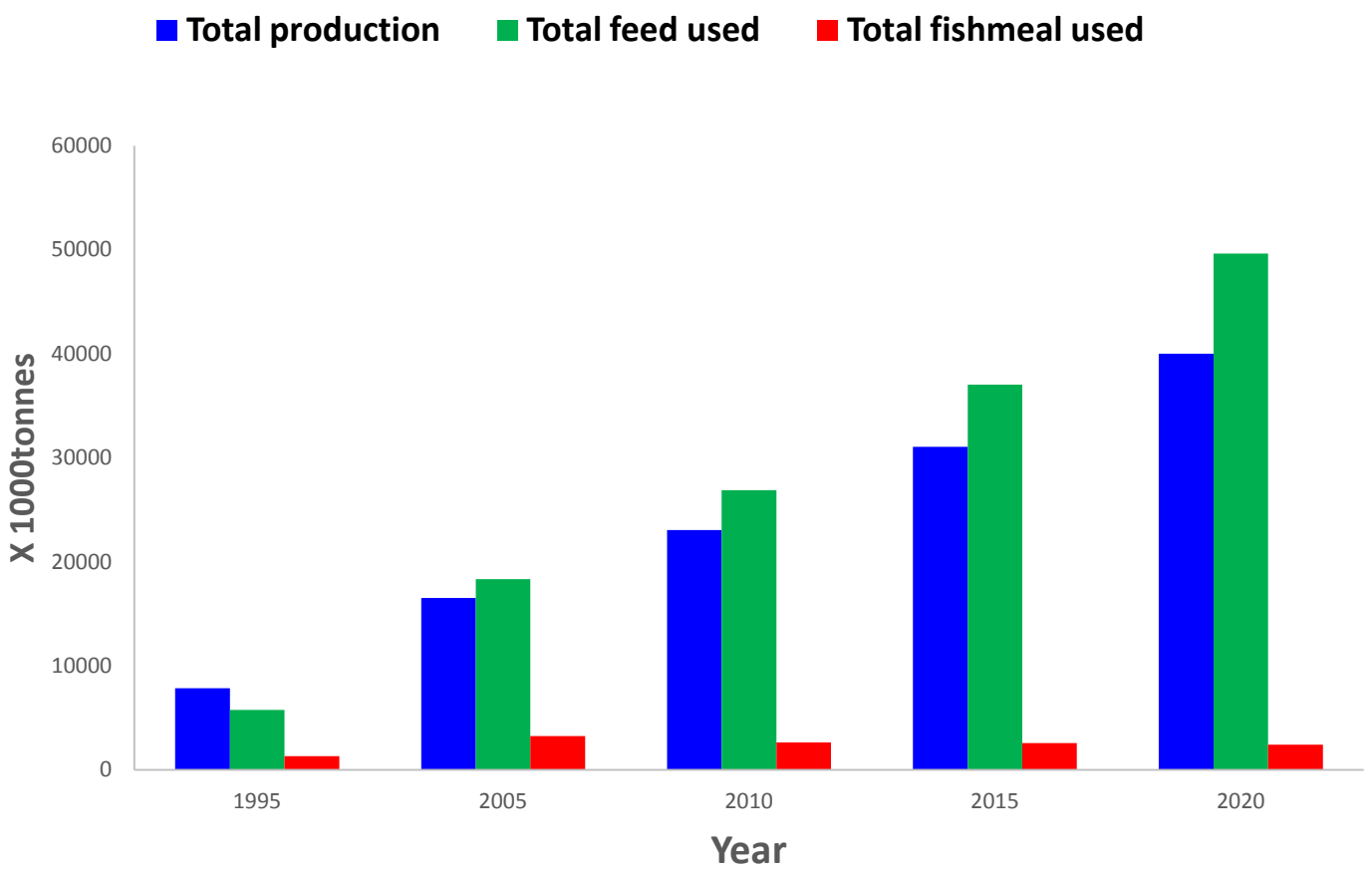


•Direct Human Consumption,
•** Other usage including fat hydrogenation & industrial use

Source IFFO

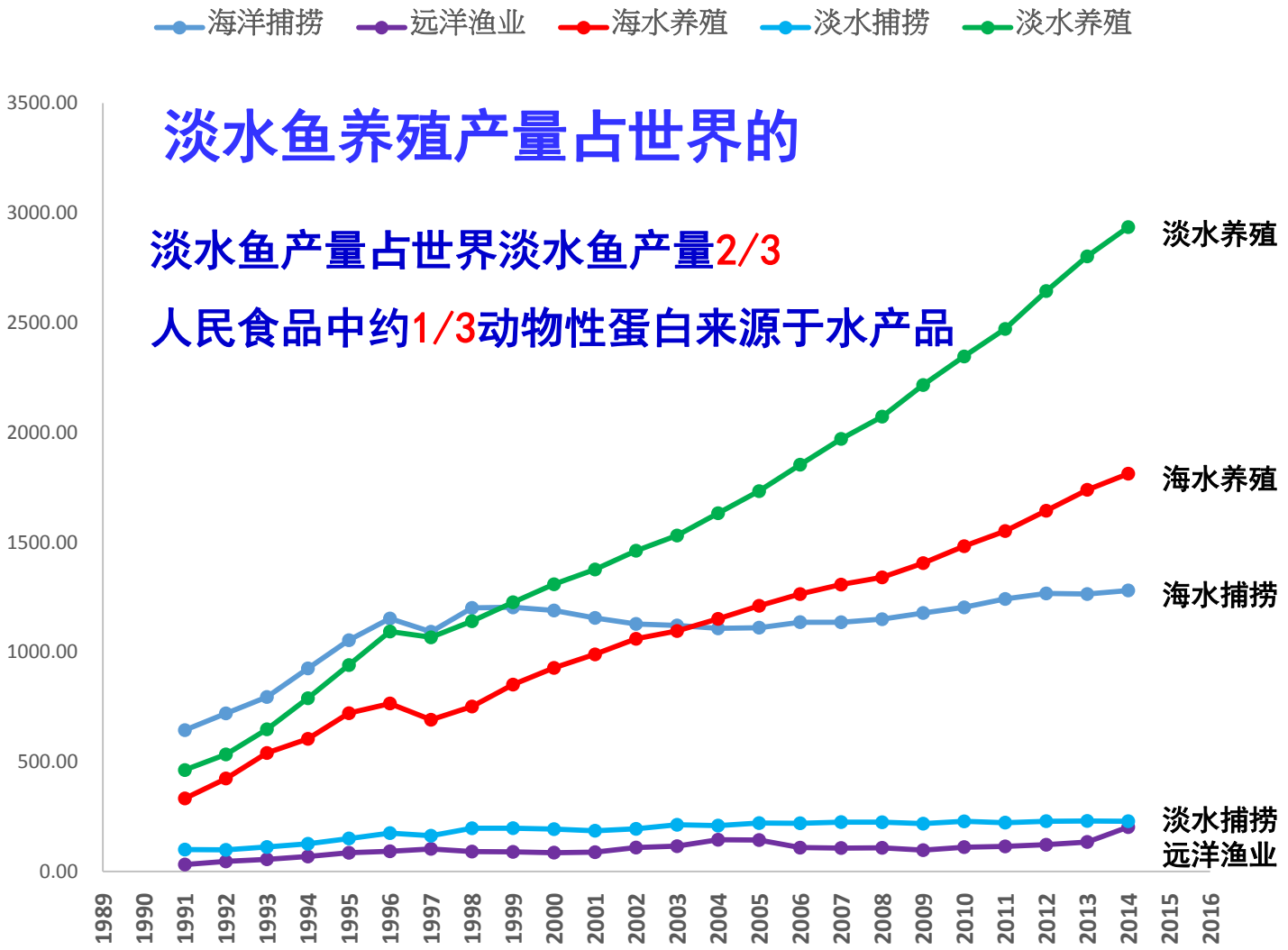
We estimate that in 2009 81% of global fish oil production went to aquaculture and that 68% of that went to salmonids.

世界水产养殖的发展增加了对鱼粉的需求
World aquaculture consumed more and more fishmeal



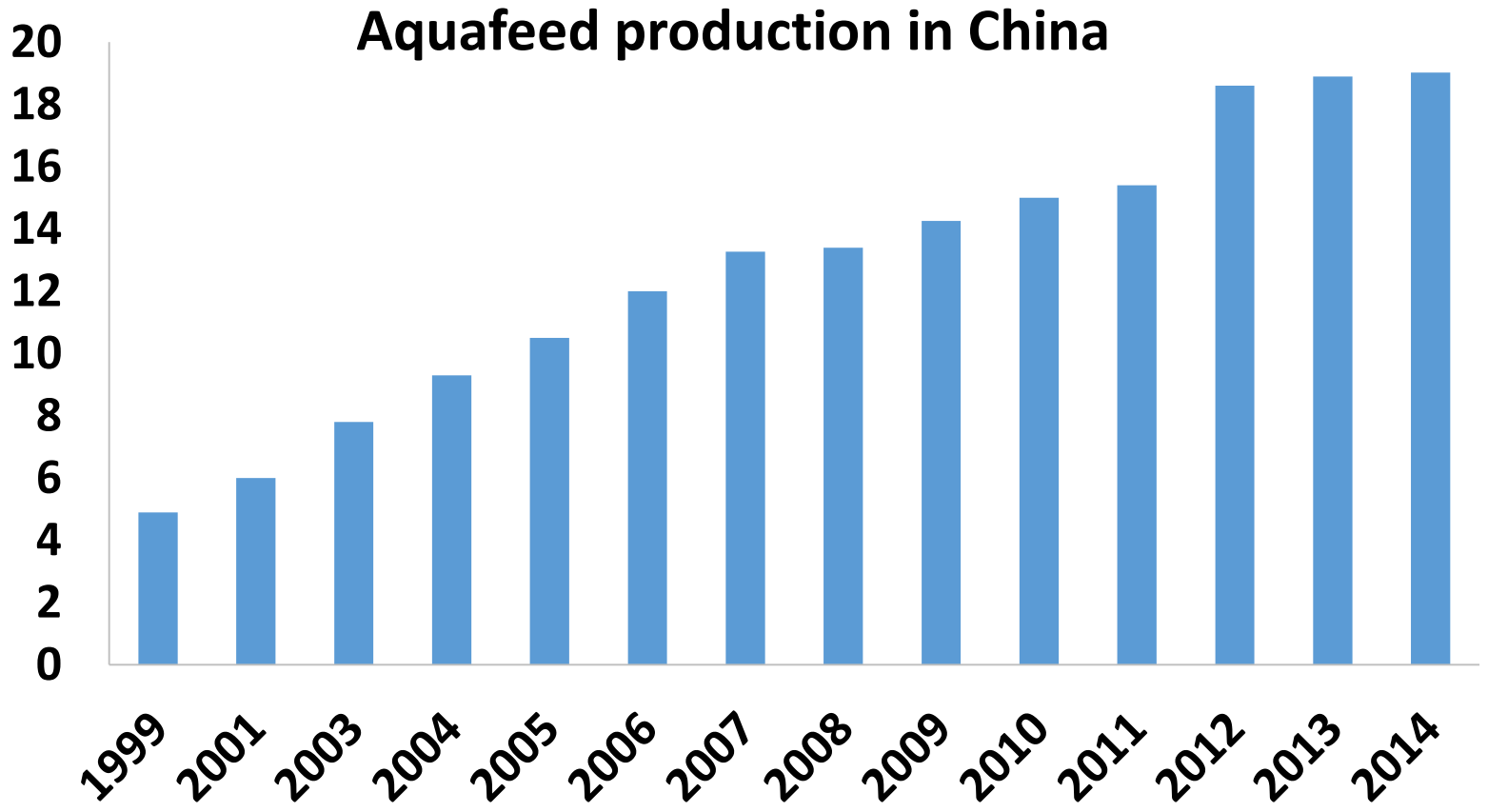
Olsen and Hasan, 2012

China Fishery Production



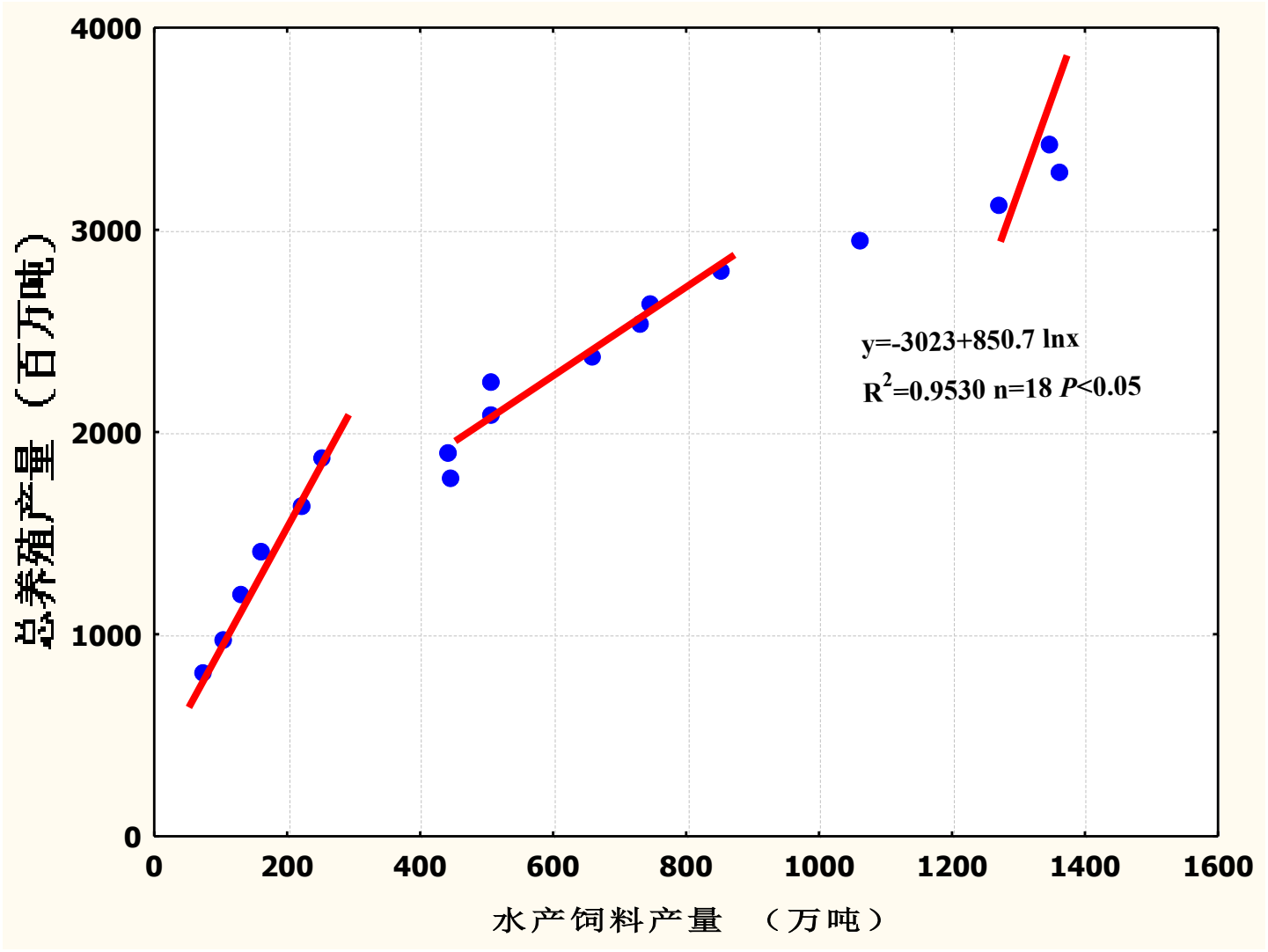
Aquafeed production in China

(X 1,000,000 tonnes)

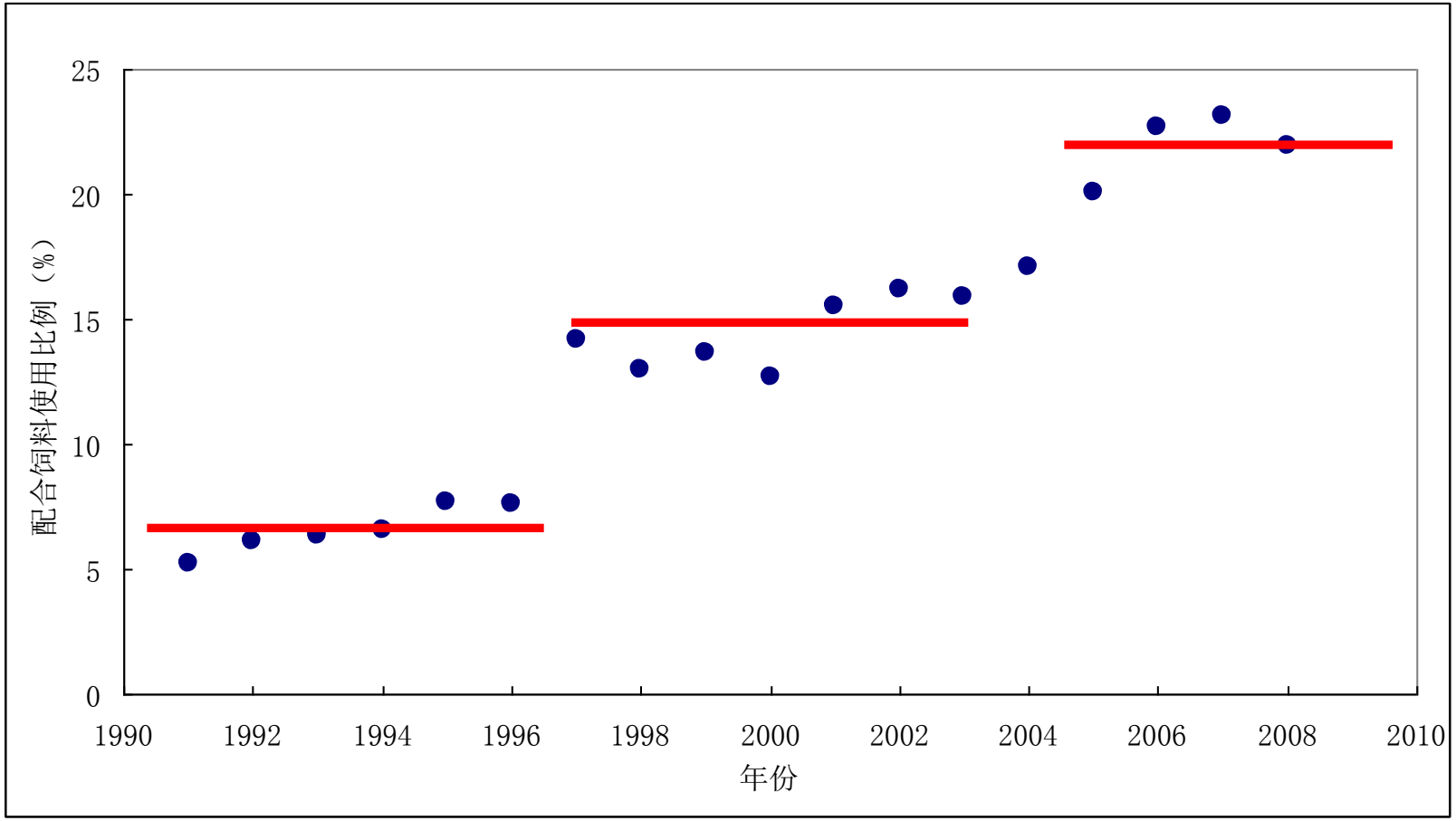


About 6 million tonnes protein (30% dietary protein) required!

The dependence of aquaculture on feed is more



Usage of Compound Feed is more



Demand for freshwater aquaculture

从2015年的养殖产量来看，按80%投饵养殖（淡水扣除鲢鳙，海水仅包括鱼虾），即2052万吨水产品需用饲料，饲料系数按1.5计算，估计需要饲料约3078万吨，而2015年水产配合饲料总产量约为1860万吨，缺口还比较大。

The development of China's aquatic feed market

根据中国科学院农业政策研究中心的预测，从2004年到2050年的需求增长中，最快的是奶制品和水产品，全国的肉禽人均需求将从41公斤增加84公斤，水产品由15公斤增加到48公斤。结合收入增长和城市化对人均畜产品和水产品需求的影响以及人口增长对总量的影响，至2050年中国居民的水产品需求将增长近3倍，畜产品和饲料粮需求将增长1.5-1.6倍

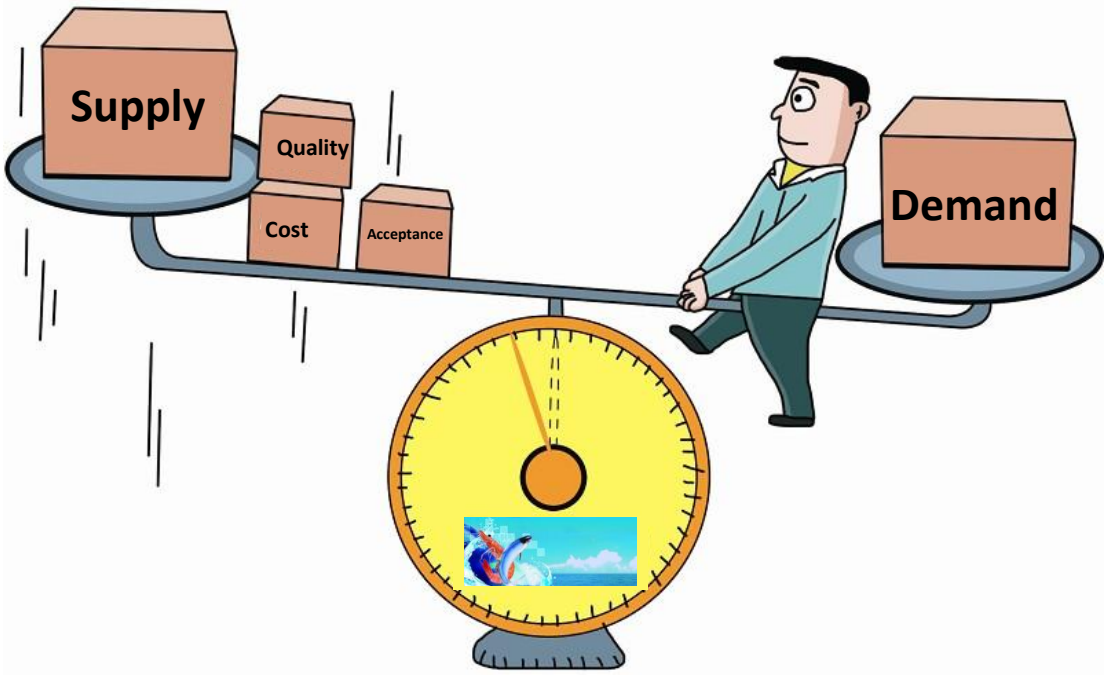
（引自《中国至2050年农业科技发展路线图》）。

中国水产养殖发展需要更多的蛋白源
China market for aquafeed proteins

Fishmeal: **more than 1 million tonnes imported**

Soybean: **more than 80 million tonnes imported**

Increasing aquaculture production makes **big gap** between the supply and demand!



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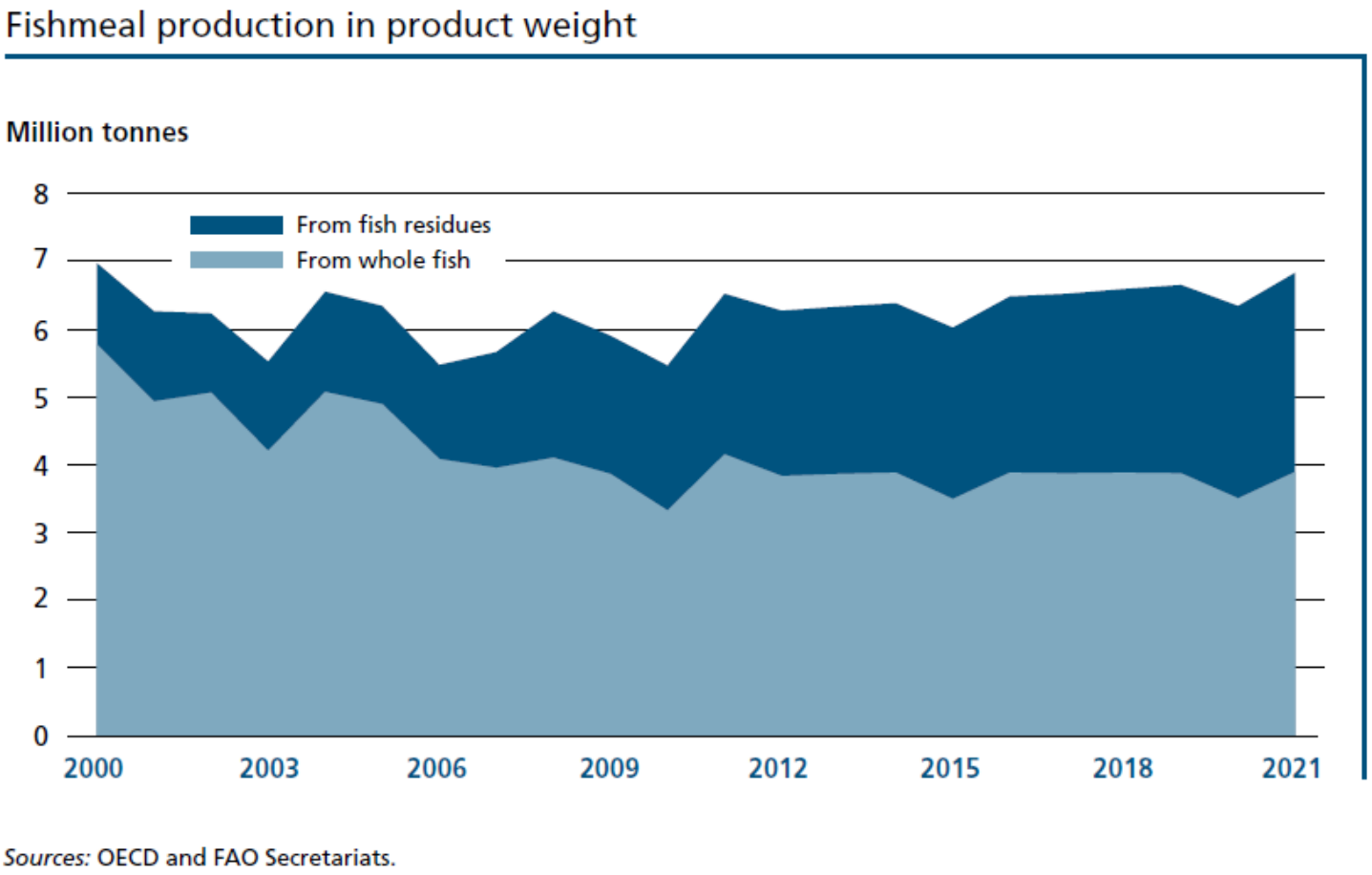
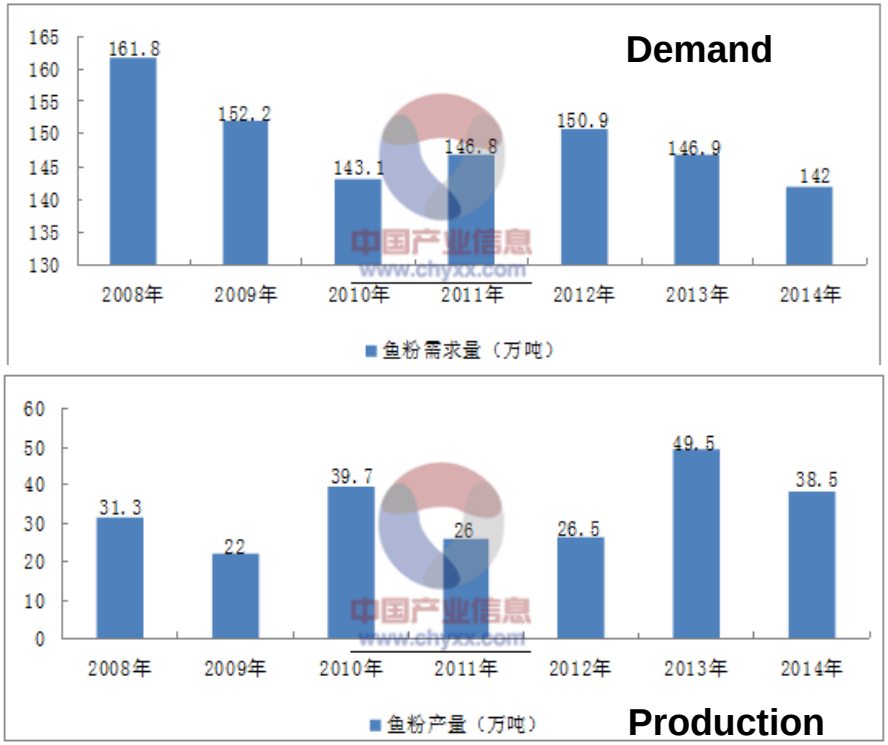
Fishmeal production 500-600 Million Tons recent years

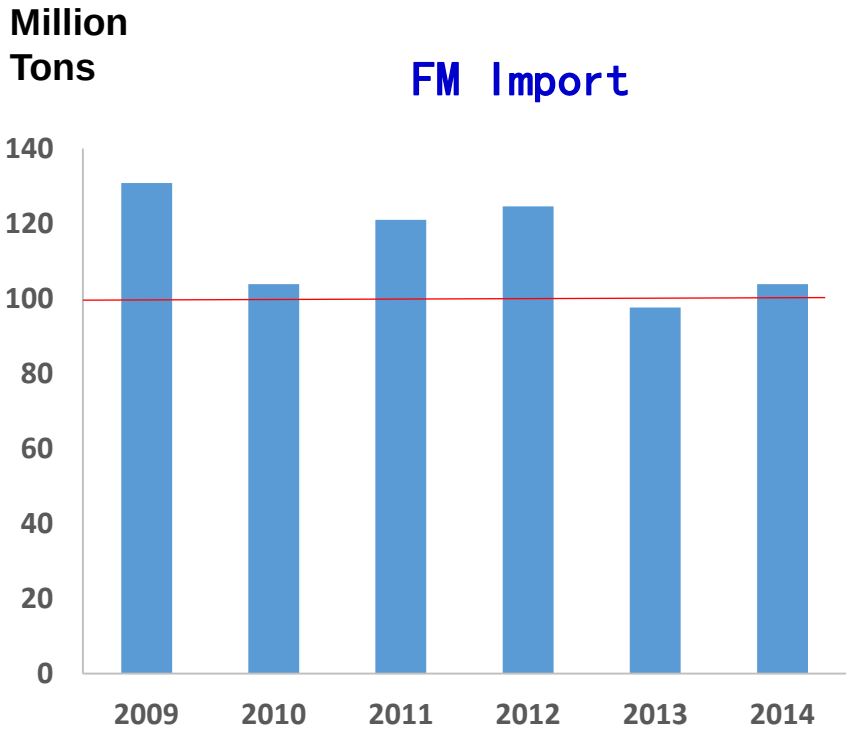


Sources: OECD and FAO Secretariats.

http://www.fao.org/docrep/016/i2727e/i2727e.pdf

Fishmeal Imports to China 2009-2014





数据来源http://www.chyxx.com/industry/201509/343143.html

Demand of Worldwide FM Import Country 2000-2009

国家及地区	十年平均进口量(万吨)	需求品种
CHINA 中国	100	特种水产，猪
EUROPE 欧洲	70	三文鱼，猪
JAPAN 日本	40	特种水产，猪
TAIWAN 台湾	25	特种水产，猪
VIETNAM 越南	10	特种水产

China Aqua Production of Worldwide 2010: 62.2%

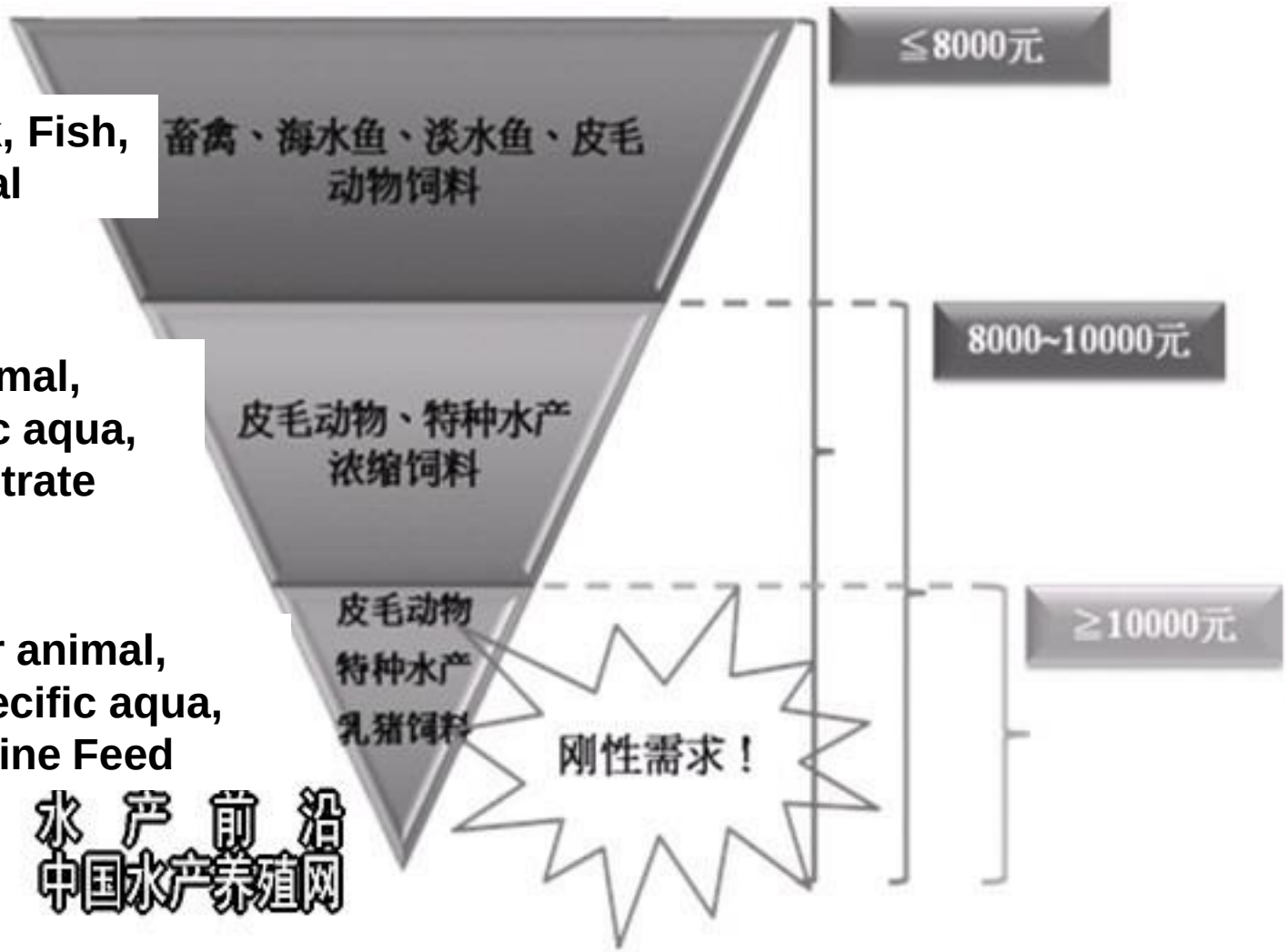
Europe Aqua Production of Worldwide 2010: 4.3%

Price and market determine the usage of FM

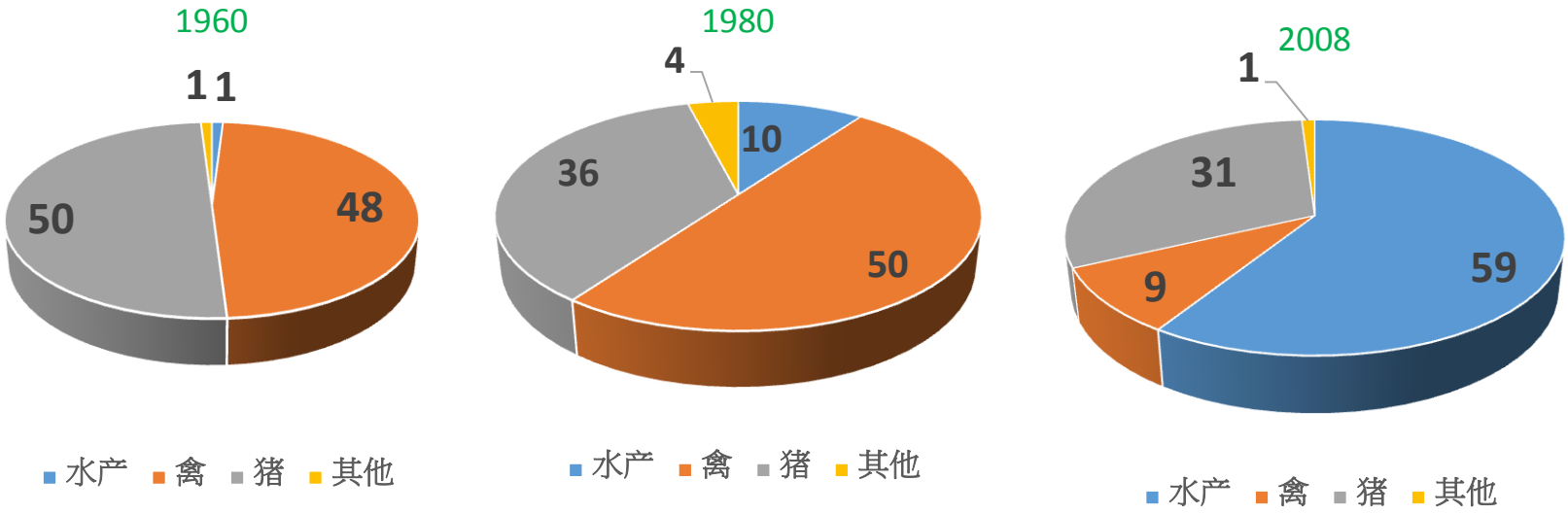
Livestock, Fish, Fur animal

Fur animal, specific aqua, concentrate feed

Fur animal, specific aqua, Swine Feed



China Imported FM Usage changes



2013: Pig Feed 8400 Million Tons， Aqua Feed 1860Million Tons

China FM Aqua Consumption questioned by the world

Fish feed for aquaculture. Unidentified species of finfish, mollusks, crustaceans, and cnidaria from the trash fish component of nontargeted fisheries packaged and frozen for delivery for a fishmeal factory in Maoming, Guangdong province, China.

GLOBAL FOOD SUPPLY

China's aquaculture and the world's wild fisheries

Curbing demand for wild fish in aquafeeds is critical

By **Ling Cao[1], Rosamond Naylor[1]*, Patrik Henriksson[2], Duncan Leadbitter[3], Marc Metian[4], Max Troell[4,5], Wenbo Zhang[6,7]**

China is the world's largest producer, consumer, processor, and exporter of

trade (*7*, *8*) makes it especially difficult to assess the impact of China's aquaculture and aquafeed use on ocean fisheries. For example, roughly 300,000 tons of marine fish "nei" (not elsewhere included or unidentified species) are cultivated annually in China's

decades (SM). Aquaculture systems throughout the country are intensifying as producers seek higher returns on scarce land, water, and coastal zone resources (*2*). Intensification is reflected in higher stocking densities, greater reliance on commercial feeds, and more frequent water exchange and aeration (*9*, *10*). The sector is transitioning from low-input, multitrophic systems (e.g., traditional carp polycultures that do not require formulated feeds) to monocultures or polycultures containing high-valued species dependent on feeds (*2*, *11*).

Fish farming remains a highly diverse industry in China and is influenced by a variety of government directives and policies (SM). More than 100 freshwater and 60 marine fish species are raised in habitats and infrastructures that include ponds, cages in lakes and coastal waters, and raft and bottom-sowing systems in shallow seas and mud flats (*2*, *3*). Carps in polyculture, tilapia in monoculture and polyculture, and penaeid shrimp in monoculture are three of the largest subsectors, constituting over half of China's total aquaculture production by volume (see the

Second, use of fish-processing wastes in aquafeeds presents food safety risks related to bioaccumulation of contaminants, cross-species transmission of pathogens, and, possibly, prions (*21*, *23*). To avoid disease transmission, the Europe Union forbids the use of farmed fish by-products in finfish feeds but allows them to be used in crustacean diets or vice versa (*21*). Although China has no such food safety regulations, there is increasing awareness on traceability and quality in aquafeed inputs (SM). China is examining a new national standard for regulating dioxins and usage of multiple species in fishmeal and oil. Development may be hindered however by the predominance of small-scale processing plants with outdated equipment and by inefficient or costly collection of raw materials along the supply chain. Overcoming these constraints is not insurmountable but will require substantial investments in research and development, and strict enforcement of advanced food safety regulations.

Strategic design of an aquafeed sector based on processing wastes from aquaculture makes perfect sense for China, especially if food safety risks can be monitored. China's massive aquaculture sector yields a steady and consistent stream of processing wastes. If processing facilities are colocated with fishmeal and feed plants, the problems of perishability, transportation costs, and supply to increase its net production of fish protein, its aquaculture industry will need to reduce FCRs and the inclusion of fish ingredients in feeds and to improve fishmeal quality. Fish-processing wastes have potential to substitute increasingly for imported fishmeal in China's aquaculture sector if appropriate technology and supply chains are developed, if nutritional qualities can be improved, and if food safety can be guaranteed.

Even if fish-processing wastes are recycled as feeds, China's aquaculture industry will continue to strain wild fisheries unless the country commits to stricter enforcement of regulations on targeted and nontargeted fishing within and outside of its EEZ and to responsible sourcing of fishmeal and/or oil (SM). Using fishmeal derived from by-catch or by-products of wild fisheries as a means of reducing pressure on wild fisheries remains controversial and should be monitored (*23*). Without such measures, China's aquaculture sector is destined to diminish wild fish stocks worldwide. ■

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SUPPLEMENTARY MATERIALS

www.sciencemag.org/content/347/6218/133/suppl/DC1

10.1126/science.1260149

Chinese impact on wild fisheries

14 Jan 2015

Scotland's University of Stirling has contributed to a major international research project to investigate the dangerous pressure China's aquaculture industry is putting on world fish supplies.

In a new paper published in the journal *Science*, the researchers try to paint a clearer picture of the enormous impact China is having on wild fisheries and present a more sustainable alternative to the current practice of using wild-caught fish to feed farm-raised fish.

One of the researchers, Wenbo Zhang, conducted the research whilst completing his PhD at the University's internationally renowned Institute of Aquaculture. He said: "Our research shows that so significant is China's impact on the world's seafood supply chain – the future availability of global seafood will be dependent on how China develops its

China is the world's leading producer, consumer and processor of fish, contributing one-third of the global supply Photo: istockphoto

http://www.worldfishing.net/news101/industry-news/chinese-impact-on-wild-fisheries

Researchers: China aquaculture 'dangerous' to wild fisheries

By James Wright, Senior Editor

Published on 09 January, 2015

China's booming aquaculture industry is putting "dangerous pressure" on global fish supplies, according to a research project spearheaded by researchers at the University of Stirling (U.K.) and Stanford University (USA).

In a new paper in the journal *Science*, the researchers detail the impact China is having on wild fisheries and present a more sustainable alternative to the current practice of using wild-caught fish to feed farm-raised fish.

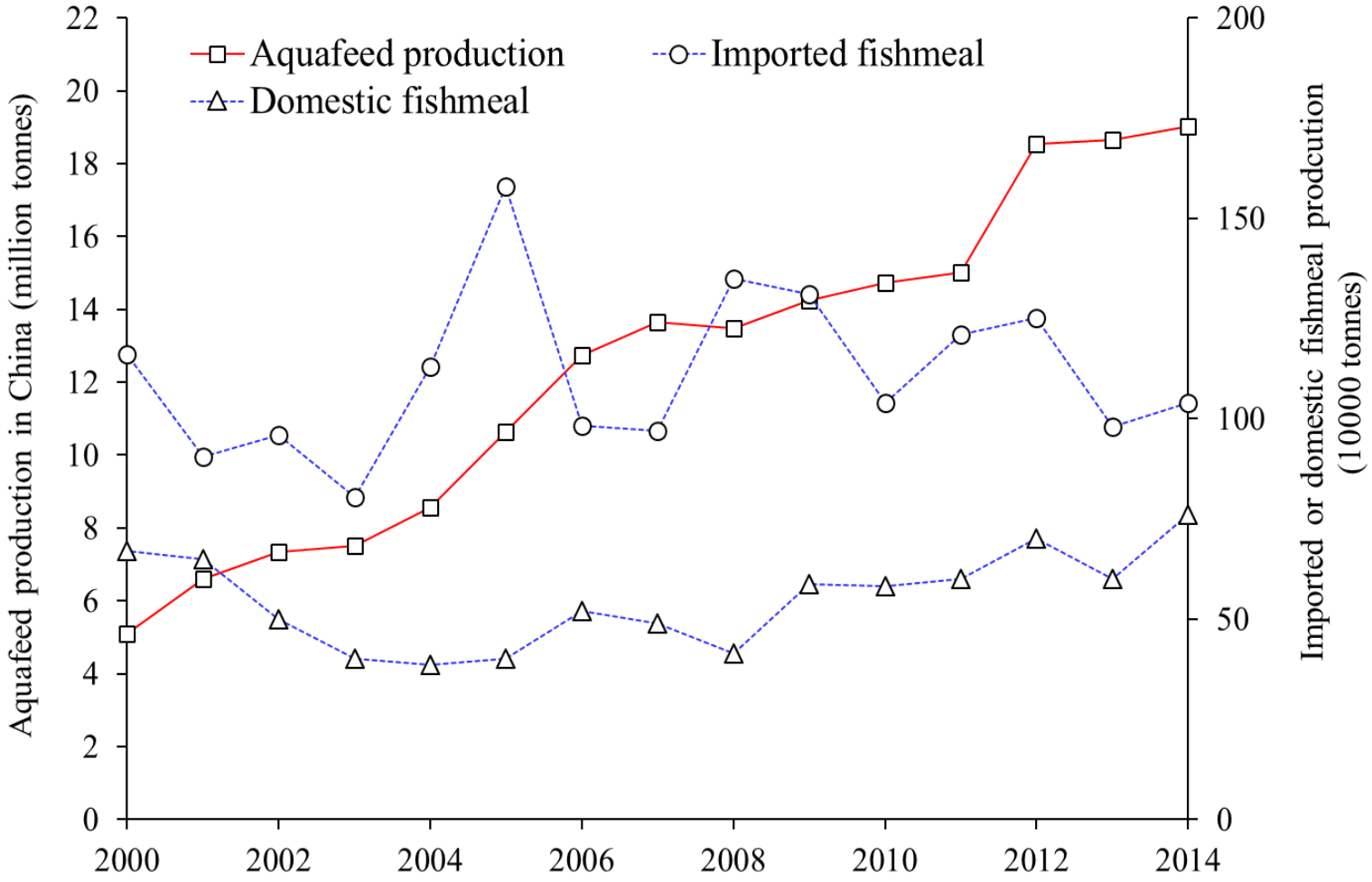
"Our research shows that so significant is China's impact on the world's seafood supply chain – the future availability of global seafood will be dependent on how China develops its aquaculture and aqua feeds sector," said University of Stirling's Wenbo Zhang, who conducted the research while completing his Ph.D. at the university's Institute of Aquaculture.

China is the world's leading producer, consumer and processor of fish, contributing one-third of the global supply, according to the researchers. Its aquaculture industry relies increasingly on fishmeal made from wild-caught fish, a practice they said depletes wild fish stocks and strains fragile ocean ecosystems. Fishing in coastal waters of China, they added, are poorly regulated and take

http://www.seafoodsource.com/news/environment-sustainability/27496-researchers-china-aquaculture-dangerous-to-wild-fisheries

中国水产饲料生产及鱼粉使用

Aquafeed production and fishmeal consumption in China



(Han et al., Review in Aquaculture, in press)

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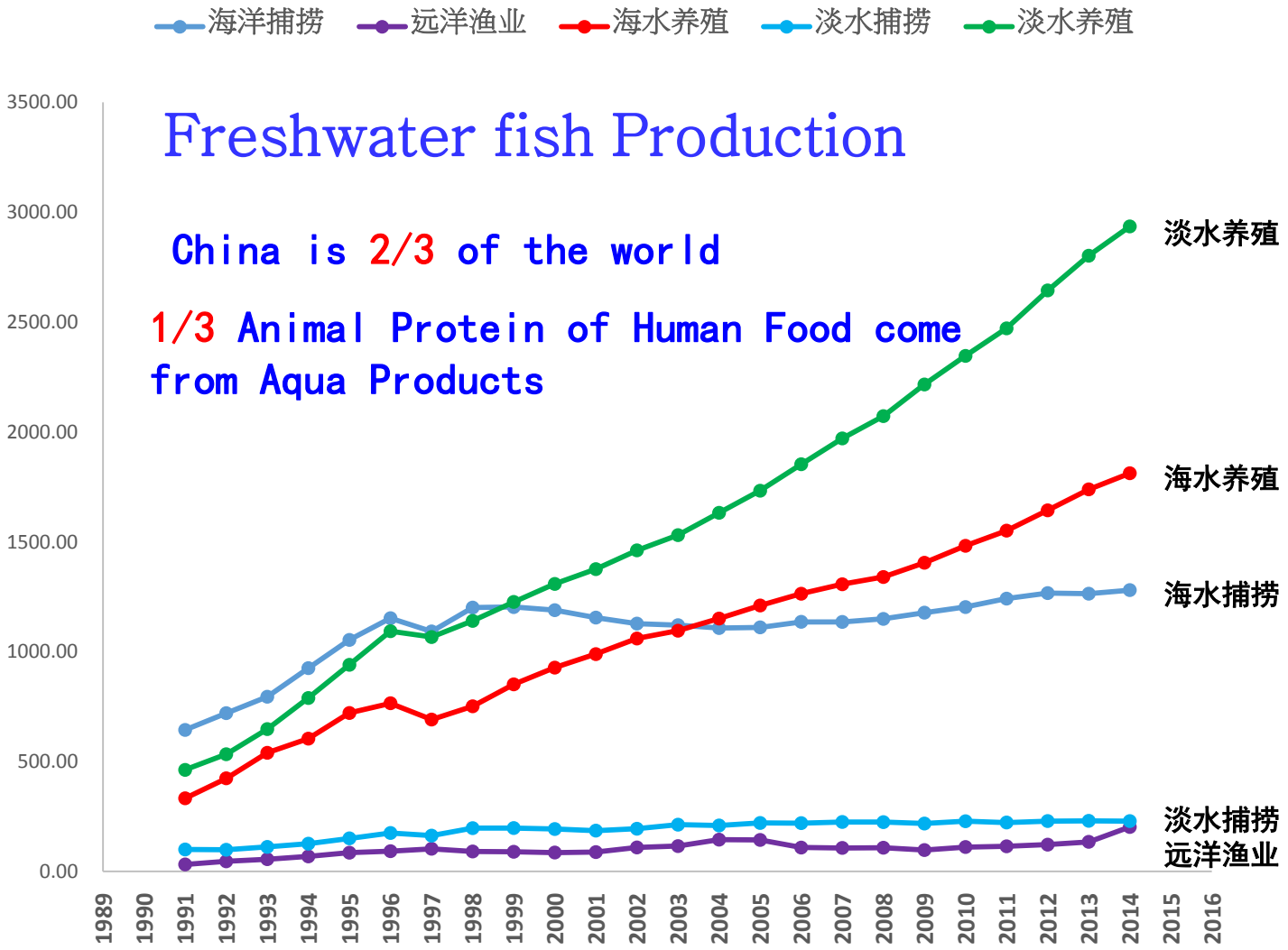
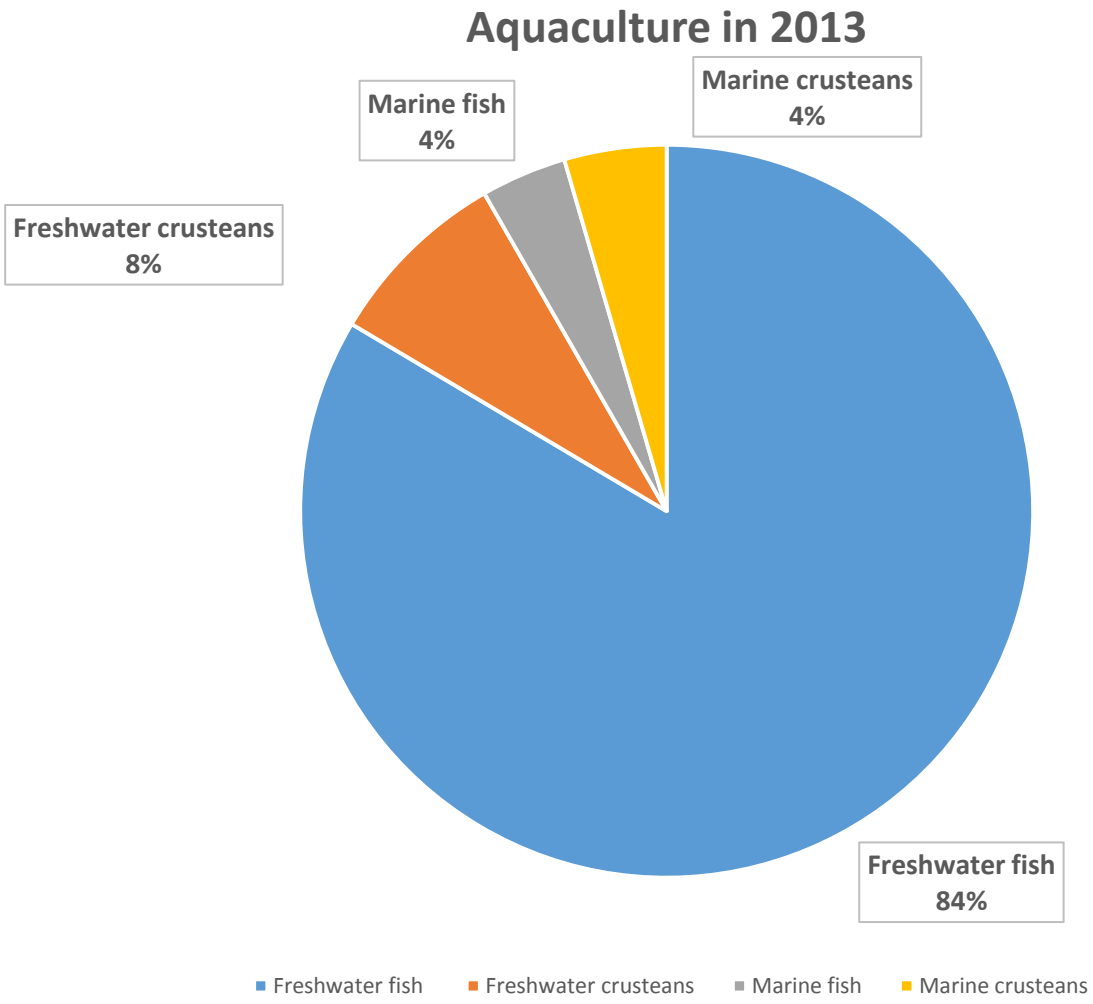
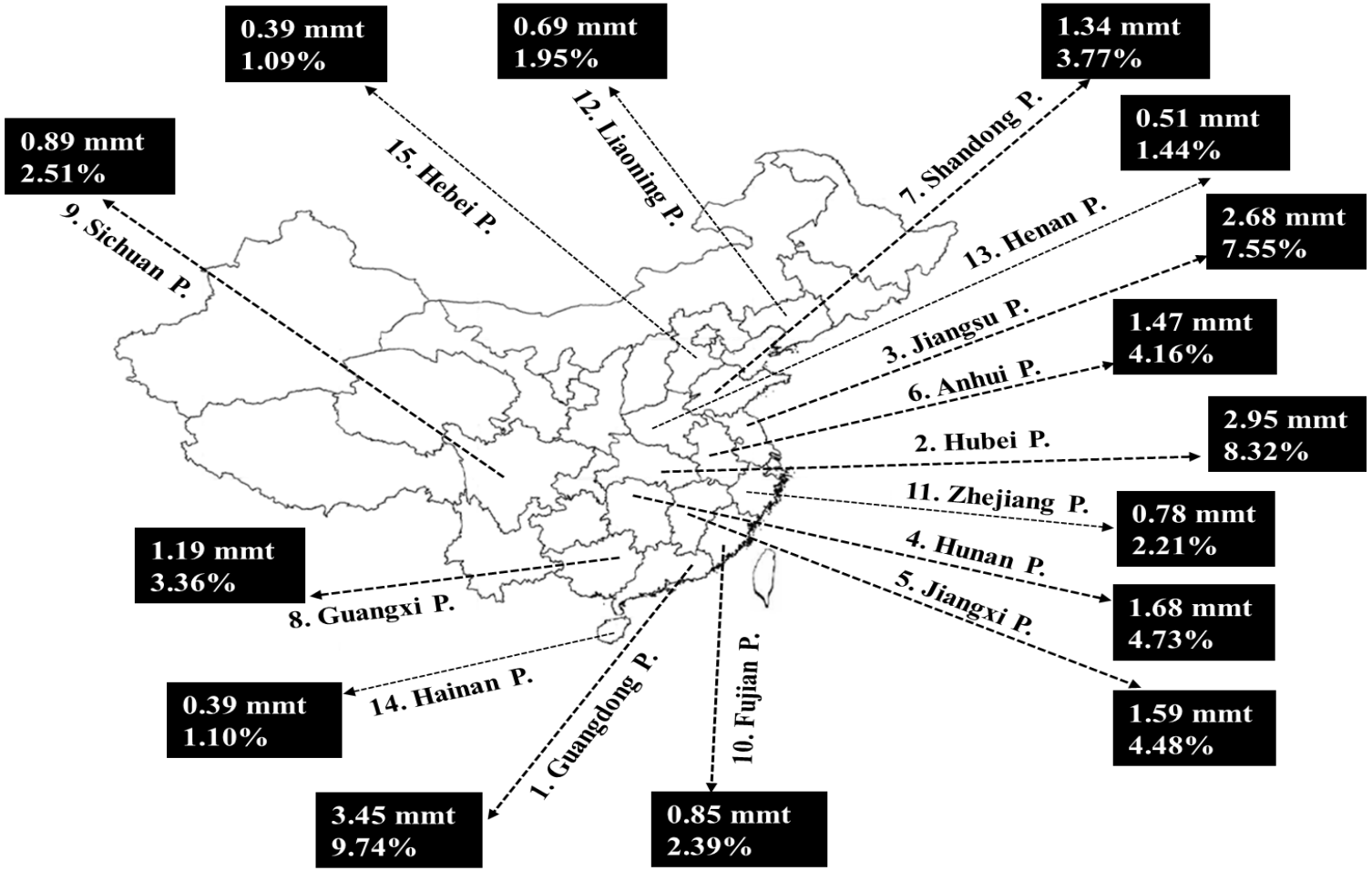
China fishery production



Freshwater Fish: 84% of Aquaculture



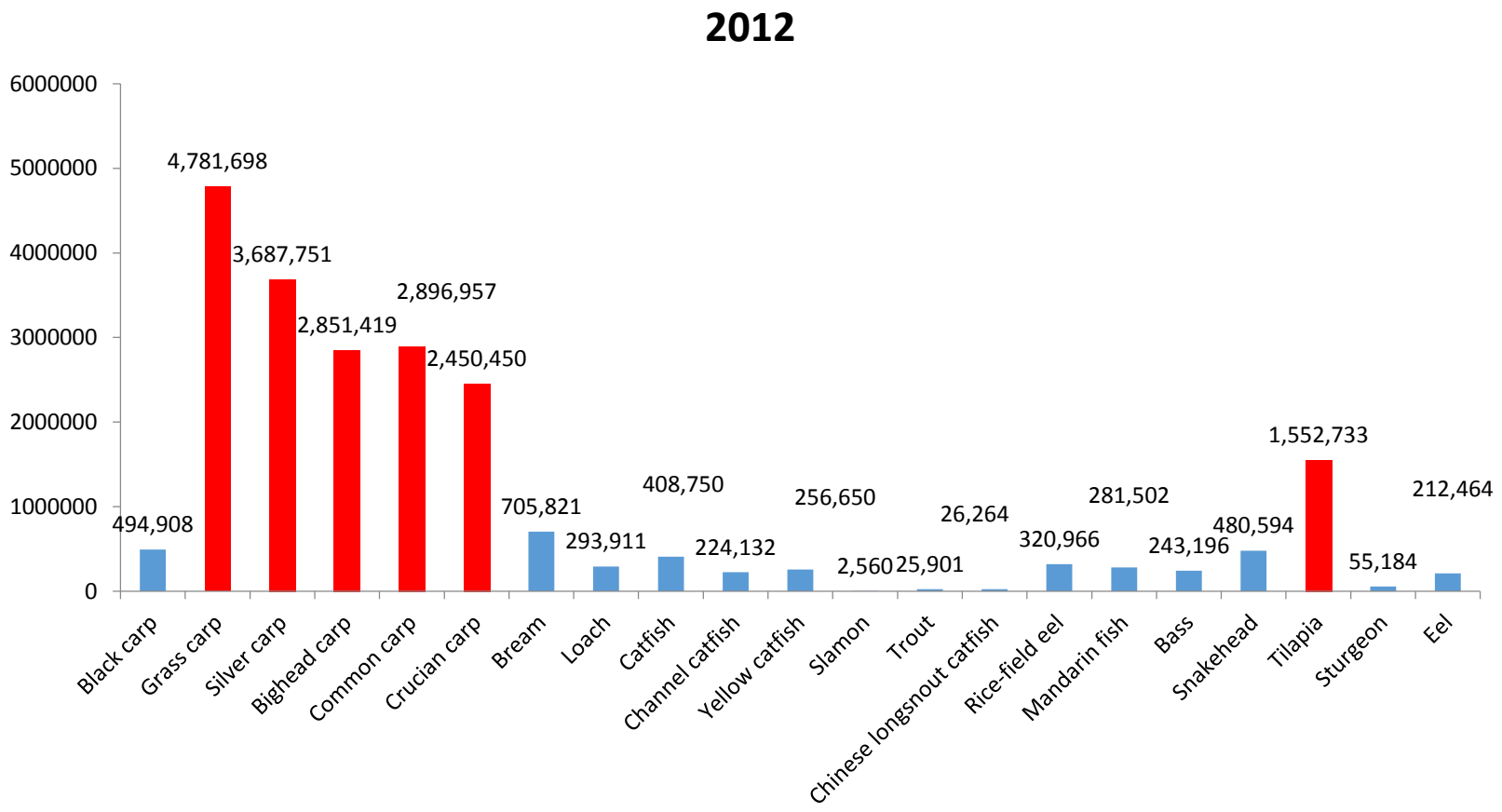
The 15 top ranked provinces for the average annual collective finfish and crustacean production (2000 to 2014) and the percent contribution of each province to the Chinese total aquaculture production (based on FAO Fishstats. 2016)



(Han et al., Review in Aquaculture, in press)

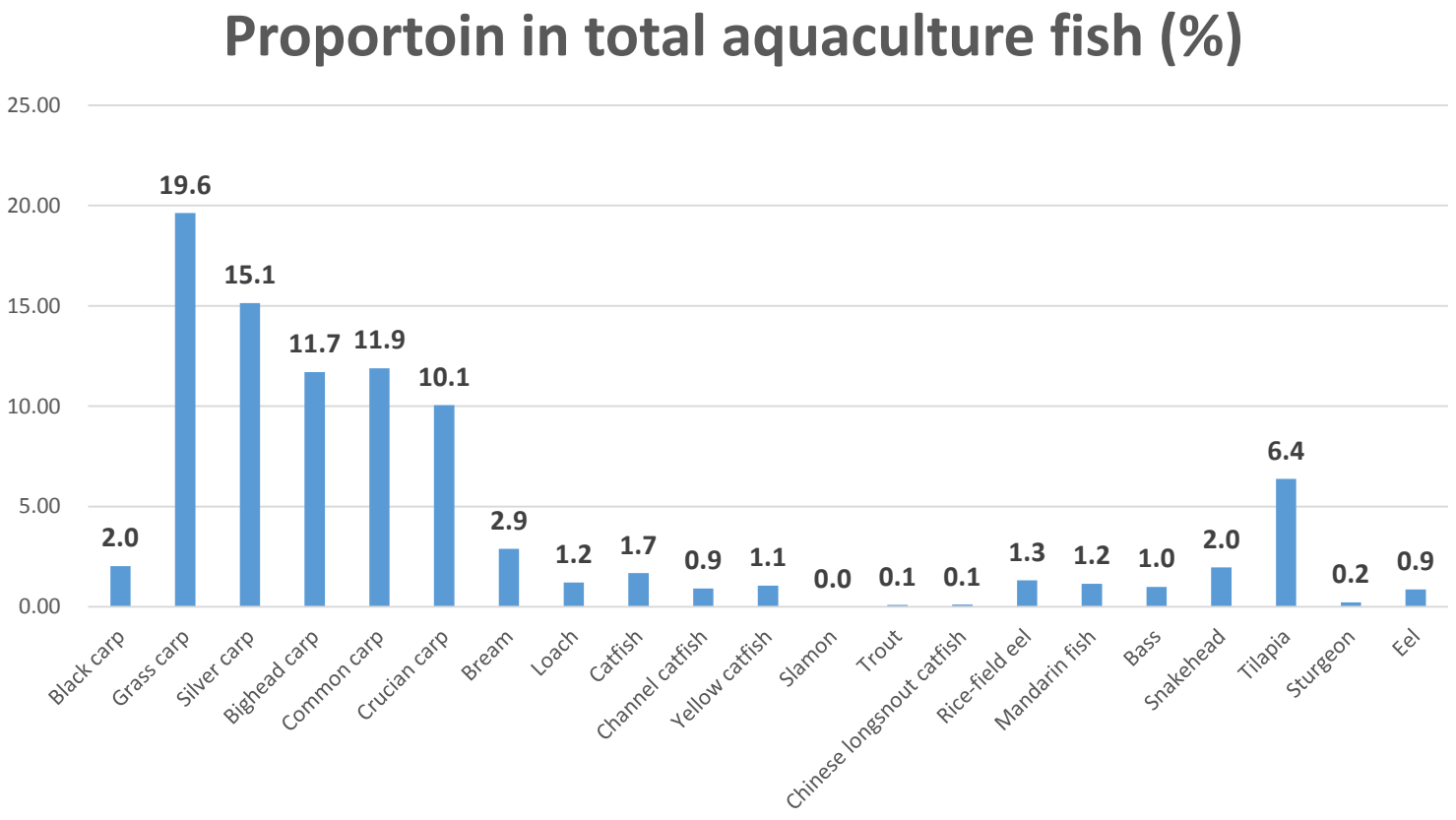
Aquaculture production in China （2012）

tonnes

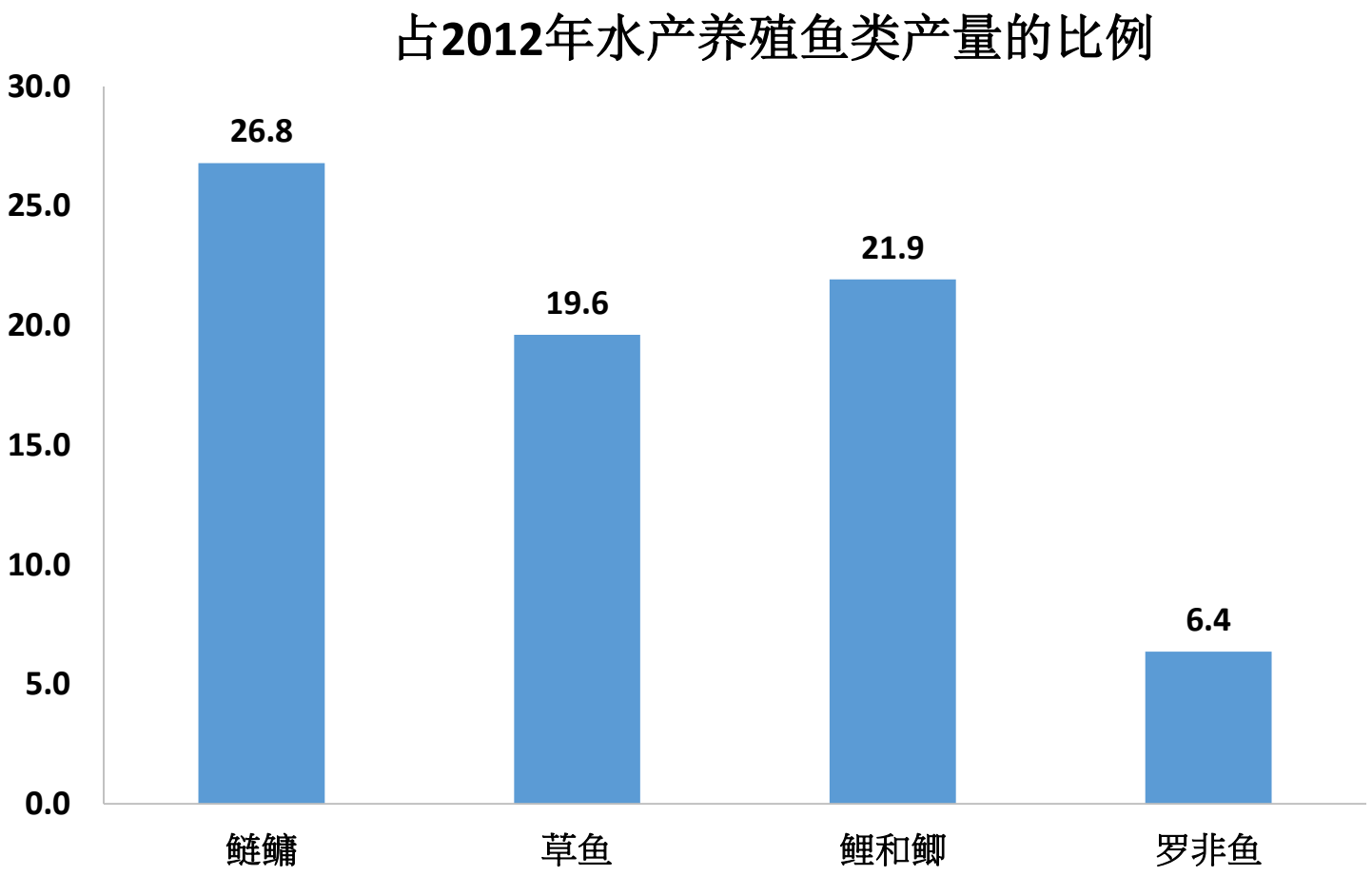


杂食性、草鱼性、滤食性鱼类占82%以上

More than 82% are omnivores, herbivores and filtering fish

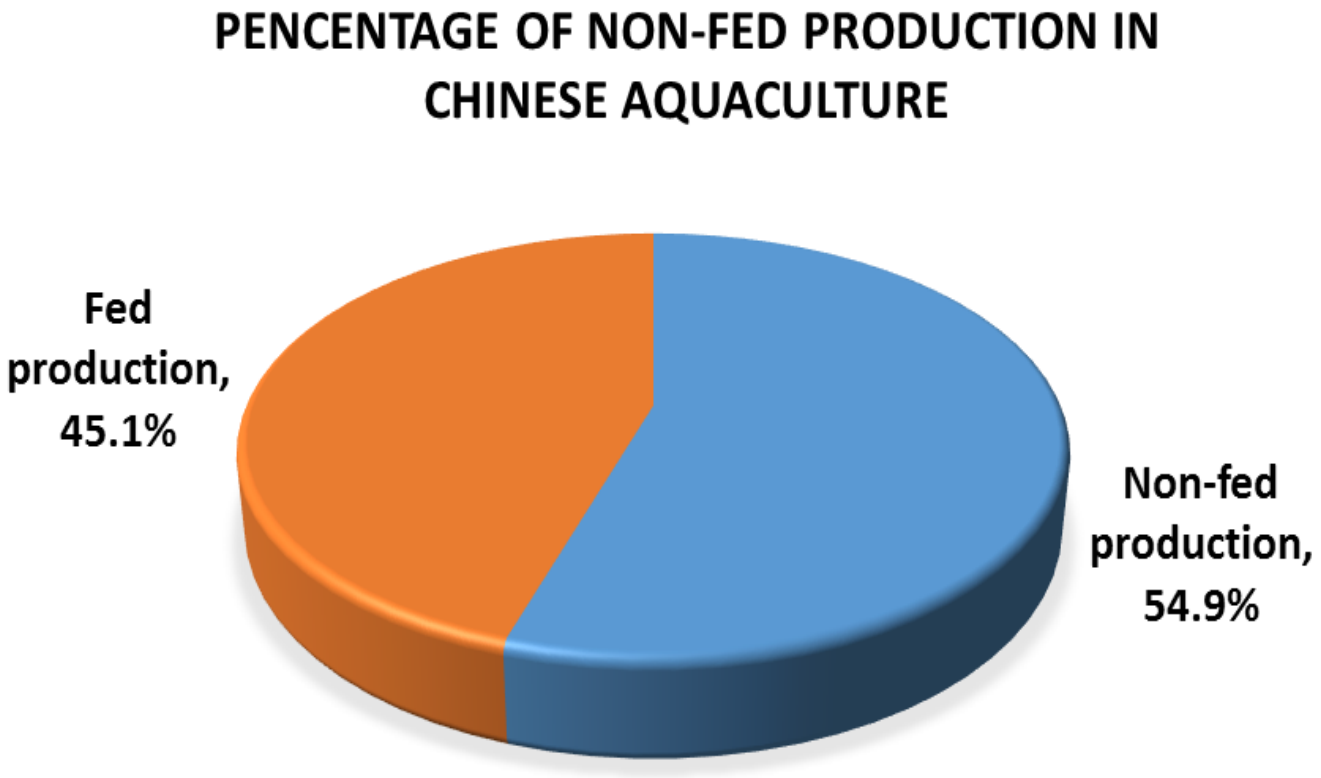


Species of China Aqua Production



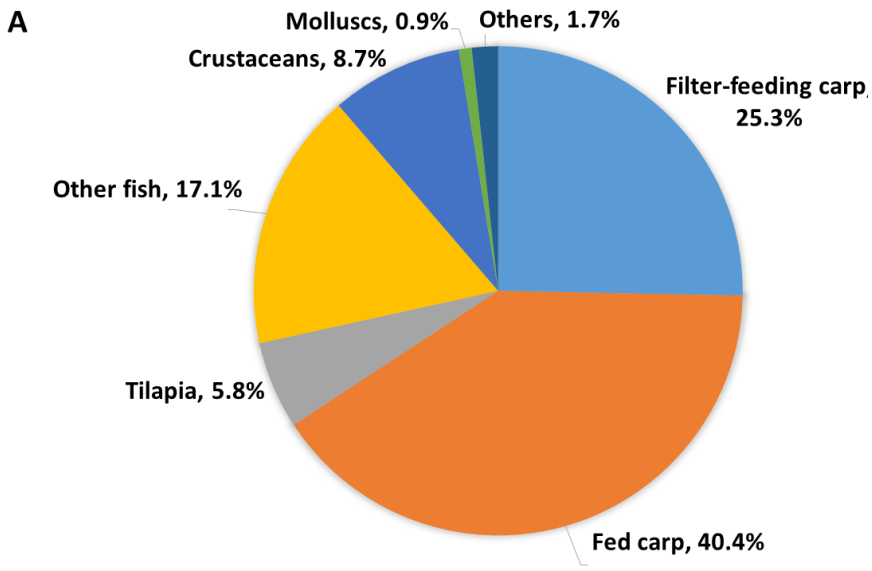
2013年中国渔业统计年鉴

Percentage of Non-Feed Production

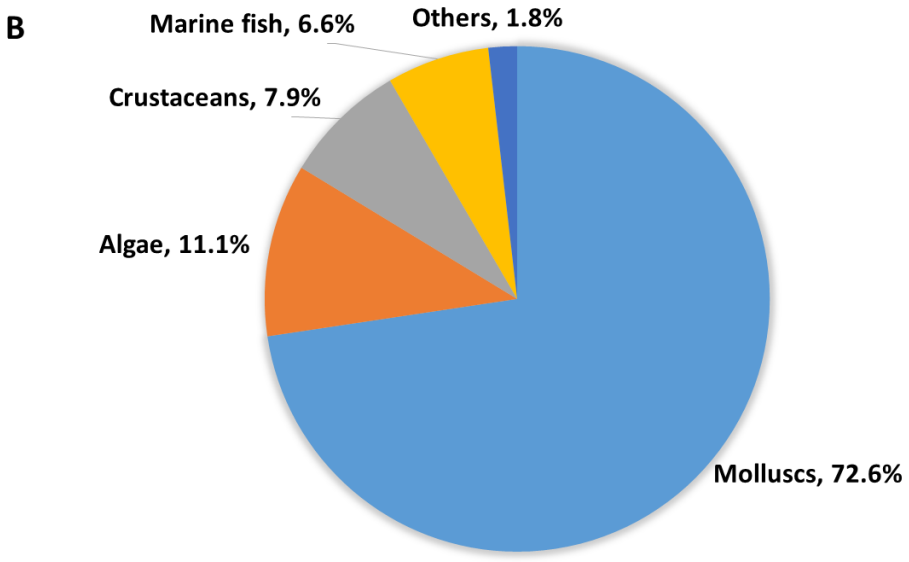


(Han et al., Review in Aquaculture, in press)

Percentage of the production of selected species in total production of A) freshwater aquaculture and B) marine aquaculture in 2014. Data are from China Fishery Statistical Yearbook (2015).

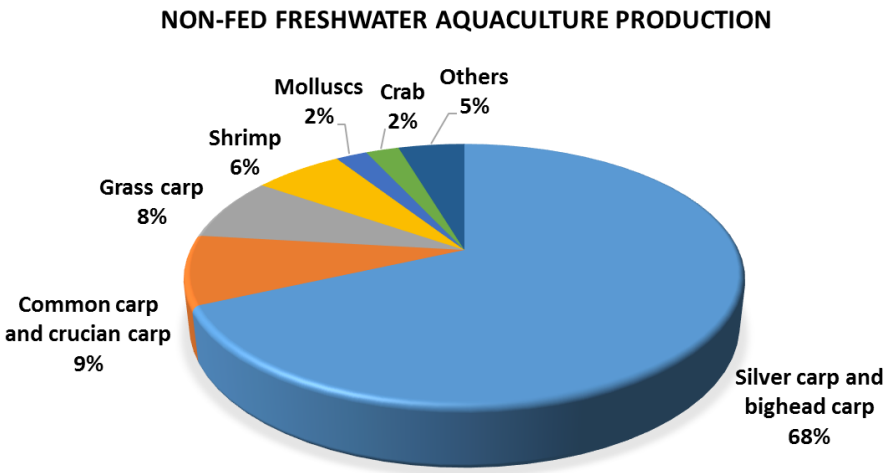


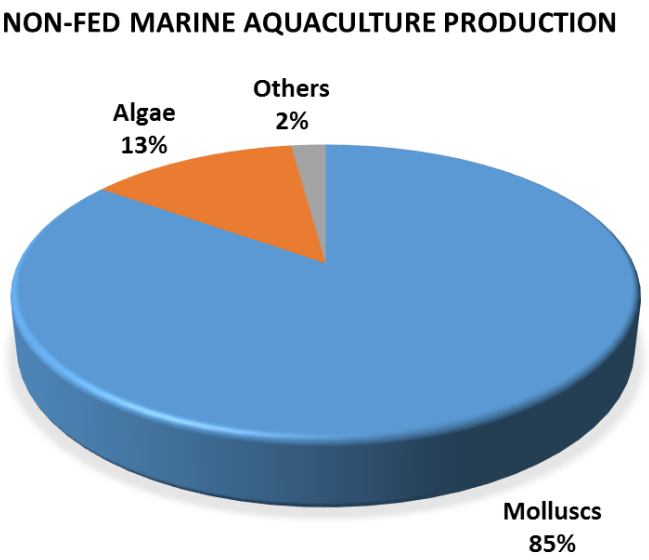
淡水养殖的比例



海水养殖的比例

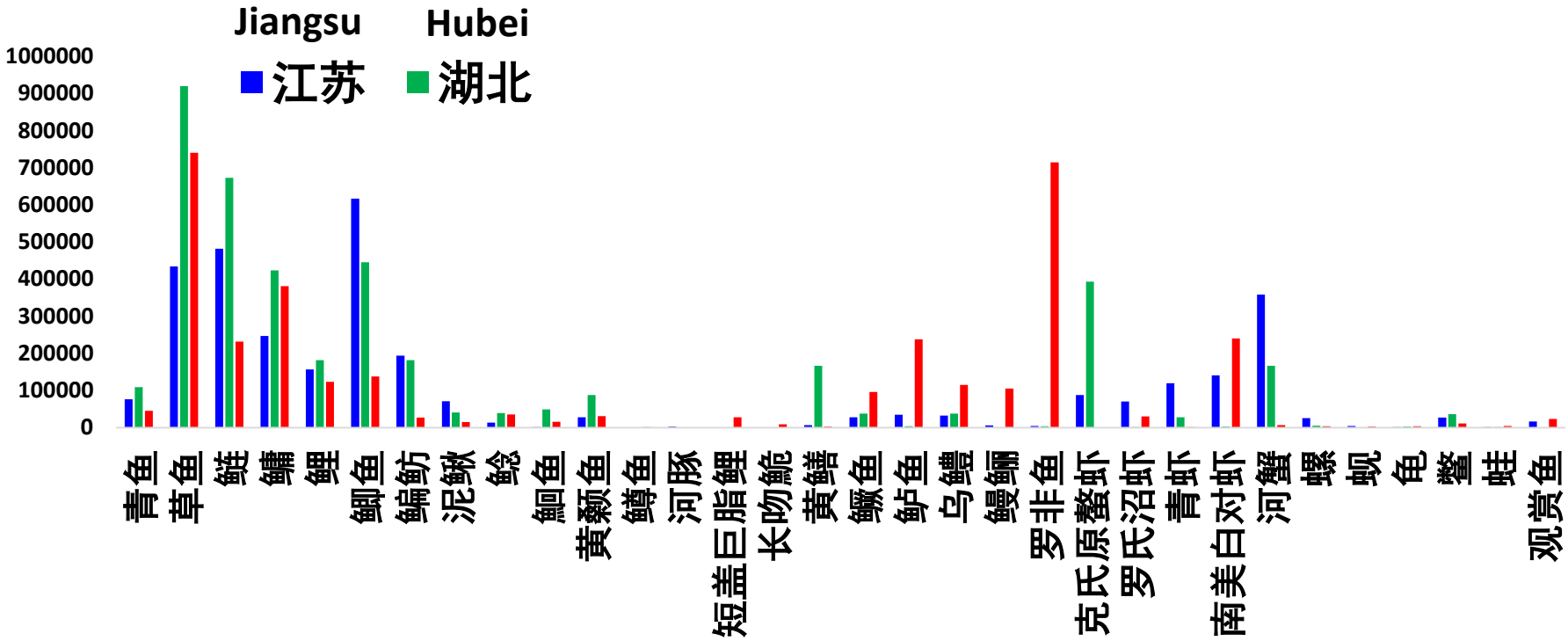
(Han et al., Review in Aquaculture, in press)



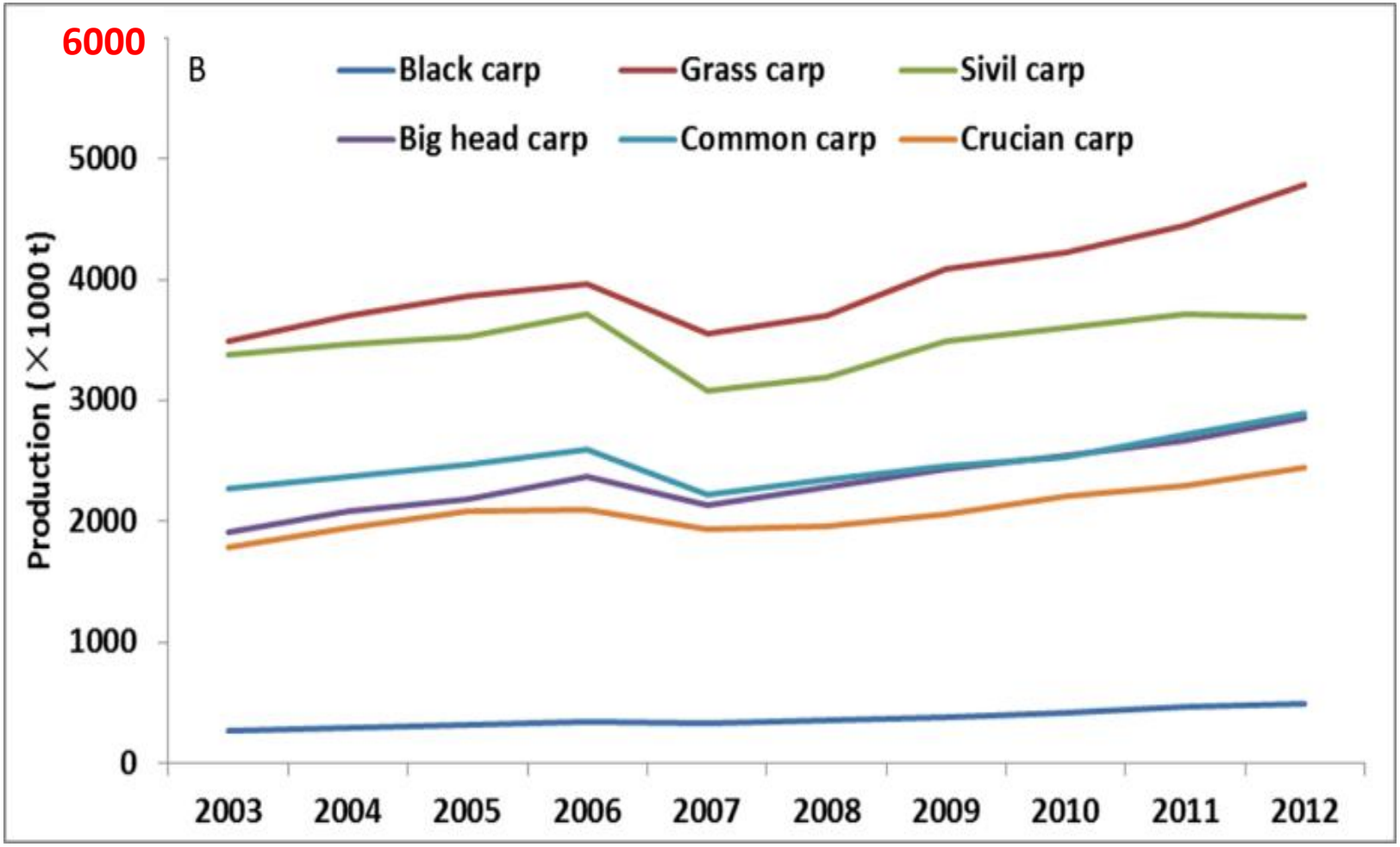


(Han et al., Review in Aquaculture, in press)

Aqua Production of Main Province 2014 (MT)

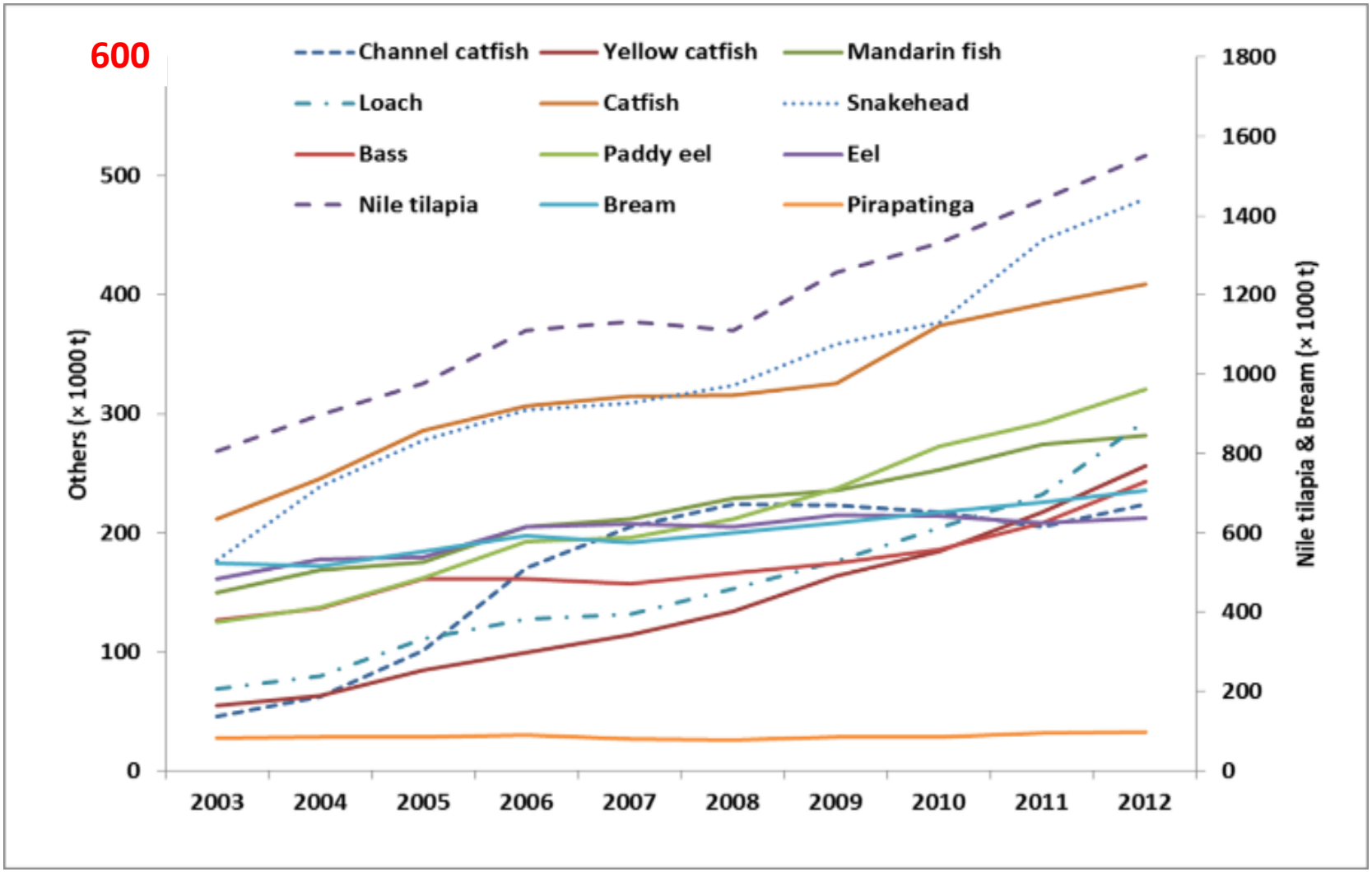


grass carp, common carp, crucian carp, big head carp production is increasing.



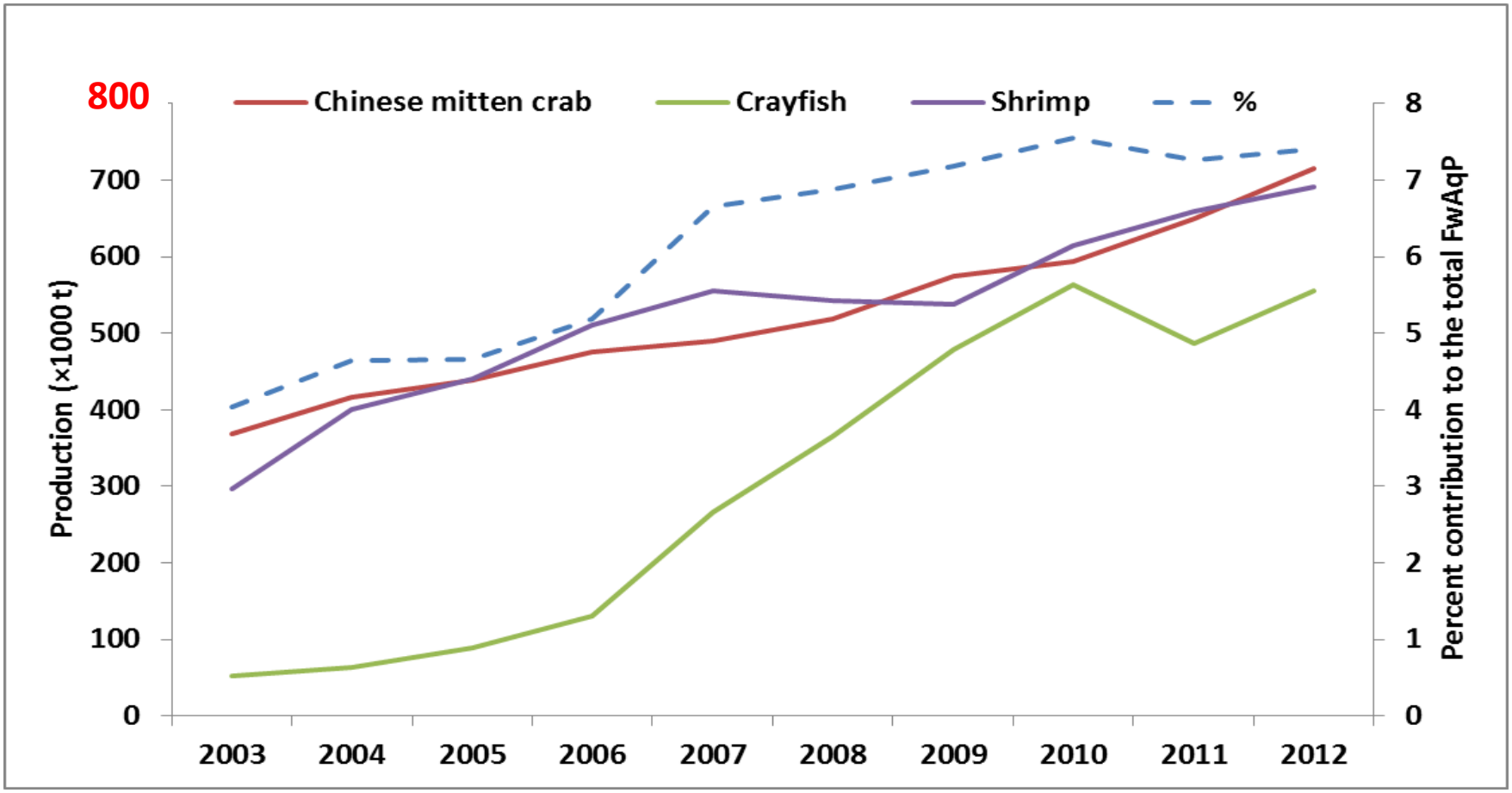
Wang et al., 2014

grass carp, common carp, crucian carp, big head carp production is increasing.



Wang et al., 2014

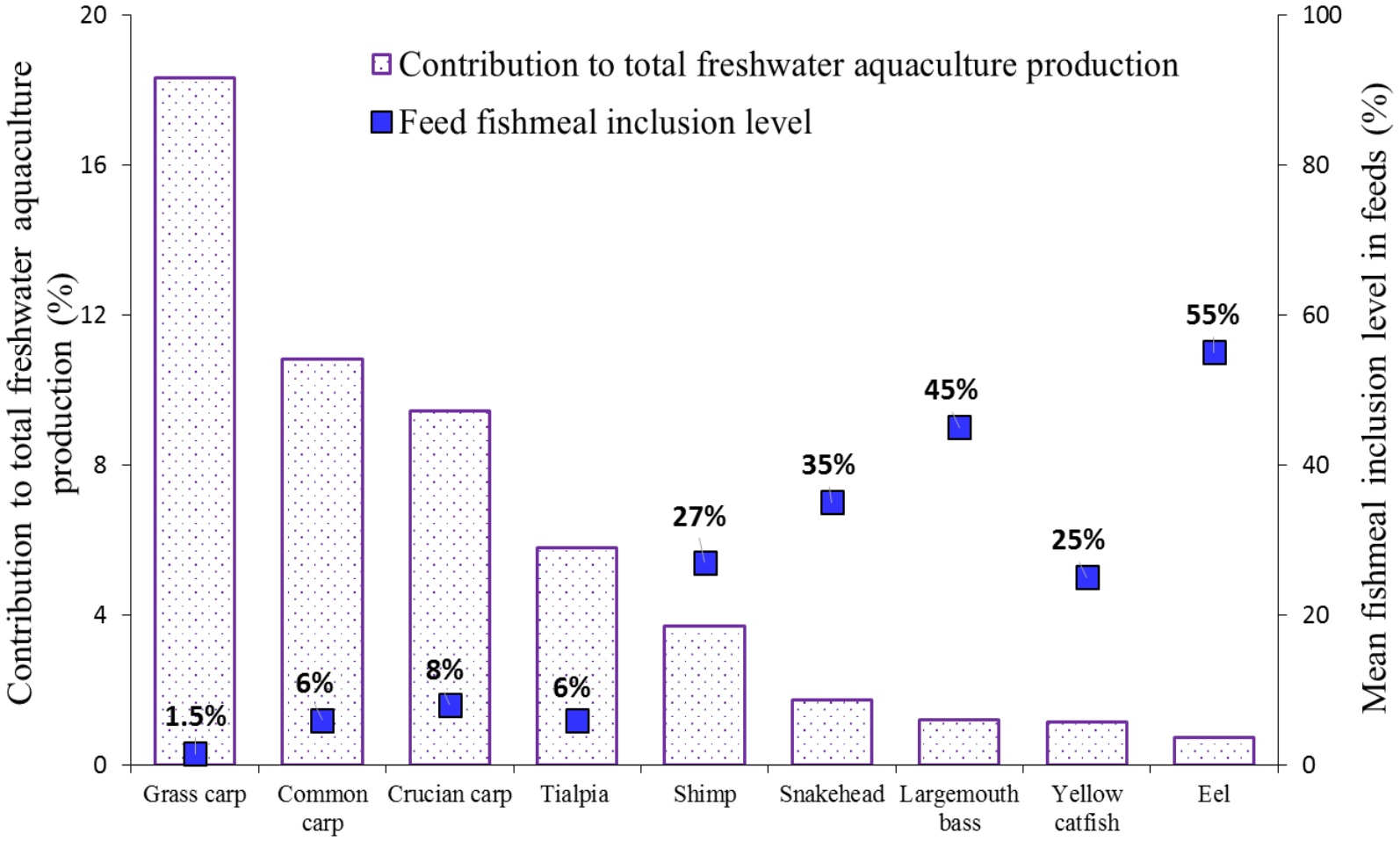
grass carp, common carp, crucian carp, big head carp production is increasing.



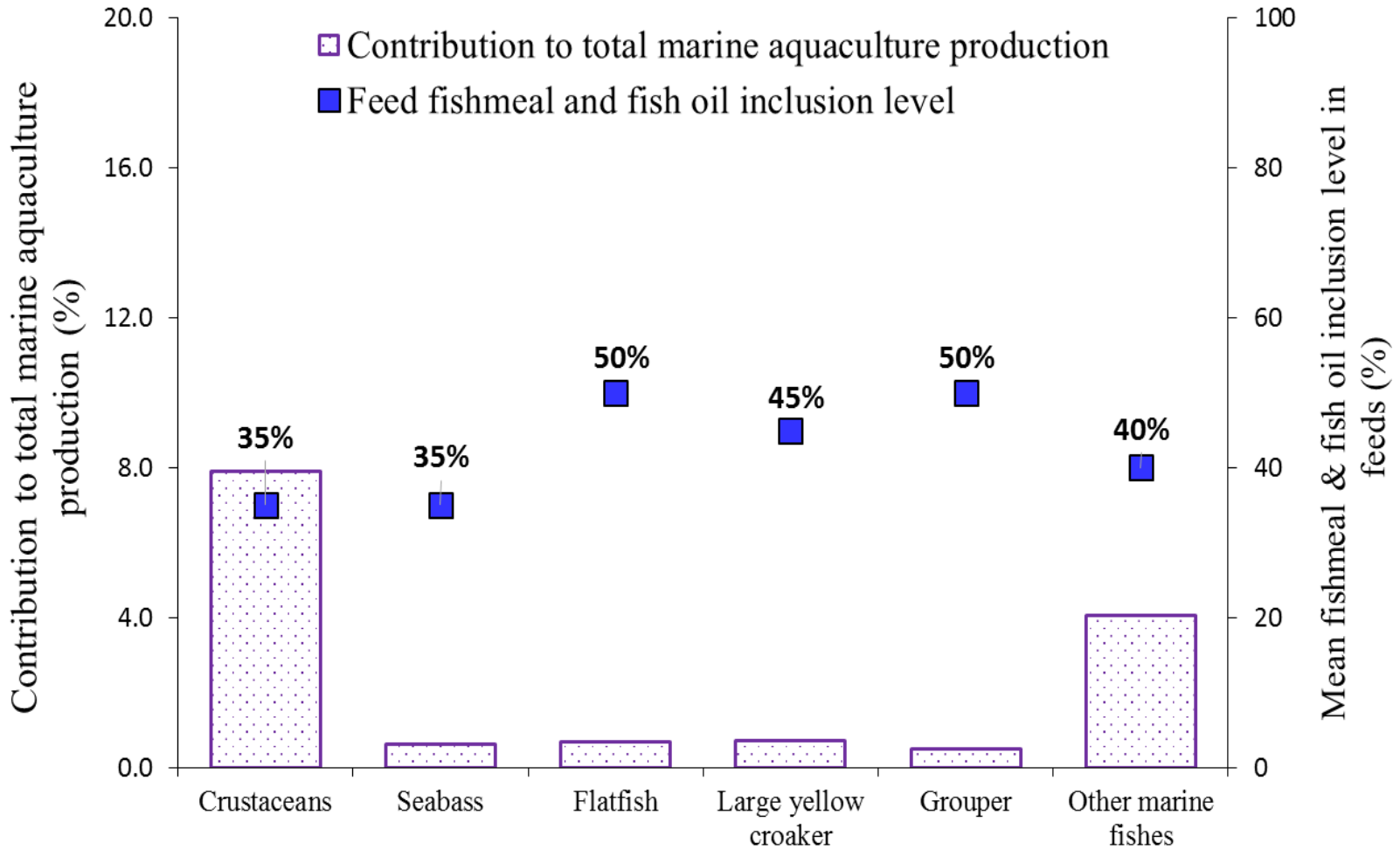
Wang et al., 2014

主产品种对鱼粉的需求不高

Dominant production do not require high dietary fishmeal



(Han et al., Review in Aquaculture, in press)

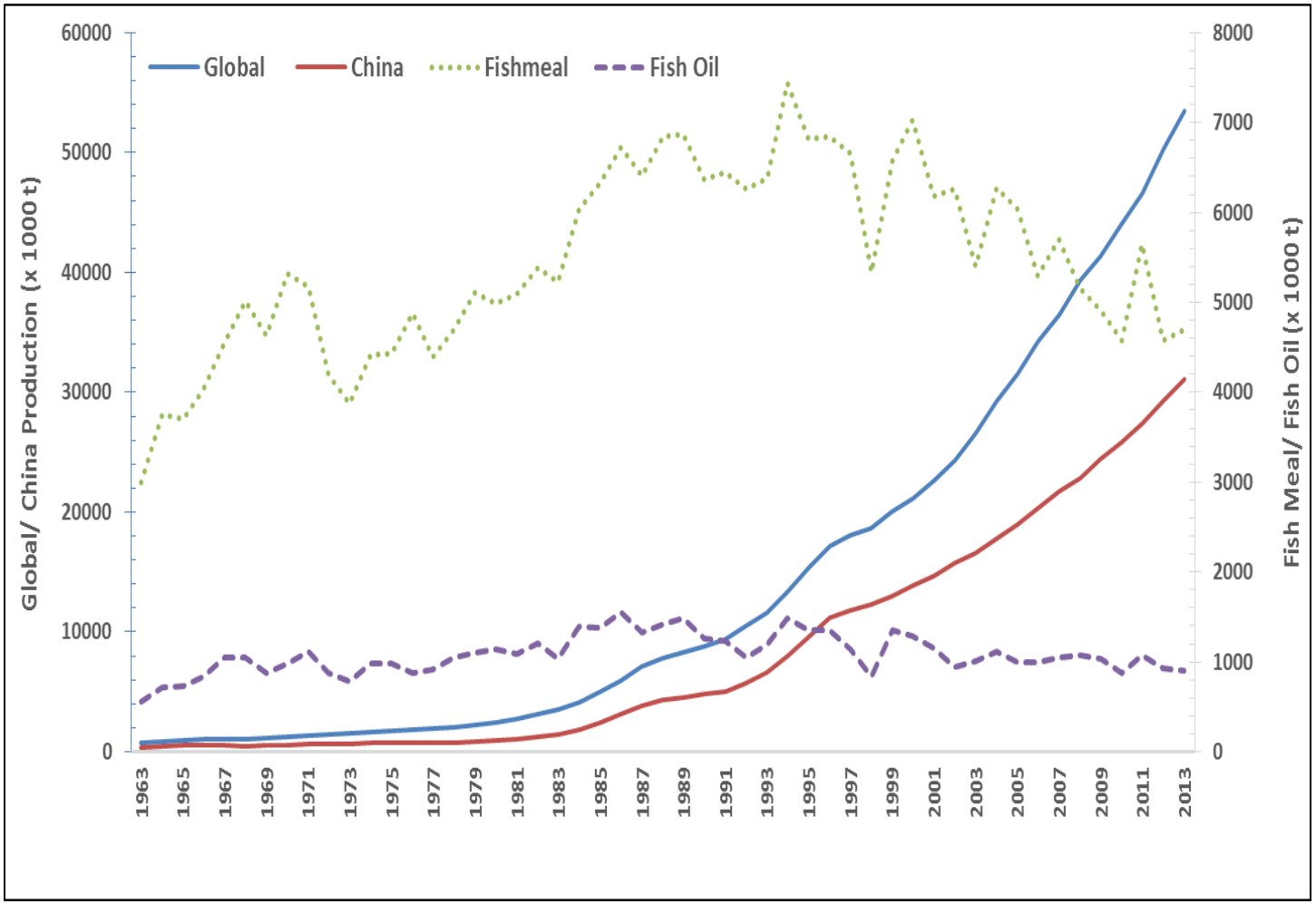


(Han et al., Review in Aquaculture, in press)

养殖产量的增加没有导致鱼粉鱼油用量的增加

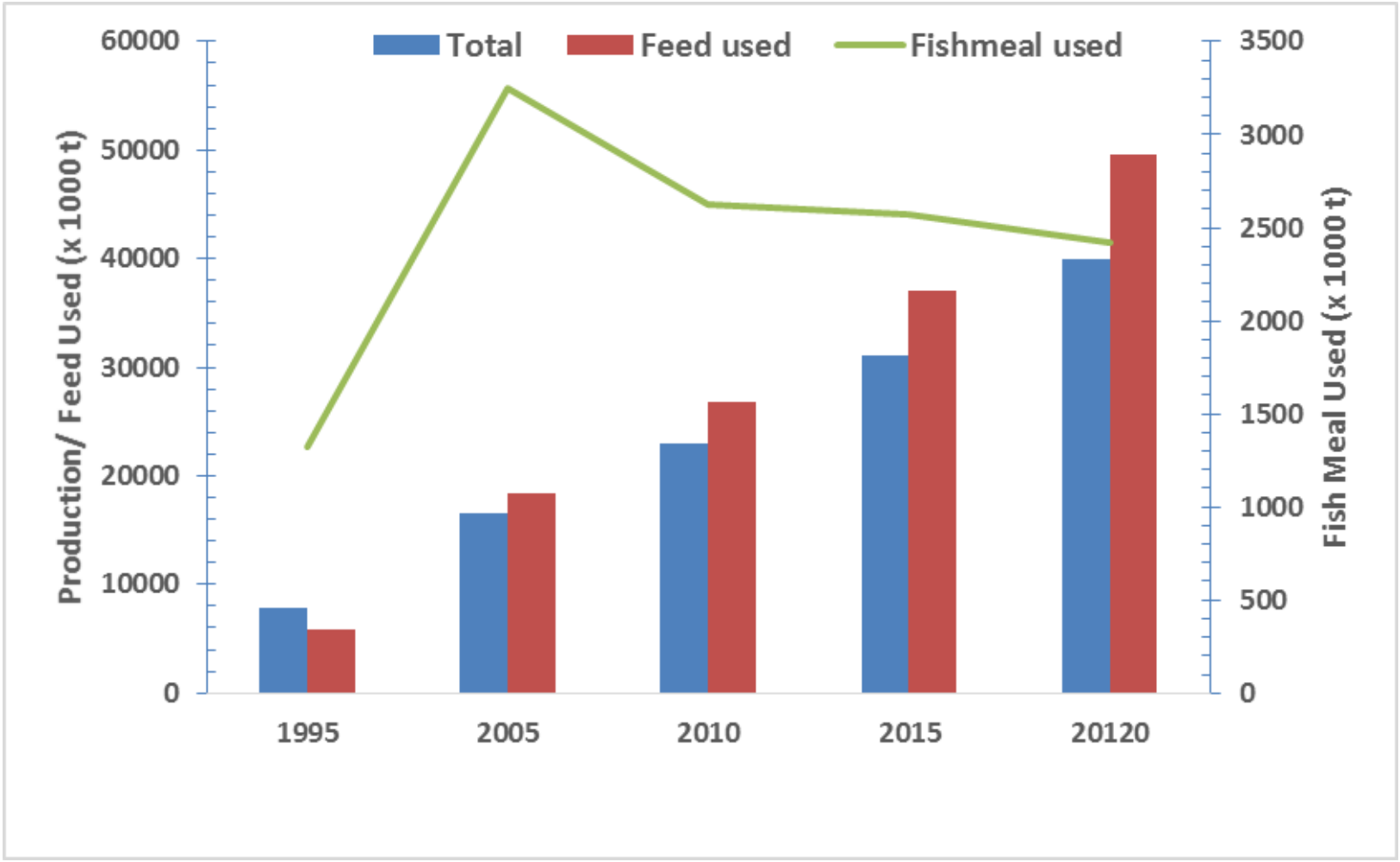
Increased aquaculture production

did not result in increased fishmeal and fish oil consumption



近期饲料产量的增加没有导致鱼粉用量的增加

Recent increased aquafeed production did not result in increased fishmeal consumption



Total Production, production with Feed, Percentage, Average, Trophic (2014)

Species	Total production (mmt)	Production with feeds (mmt)	Percent of freshwater or marine output (%)	Average fishmeal in feed (%)	[1]Trophic level
Freshwater culture					
Grass carp	5.38	4.57	18.33	1.5	2.03
[2]Silver carp	4.23	0.19	14.41	0.0	2.33
[2]Big-head carp	3.20	0.15	10.90	0.0	2.77
Common carp	3.17	2.70	10.80	6.0	2.12
Crucian carp	2.77	2.35	9.44	8.0	2.16
Tilapia	1.70	1.53	5.79	6.0	2.12
[3]Other fishes	5.58	3.82	19.01	25.0	2.50
Shrimp	1.76	1.10	6.00	27.0	2.54
Crab	0.80	0.56	2.73	40.0	2.80
Molluscs	0.25	0.00	0.85	-	2.25
Algae	0.01	0.00	0.03	-	1.00
[4]Others	0.51	0.51	1.74	45.0	2.90
Total	29.36	17.48	100.0		[7]2.36
Marine culture					
Seabass	0.11	0.10	0.61	35.0	3.08
Flatfish	0.13	0.08	0.72	50.0	3.85
Large yellow croaker	0.13	0.03	0.72	45.0	4.25
Grouper	0.09	0.01	0.50	50.0	4.44
[5]Other fishes	0.74	0.37	4.08	40.0	3.46
Crustaceans	1.43	1.06	0.00	35.0	2.75
Molluscs	13.17	0.01	7.89	-	2.03
Algae	2.00	0.00	72.64	-	1.00
[6]Others	0.33	0.00	11.03	0.0	2.60
Total	18.13	1.66	100.0		[7]2.09

(Han et al., Review in Aquaculture, in press)

Index

1. Development of aquaculture and demand for protein
2. International fishmeal production is relatively stable
3. Structure and trophic level of cultured breeds in China
4. Feed technology is becoming more mature, alternative source technology has been developed
5. Aquatic products processing ratio increased, more by-products can be reused
6. Nutrient utilization improved and the recycle concept developed
7. Recent industrial development goals

FM in aquafeed is decreasing

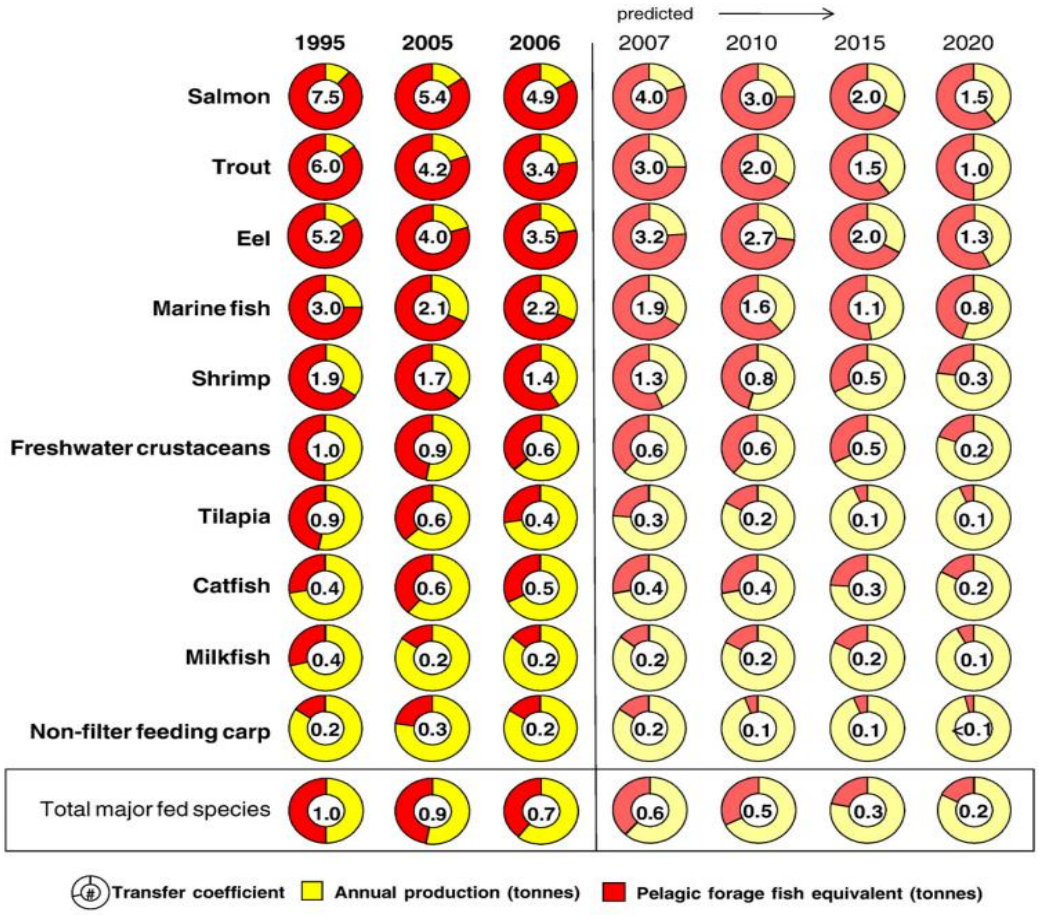
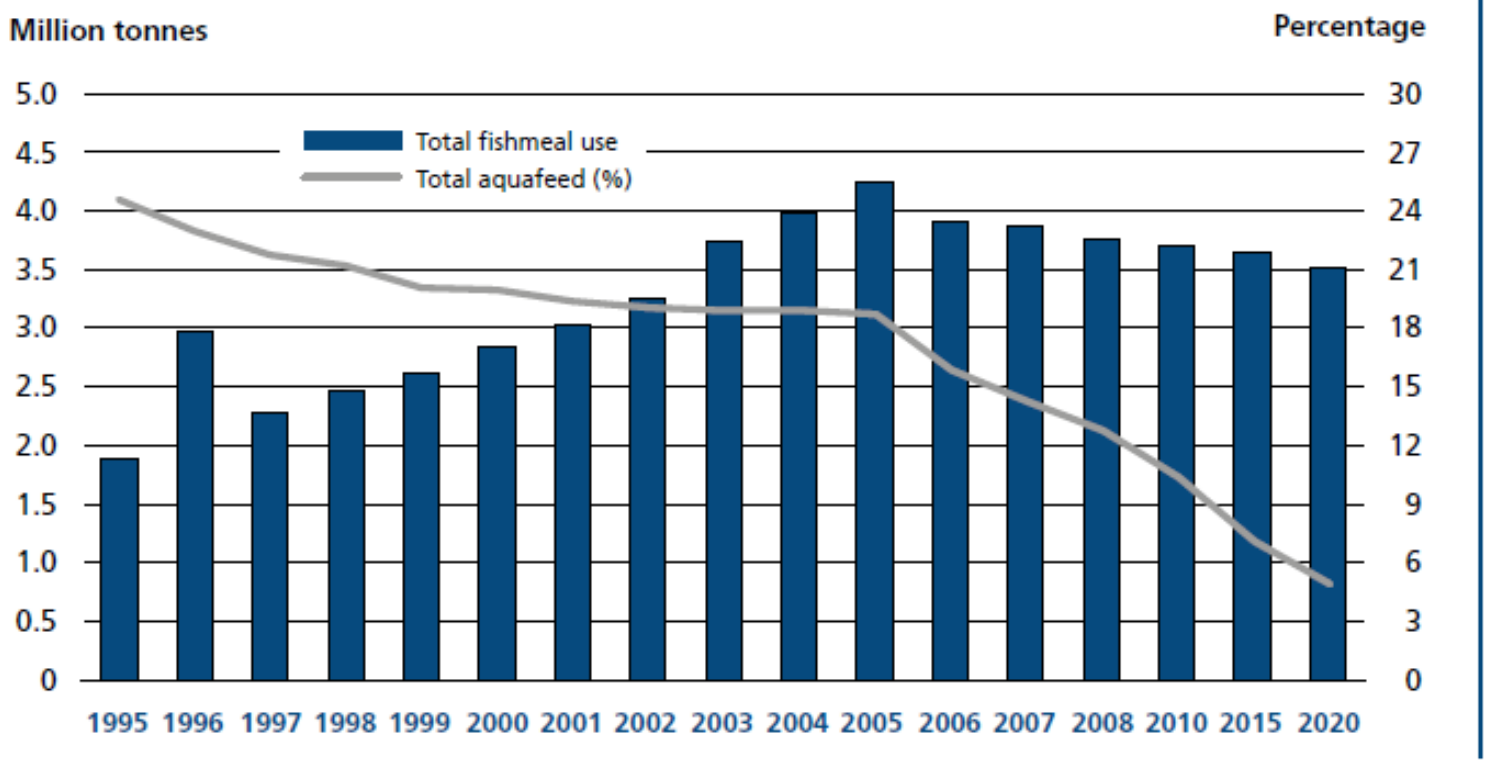


Fig. 7. Calculated pelagic forage fish equivalent per unit of production for major cultivated species groups.

Tacon and Metian, 2008

Low FM、No FM Technology mature

Actual and predicted reduction in fishmeal use relative to the global production of compound aquafeed



Source: Adapted from Tacon, A.G.J., Hasan, M.R. and Metian, M. 2011. *Demand and supply of feed ingredients for farmed fish and crustaceans: trends and prospects.* FAO Fisheries and Aquaculture Technical Paper No. 564. Rome, FAO. 87 pp.

http://www.fao.org/docrep/016/i2727e/i2727e.pdf

Reduction in fishmeal inclusion in compound aquafeed of different fish species and species groups

Species/species group	Fishmeal inclusion in compound aquafeed		
	1995	2008	2020*
	(Percentage)		
Fed carp	10	3	1
Tilapias	10	5	1
Catfishes	5	7	2
Milkfish	15	5	2
Miscellaneous freshwater fishes	55	30	8
Salmons	45	25	12
Trouts	40	25	12
Eels	65	48	30
Marine fishes	50	29	12
Marine shrimps	28	20	8
Freshwater crustaceans	25	18	8

* Projected.

Source: Adapted from Tacon, A.G.J., Hasan, M.R. and Metian, M. 2011. *Demand and supply of feed ingredients for farmed fish and crustaceans: trends and prospects.* FAO Fisheries and Aquaculture Technical Paper No. 564. Rome, FAO. 87 pp.

http://www.fao.org/docrep/016/i2727e/i2727e.pdf

Table 5

Aquaculture production by region: quantity and percentage of world total production

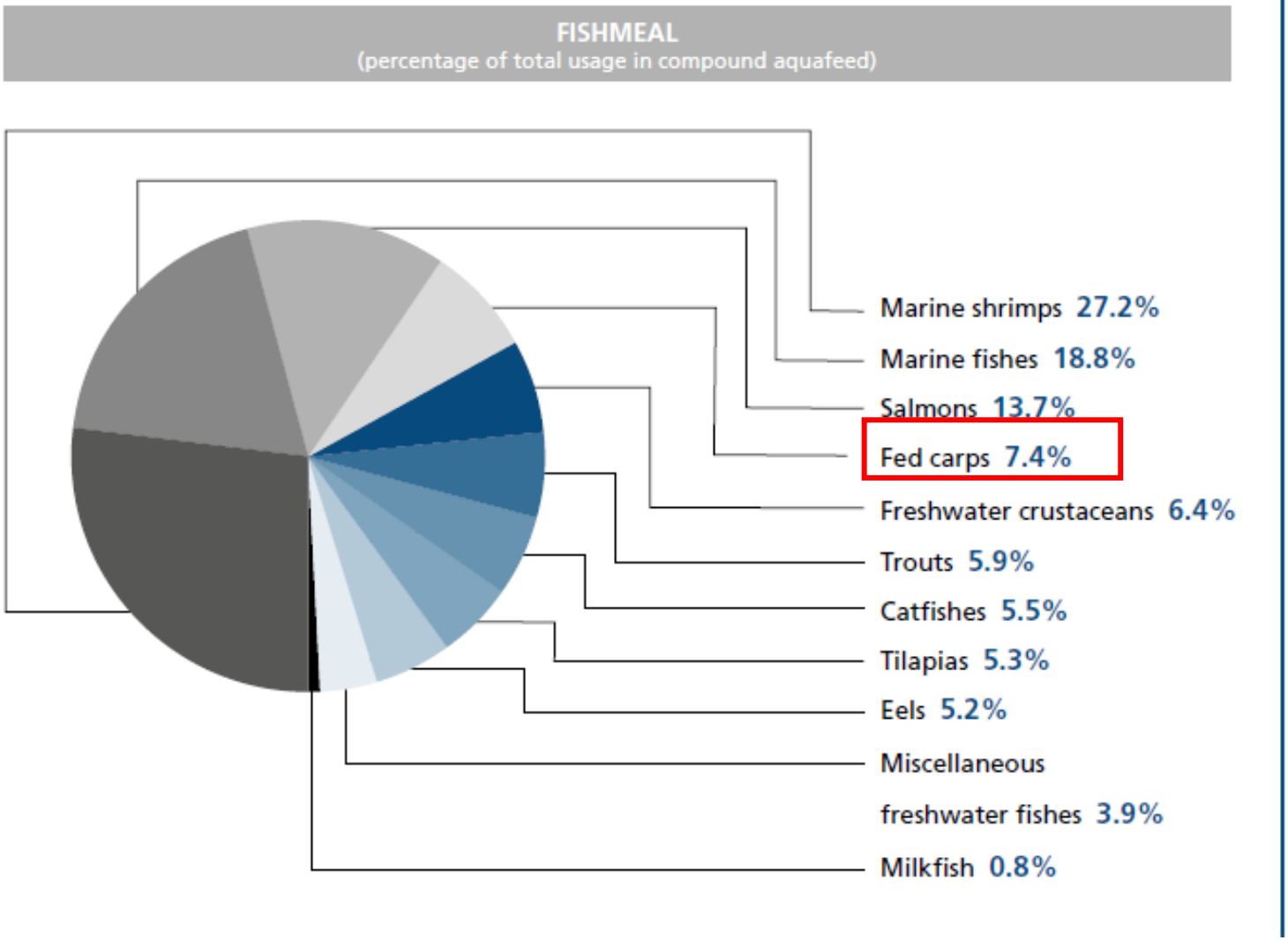
Selected groups and countries		1970	1980	1990	2000	2009	2010
Africa	(tonnes)	**10 271**	**26 202**	**81 015**	**399 676**	**991 183**	**1 288 320**
	(percentage)	***0.40***	***0.60***	***0.60***	***1.20***	***1.80***	***2.20***
Sub-Saharan Africa	(tonnes)	4 243	7 048	17 184	55 690	276 906	359 790
	(percentage)	*0.20*	*0.10*	*0.10*	*0.20*	*0.50*	*0.60*
North Africa	(tonnes)	6 028	19 154	63 831	343 986	714 277	928 530
	(percentage)	*0.20*	*0.40*	*0.50*	*1.10*	*1.30*	*1.60*
Americas	(tonnes)	**173 491**	**198 850**	**548 479**	**1 423 433**	**2 512 829**	**2 576 428**
	(percentage)	***6.80***	***4.20***	***4.20***	***4.40***	***4.50***	***4.30***
Caribbean	(tonnes)	350	2 329	12 169	39 704	42 514	36 871
	(percentage)	*0.00*	*0.00*	*0.10*	*0.10*	*0.10*	*0.10*
Latin America	(tonnes)	869	24 590	179 367	799 234	1 835 888	1 883 134
	(percentage)	*0.00*	*0.50*	*1.40*	*2.50*	*3.30*	*3.10*
North America	(tonnes)	172 272	171 931	356 943	584 495	634 427	656 423
	(percentage)	*6.70*	*3.70*	*2.70*	*1.80*	*1.10*	*1.10*
Asia	(tonnes)	**1 799 101**	**3 552 382**	**10 801 356**	**28 422 189**	**49 538 019**	**53 301 157**
	(percentage)	***70.10***	***75.50***	***82.60***	***87.70***	***88.90***	***89.00***
Asia (excluding China and Near East)	(tonnes)	1 034 703	2 222 670	4 278 355	6 843 429	14 522 862	16 288 881
	(percentage)	*40.30*	*47.20*	*32.70*	*21.10*	*26.10*	*27.20*
China	(tonnes)	764 380	1 316 278	6 482 402	21 522 095	34 779 870	36 734 215
	(percentage)	*29.80*	*28.00*	*49.60*	*66.40*	*62.40*	*61.40*
Near East	(tonnes)	18	13 434	40 599	56 665	235 286	278 061
	(percentage)	*0.00*	*0.30*	*0.30*	*0.20*	*0.40*	*0.50*
Europe	(tonnes)	**575 598**	**916 183**	**1 601 524**	**2 050 958**	**2 499 042**	**2 523 179**
	(percentage)	***22.40***	***19.50***	***12.20***	***6.30***	***4.50***	***4.20***
European Union (27)	(tonnes)	471 282	720 215	1 033 982	1 395 669	1 275 833	1 261 592
	(percentage)	*18.40*	*15.30*	*7.90*	*4.30*	*2.30*	*2.10*
Non-European-Union countries	(tonnes)	26 616	38 594	567 667	657 167	1 226 625	1 265 703
	(percentage)	*1.00*	*0.80*	*4.30*	*2.00*	*2.20*	*2.10*
Oceania	(tonnes)	**8 421**	**12 224**	**42 005**	**121 482**	**173 283**	**183 516**
	(percentage)	***0.30***	***0.30***	***0.30***	***0.40***	***0.30***	***0.30***
World	(tonnes)	**2 566 882**	**4 705 841**	**13 074 379**	**32 417 738**	**55 714 357**	**59 872 600**

Notes: Data exclude aquatic plants and non-food products. Data for 2010 for some countries are provisional and subject to revisions. Production values for 1980 for Europe include the former Soviet Union.

China consumes about 30% world fishmeal and produce about 60% aquaculture production.

http://www.fao.org/docrep/016/i2727e/i2727e.pdf

Global consumption of fishmeal and fish oil by major aquaculture species groups in 2008



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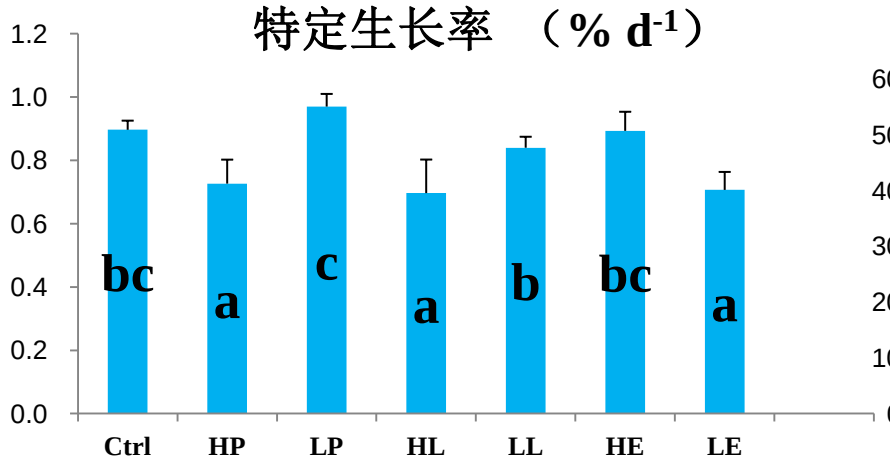
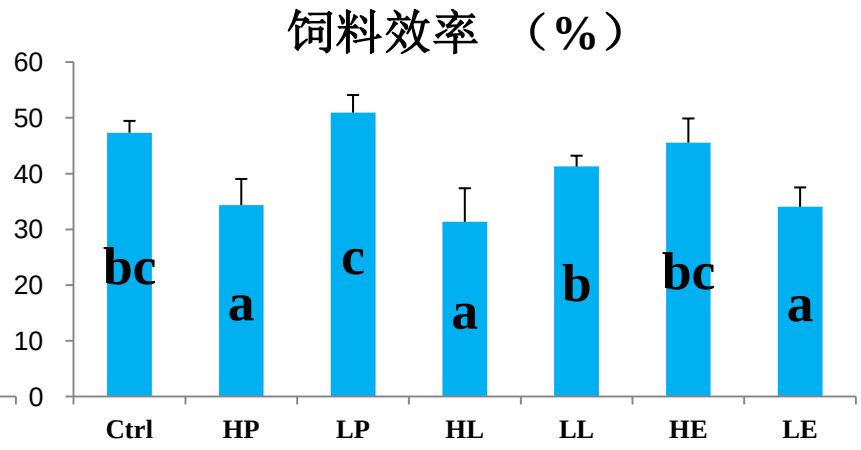
新型饲料技术降低对鱼粉的需求：

New technology help to reduce dietary fishmeal

降低饲料蛋白含量

Reduce dietary protein



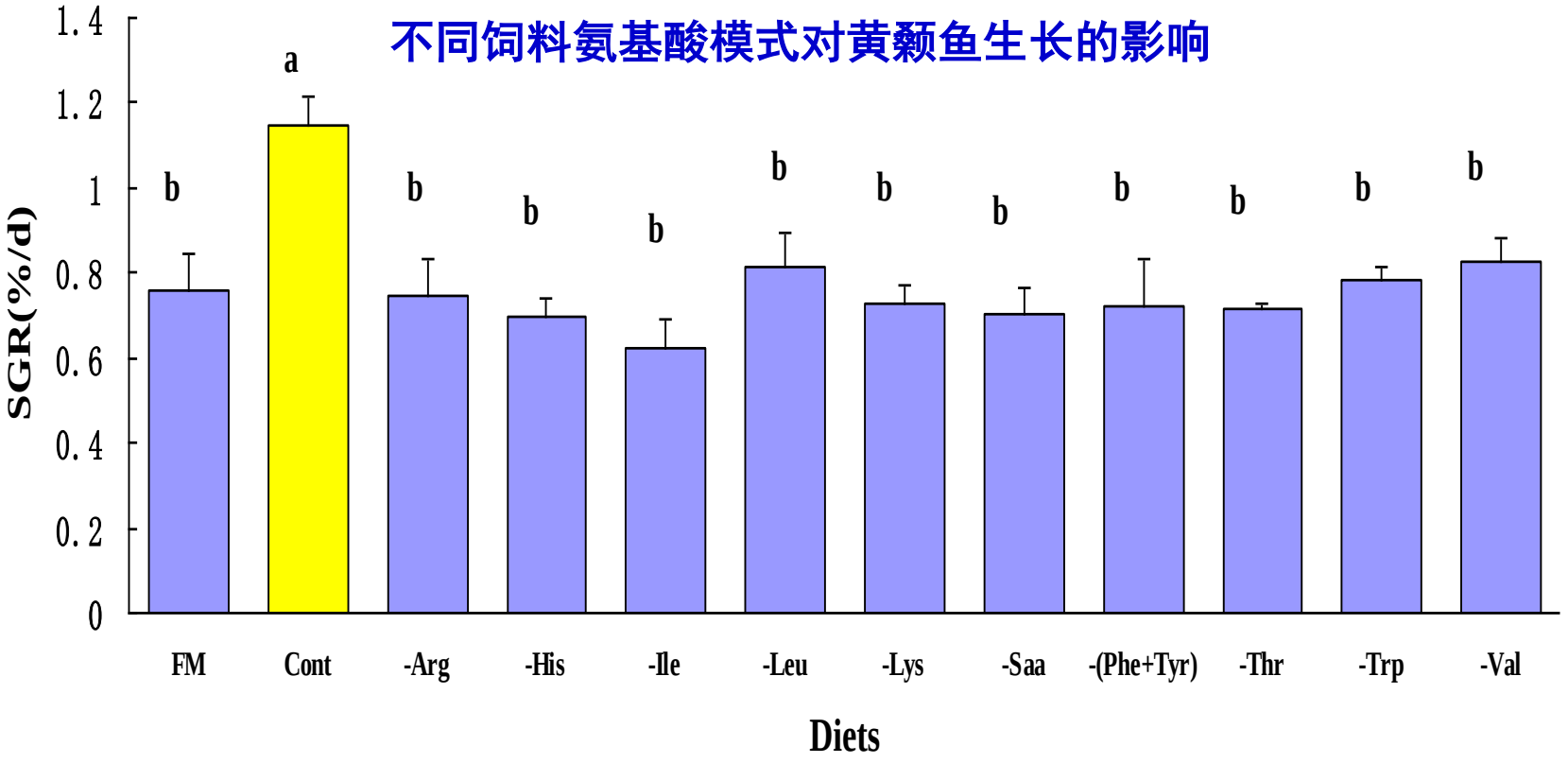


新型饲料技术降低对鱼粉的需求：

New technology help to reduce dietary fishmeal

理想氨基酸模式

Ideal dietary amino acid composition



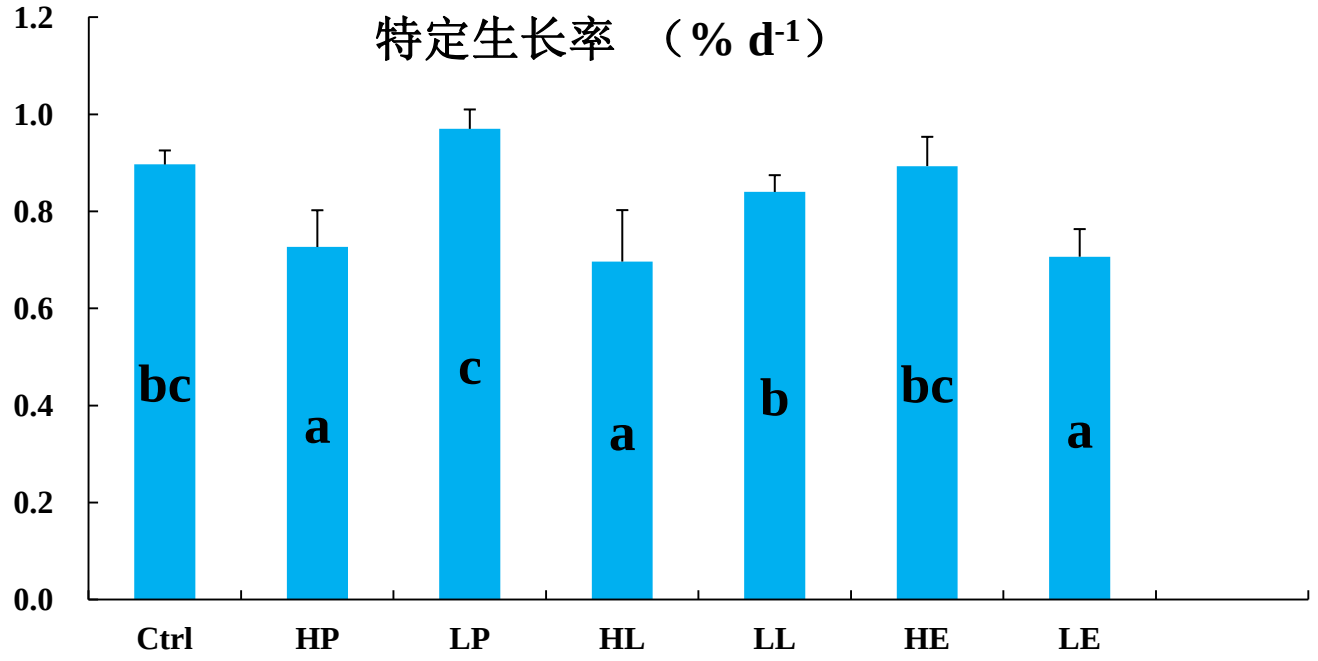
新型饲料技术降低对鱼粉的需求：

New technology help to reduce dietary fishmeal

利用能量饲料

Increase dietary non-protein energy

不同饲料配方对异育银鲫生长的影响



新型饲料技术降低对鱼粉的需求：

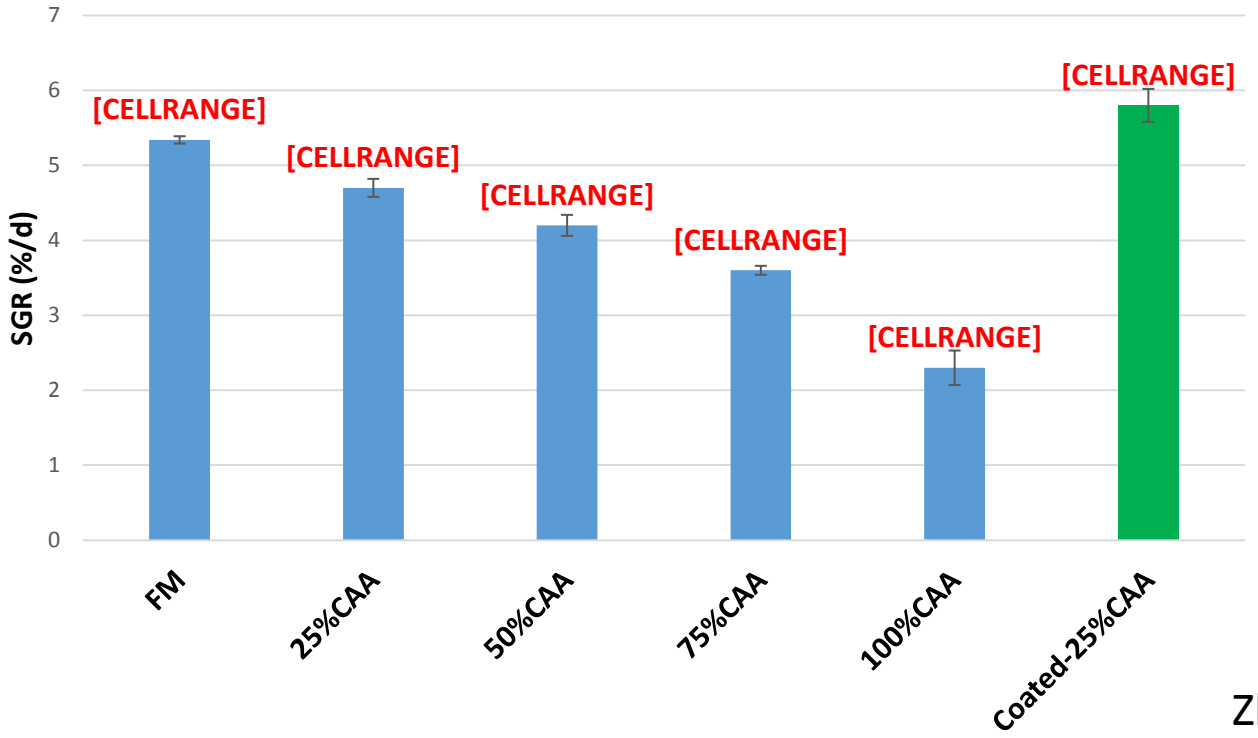
New technology help to reduce dietary fishmeal

提高氨基酸利用率

Increase the utilization of crystal amino acids

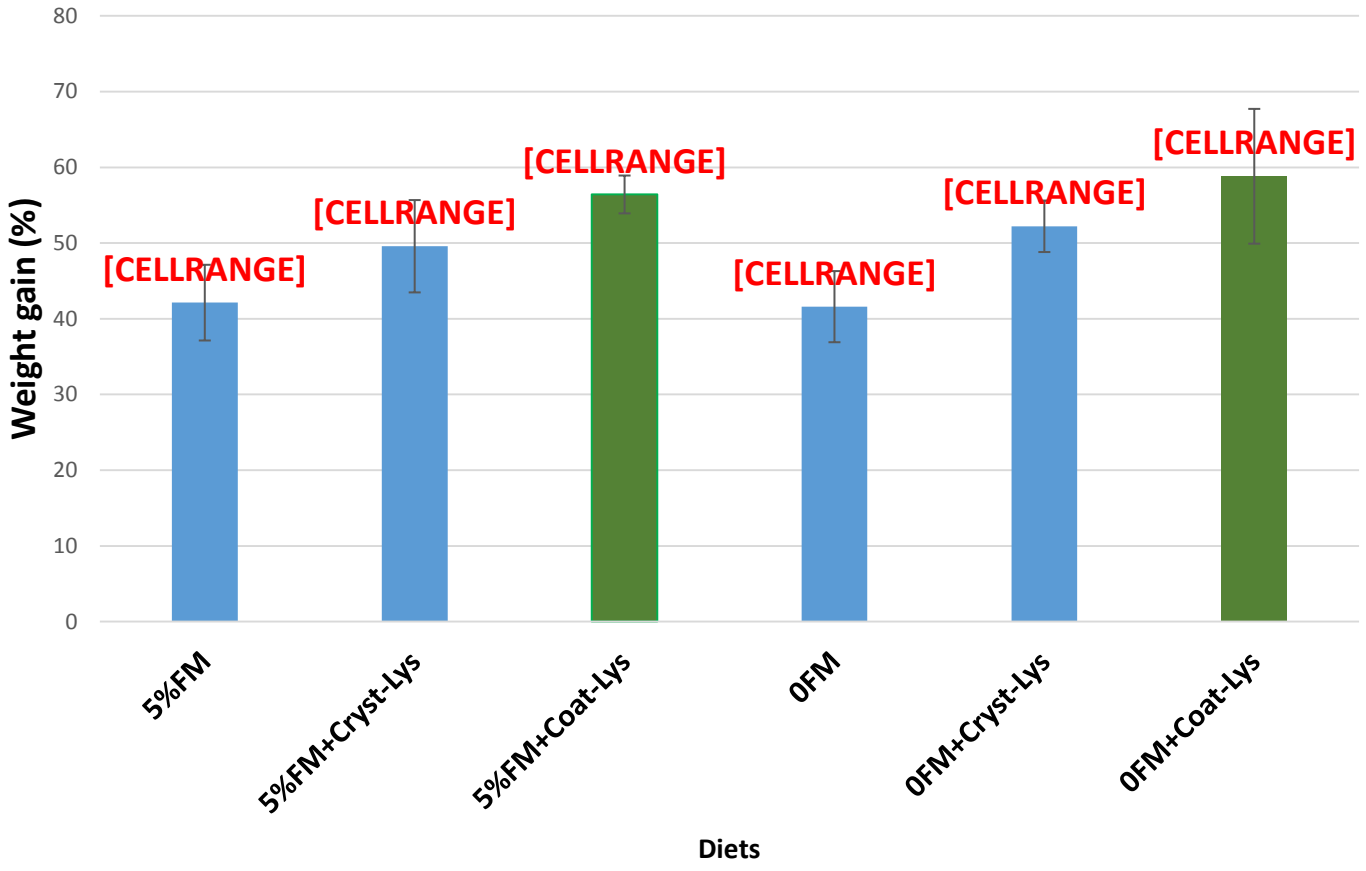
Coated amino acids could improve the utilization

Crystalline amino acid supplementation in the diets for tongue sole larvae



Zhang, 2013

Dietary supplemental coated amino acid showed better growth than crystalline amino acid



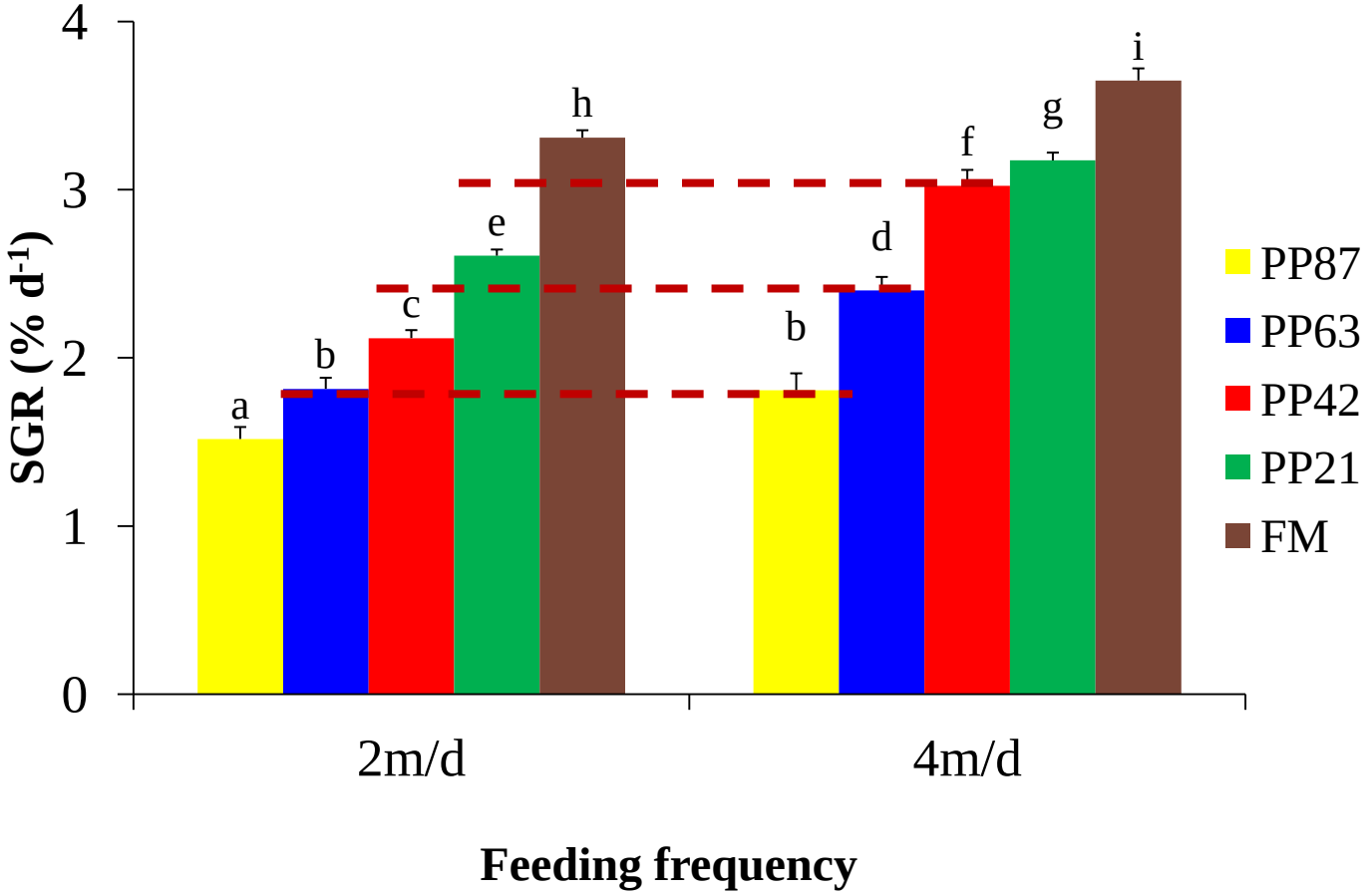
Liu et al., 1999

新型饲料技术降低对鱼粉的需求：

New technology help to reduce dietary fishmeal

改变投喂模式

Improve feeding regime



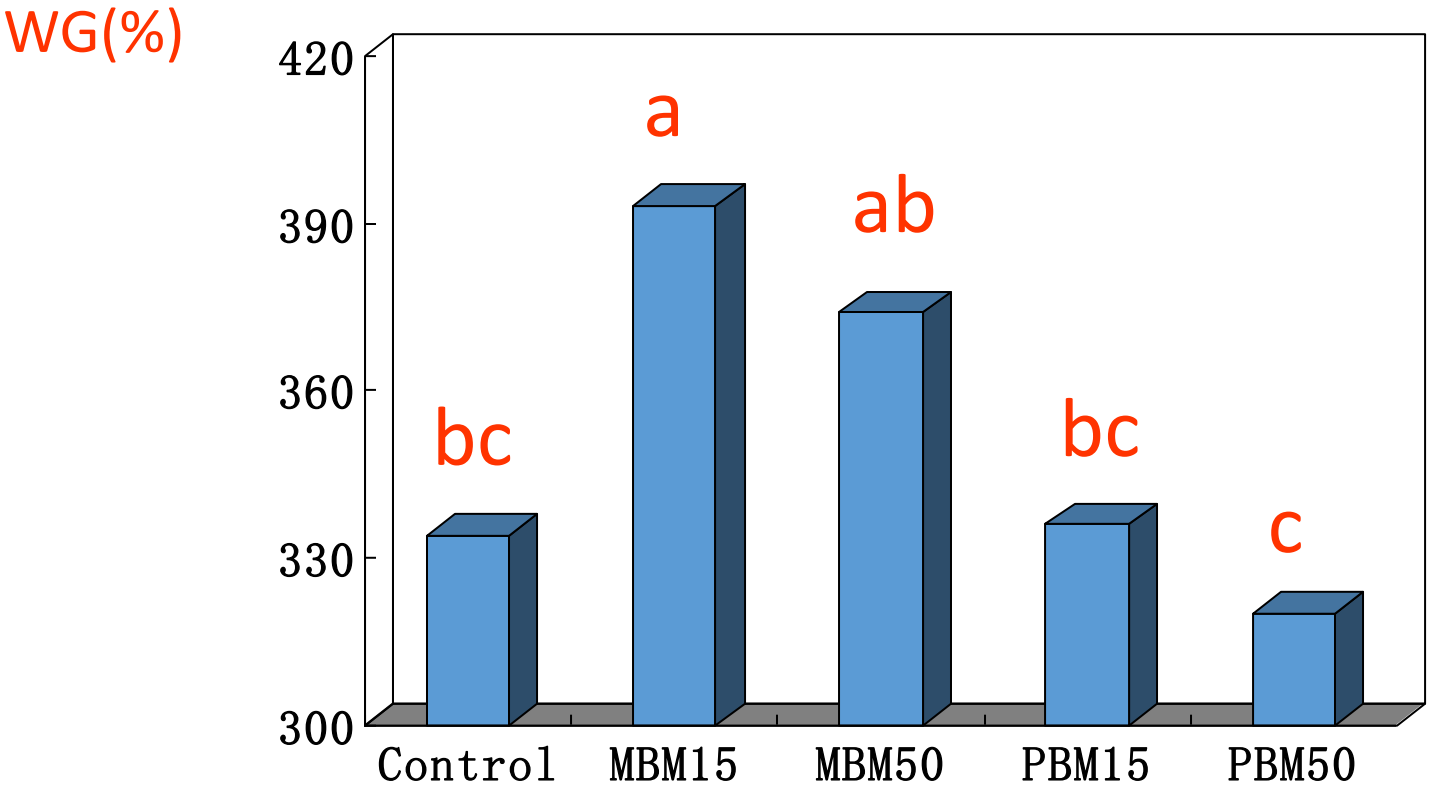
新型饲料技术降低对鱼粉的需求：

New technology help to reduce dietary fishmeal

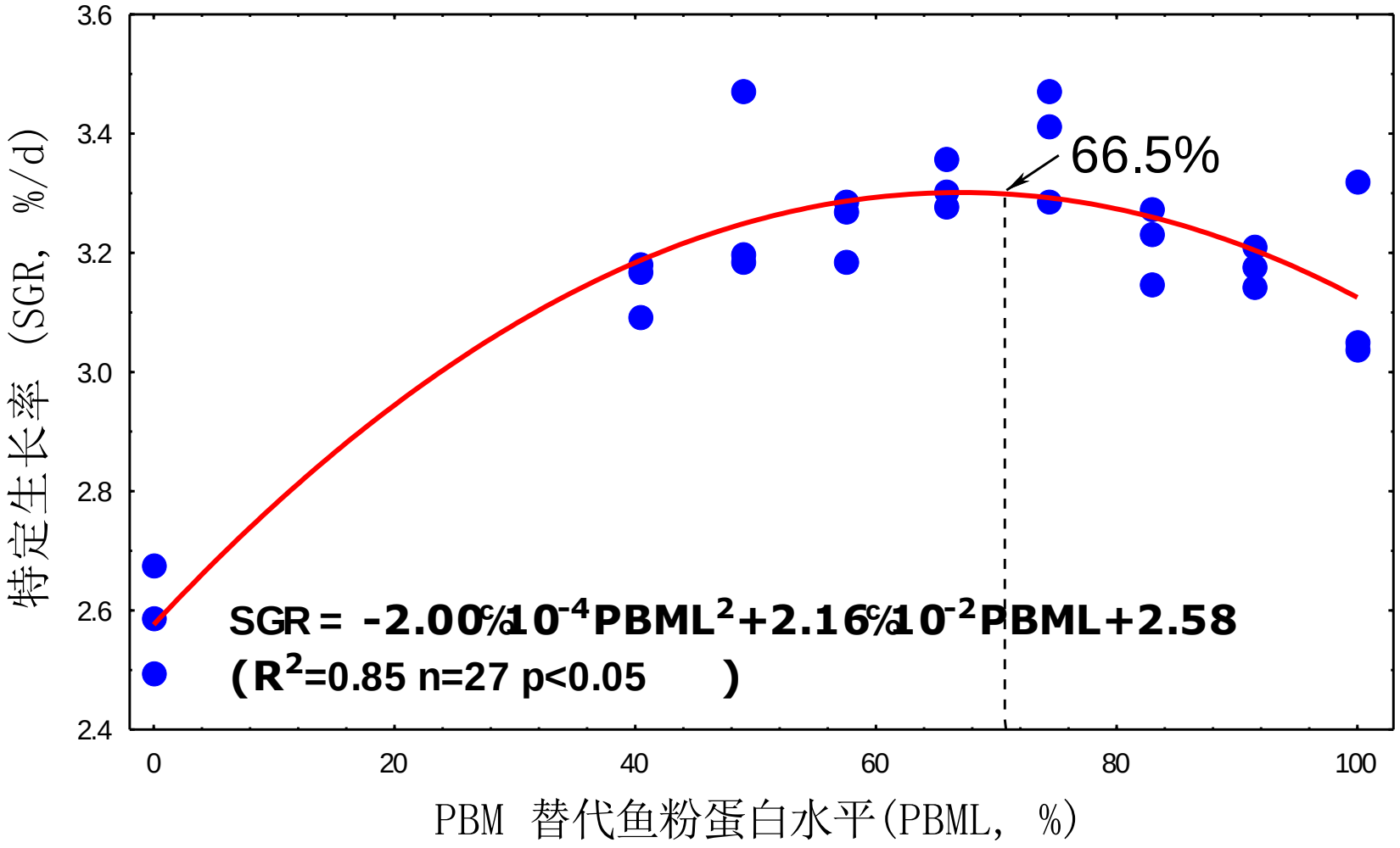
替代蛋白源

Alternative proteins

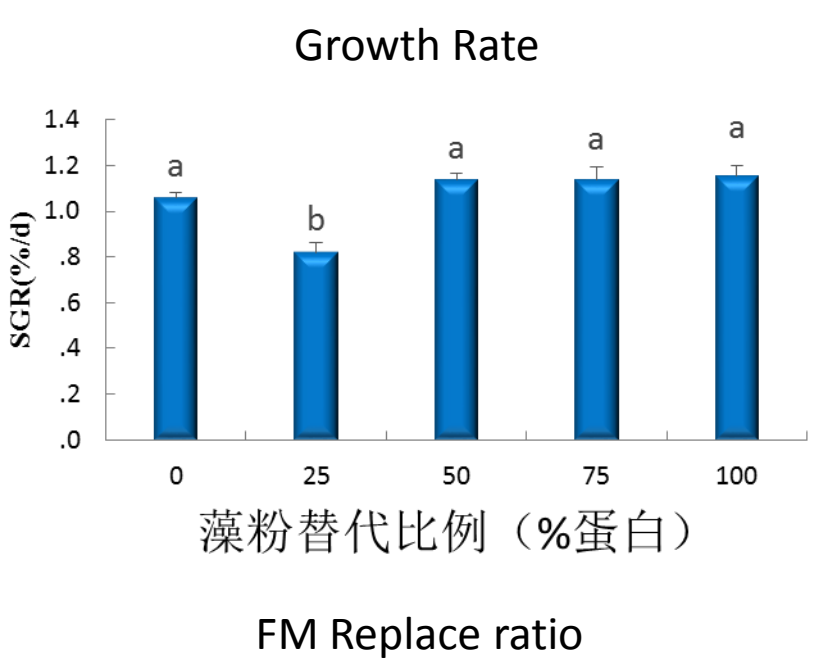
饲料中肉骨粉和鸡肉粉替代鱼粉对异育银鲫生长的影响

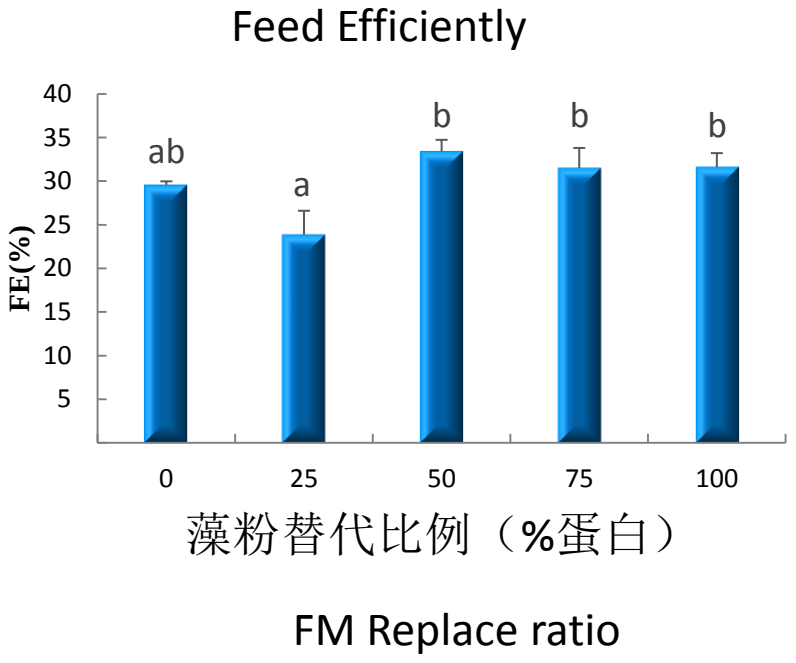


PBM replace FM in Carp Feed



Algae Meal can replace Fishmeal





Plant Protein Replace FM in different Animal

Protein source	Species	Initial fish size	Fishmeal inclusion in basal diet	Substitution rate	Reference
Extruded soybean meal	Rainbow trout	4.0±0.04 g	50%	60%	Lu et al. 2010
Soy protein concentrate	Soft-Shelled Turtle (Pelodiscus sinensis)	4.6±0.09g	50%	<60%	Zhou et al. 2015
Soy protein concentrate	Atlantic halibut (Hippoglossus hippoglossus)	633 g	61%	39%	Berge et al. 1999
Soy protein concentrate	Japanese flounder (Paralichthys olivaceus)	2.5 ± 0.01 g	74%	<25%	Deng et al. 2006
Soy protein concentrate	Large yellow croaker (Pseudosciaena crocea)	1.9 ± 0.02 g	55%	45%	Ai et al. 2006
Soybean meal	Large yellow croaker (Pseudosciaena crocea)	10.6 ± 0.4g	55%	45%	Zhang et al. 2012
Soy protein concentrate	Turbot (Psetta maxima)	13.3 ± 2.5g	70.5%	25%	Day & Gonzalez 2000
Corn gluten meal	Turbot (Psetta maxima)	65.6 ± 0.1 g	52%	17.3%	Regost et al. 1999
Mixture of lupin, corn gluten and wheat gluten meal	Turbot (Psetta maxima)	26.0 ± 0.1 g	40%	50%	Fournier et al. 2004
Mixture of soybean meal, rapeseed meal, corn gluten and broad bean meal (1:1:1:1)	Tilapia (Oreochromis niloticus)	7.2±0.8 g	24%	75%	Zhong et al. 2010

(Han et al., Review in Aquaculture, in press)

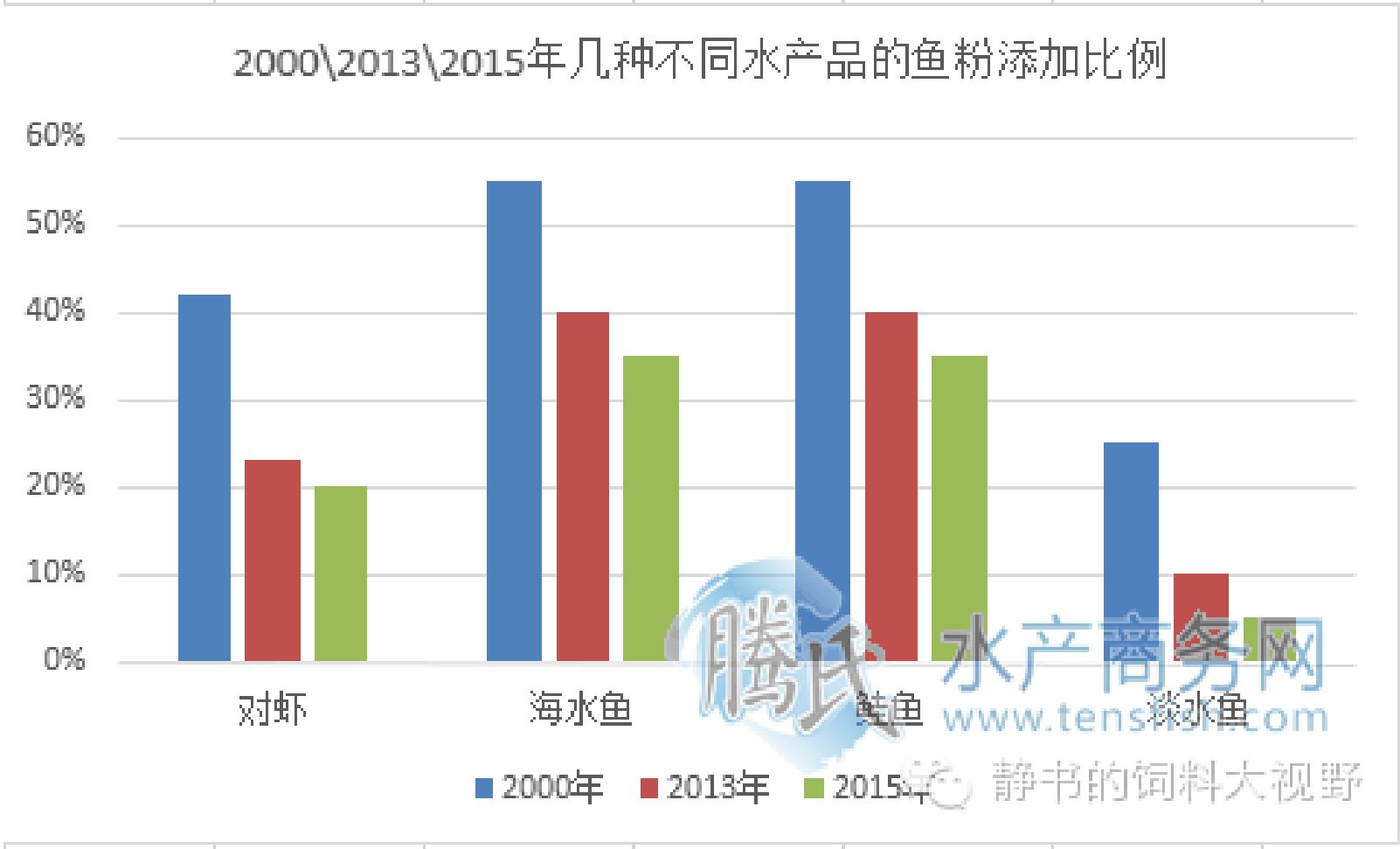
Plant Protein Replace FM in different Animal

Protein source	Species	Initial fish size	Fishmeal inclusion in basal diet	Substitution rate	Reference
Defatted silkworm pupae	Jian carp (Cyprinus carpio var. Jian)	15.3 ± 3.0 g	10%	50%	Zhang et al. 2013
Silkworm pupae	Mirror carp (Cyprinus carpiovar var. Specularis)	12.1±0.9 g	10%	50%	Ji et al. 2012
Poultry by-product meal	Cobia (Rachycentron canadum)	5.8 g	50%	30.8%	Zhou et al. 2011
Poultry by-product meal, meat and bone meal	Cuneate drum (Nibea miichthioides)	27.4 ± 0.2 g	35%	50%	Wang et al. 2006
Mixture of poultry by-products meal, meat and bone meal, feather meal and blood meal (5:2:2:1)	Malabar grouper (Epinephelus malabricus)	51.0 ± 0.2 g	50%	50%	Wang et al. 2008
Housefly maggot meal	White shrimp (Litopenaeus vannamei)	2.2±0.2 g	28%	40%	Cao et al. 2012
Housefly maggot meal	Tilapia (Oreochromis niloticus)	2.0±0.1 g	43%	100%	Ogunji et al. 2008
Non-defatted silkworm-pupae	Common carp (Cyprinus carpio)	15.3g	15%	30%	Nandeesha et al. 1990
Maggot culture	Yellow catfish (Peltobagrus fulvidraco)	2.0g	36%	<20%	Wen et al. 2013

(Han et al., Review in Aquaculture, in press)

Status of algae used in aquafeed

Species	Algae	Dietary protein	Fishmeal content	Other proteins	Substitution level (%)	References
Tilapia	*Spirulina maxima*	35%	51.90%	No	40	Olvera-Novoa et al., 1998
Common carp	*Spirulina platensis*	30%	25%	No	100	Nandeesha et al., 1998
Indian carp	*Spirulina platensis*	54.5%	25%	No	100	Nandeesha et al., 2001
Siberia sturgeon	*Spirulina*	42%	54%	No	60	Palmegiano et al., 2005
White sturgeon	*Spirulina*	45%	54%	No	63	Palmegiano et al., 2008
Blunthead bream	Algae	35%	8%	Soybean meal/rape seed meal	33.25	Ci，2011
Stripped bream	*Spirulina platensis*	48%	53%	Soybean meal	15	Kim et al., 2013
Vannamei white shrimp	*Spirulina platensis*	35%	40%	Soybean meal	75	Macias-Sancho et al., 2014



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1. Development of aquaculture and demand for protein
2. International fishmeal production is relatively stable
3. Structure and trophic level of cultured breeds in China
4. Feed technology is becoming more mature, alternative source technology has been developed
5. Aquatic products processing ratio increased, more by-products can be reused
6. Nutrient utilization improved and the recycle concept developed
7. Recent industrial development goals

2013年，全国水产品加工企业9774家，水产品加工能力达2745.3万吨／年，已成为世界上最大的水产品加工工业国家。

淡水：

显著提高水产品精深加工率，使水产品精深加工率提高到60%以上，副产物综合利用率超过80%。

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Feed nutrient efficiency increased

- 高转化效率的养殖品种/品系提高饲料利用效率
- 饲料配方、加工工艺和投喂技术的改进提高饲料利用效率
- 混养模式和养殖小区理念提高饲料营养素利用效率
- 底泥释放技术提高营养素利用
- …

Feed efficiencies and wild fish inputs in feed for farmed species

SPECIES	TOTAL PRODUCTION (MMT)	PRODUCTION WITH FEEDS (MMT)	AVERAGE FCR	AVERAGE FM IN FEED (%)	AVERAGE FO IN FEED (%)	TOTAL FM USED (MMT)	FORAGE FISH EQUIVALENT (MMT)
I. Carps							
Grass carp	4.8	2.6	1.7	1.5	0	0.07	0.32
Silver carp*	3.7	0	0	0	0	0	0
Bighead carp*	2.9	0	0	0	0	0	0
Common carp	2.9	1.6	1.7	6	0	0.16	0.77
Crucian carp	2.5	1.3	1.7	8	0	0.18	0.87
Bream	0.7	0.4	1.7	2.6	0	0.02	0.08
Black carp	0.5	0.3	1.7	2.6	0	0.01	0.06
II. Tilapa	1.6	1.3	1.6	6	0.5	0.13	0.60
III. Penaeid shrimp	1.6	1.5	1.2	27	2	0.50	2.36
Total	**21**	**9.1**	—	—	—	**1.06**	**5.07**

Feed efficiencies and wild fish inputs in feed for nine leading farmed species in China. Total production data in 2012 for each species from (*1*). Production with feeds was estimated based on (*28*). All other data were estimated from primary field surveys. Average economic FCR = total feed fed/total biomass increase. FM, fishmeal; FO, fish oil. An average reduction ratio of 21% for fishmeal and 5% for fish oil obtained from our field surveys were used to estimate wet weight equivalent of forage fish. *Filter-feeding species are not fed; they graze planktons proliferated through fertilization and the leftover feeds in the polyculture system.

Cao et al., 2015

FCR is decreasing.

106 Million FM will use in more Aqua Products

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China Aqua consumption increase slow in future

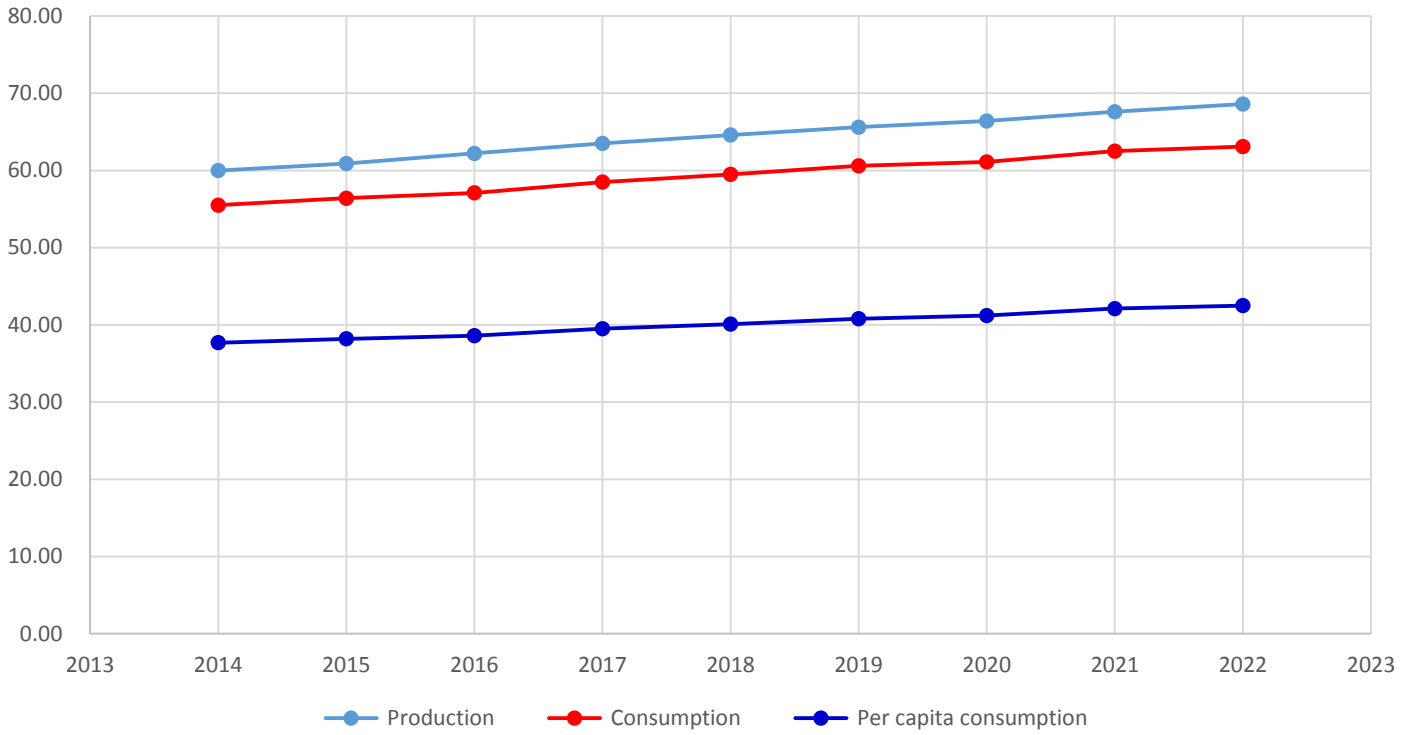


Table 2.A.1. Commodity projections for China *(cont.)*

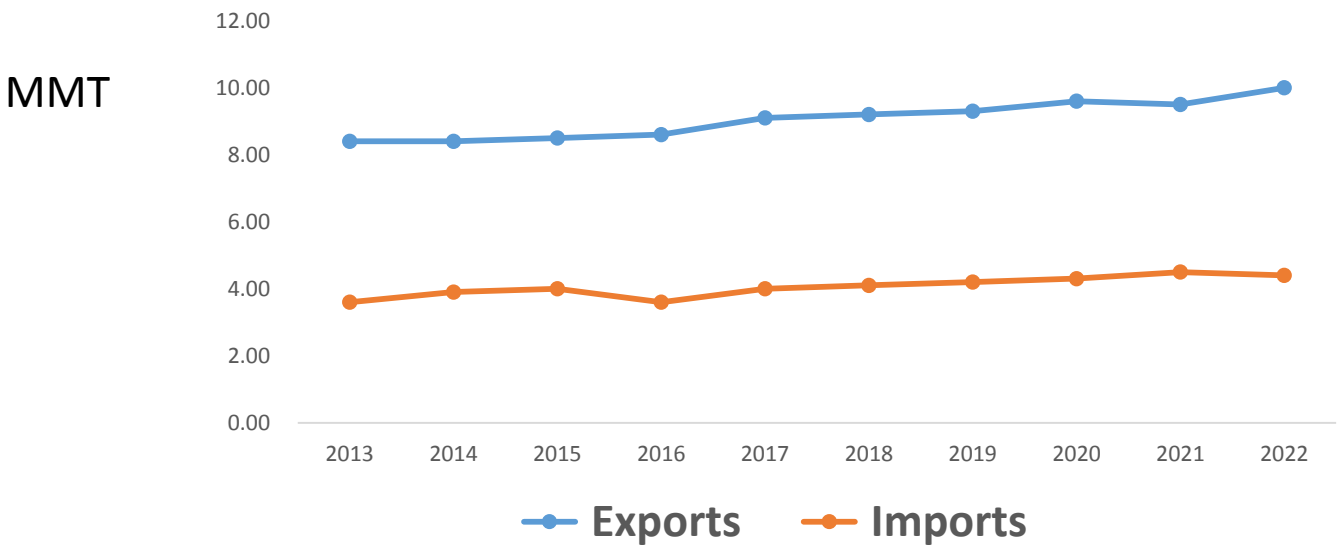
		Average 2010-12est	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Fish												
Production	mt	54.6	58.7	60.0	60.9	62.2	63.5	64.6	65.6	66.4	67.6	68.6
Consumption	mt	50.1	53.9	55.5	56.4	57.1	58.5	59.5	60.6	61.1	62.5	63.1
Per capita consumption	kg	34.2	36.6	37.7	38.2	38.6	39.5	40.1	40.8	41.2	42.1	42.5
Exports	mt	7.8	8.4	8.4	8.5	8.6	9.1	9.2	9.3	9.6	9.5	10.0
Imports	mt	3.2	3.6	3.9	4.0	3.6	4.0	4.1	4.2	4.3	4.5	4.4
Butter												

http://www.agri-outlook.org/highlights-2013-EN.pdf

China Aqua Production will support more people

OECD-FAO Agricultural Outlook 2013-2022

HIGHLIGHTS



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Fish												
Production	mt	54.6	58.7	60.0	60.9	62.2	63.5	64.6	65.6	66.4	67.6	68.6
Consumption	mt	50.1	53.9	55.5	56.4	57.1	58.5	59.5	60.6	61.1	62.5	63.1
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Exports	mt	7.8	8.4	8.4	8.5	8.6	9.1	9.2	9.3	9.6	9.5	10.0
Imports	mt	3.2	3.6	3.9	4.0	3.6	4.0	4.1	4.2	4.3	4.5	4.4
Butter												

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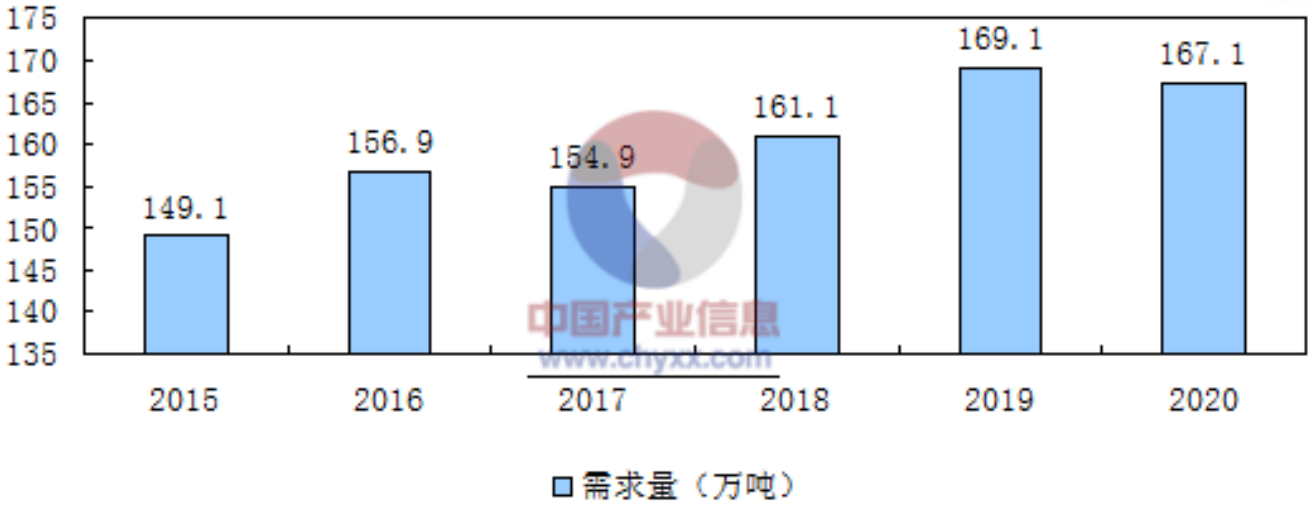
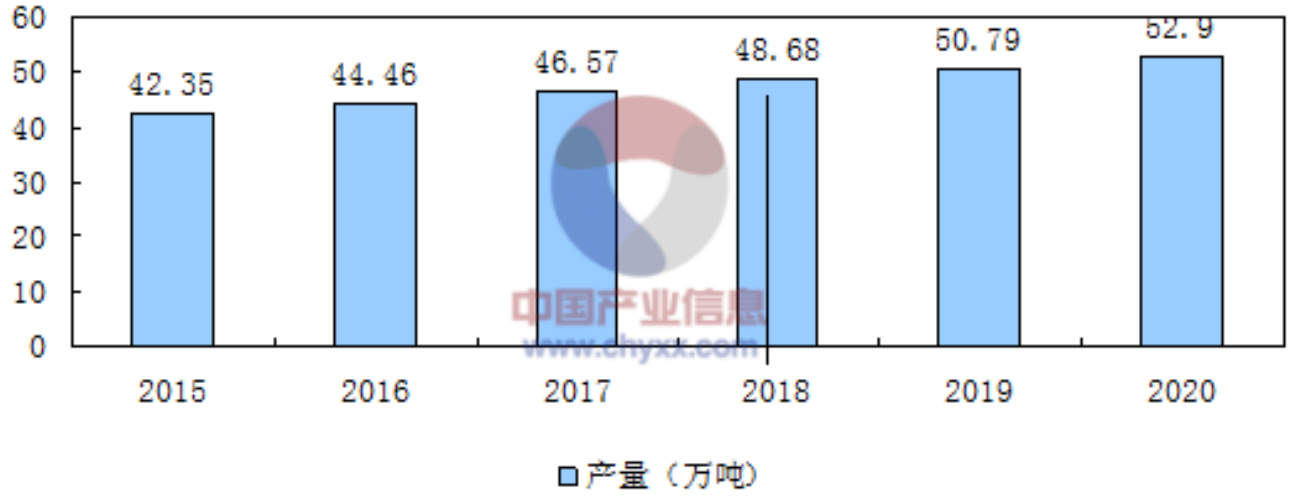
FM Demand of China Aqua Production



Protein Demand!



http://www.chyxx.com/industry/201509/343143.html

Aquaculture New status

供给侧结构性改革：

优质水产品（品种、质量）

功能性水产品

……

Aquaculture New status

Processing Products…

图片来自百度

Aquaculture New status

Environmentally friendly Goal

- Fishing Control
- Nitrogen and phosphorus emissions Control
- Feed coefficient Control
- Other Control….

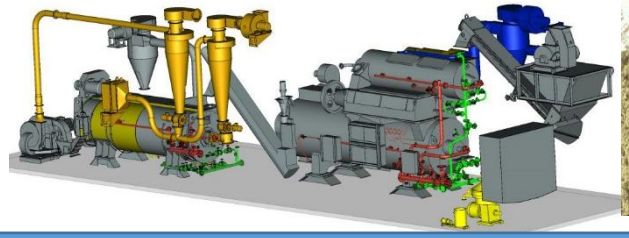
Aquaculture New status

Ice fish feeding directly restricted

水产养殖质量安全管理规定(农业部令第31号)

第四章　　渔用饲料和水产养殖用药

第十五条　　使用渔用饲料应当符合《饲料和饲料添加剂管理条例》和农业部《无公害食品渔用饲料安全限量》(NY5072-2002)。鼓励使用配合饲料。限制直接投喂冰鲜(冻)饵料，防止残饵污染水质。

小　结 Conclusion

- 中国水产养殖仍然又较大潜力
- 养殖结构性调整将会对优质蛋白有进一步的需求
- 饲料中鱼粉含量有可能会有所下降（价格、环境…）
- 现有鱼粉养殖更多产品（混合蛋白源、再利用）
- 市场价格和环境约束会影响鱼粉使用
- 国产鱼粉的加工需要加强（捕捞渔业、水产品废弃物）


谢谢大家
THANK YOU
敬请批评指正
欢迎大家到水生所交流