

Overview on the Development of Aquaculture and Aquafeed Production in Korea

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Abstract

Sung-Sam Kim and Jeong-Dae Kim. 2019. Overview on the Development of Aquaculture and Aquafeed Production in Korea. *Aquacultura Indonesiana*, 20 (1): 1-7. According to KOSIS (2018), total landings of capture and culture fisheries in Korea increased from 1,073,000 metric tons (MT) in 1971 to 3,743,000 MT in 2017 mainly due to the development in marine aquaculture practices. During the last four decades, marine aquaculture production in Korea showed around 5-fold increases from 491,000 MT in 1977 to 2,310,000 MT in 2017 recording the value of 2.9 billion USD. Last year, the main production was derived from seaweed (1,755,630 MT), while the aquatic animal production was made from shellfish (428,160 MT), fish (86,400 MT), crustacean (mainly shrimp of 5,100 MT) and others (34,530 MT). Either trash fish or moist pellet based on the raw fish is still being fed to marine culture fish, which is the main obstacle for developing the farming. The present situation and development direction are suggested for the mariculture development in Korea.

Keywords: Aquaculture; Extruded pellets; Mariculture; Production; Trash fish

History of Aquaculture

South Korea has mostly surrounded by sea and has 2,413 km coastline along three coasts (east, west and south coasts) and its land mass is approximately 100,032 km². As capture production mainly from inshore and offshore catches continuously decreased, a great attention has been paid to aquaculture which is now one of the very important sectors in terms of food security, revenue and employment to the country (Yoon, 2008). Aquaculture is mainly divided into two categories, marine and inland cultures.

Mariculture production is composed of seaweed, molluscs, finfish, crustacean and other animals, while inland aquaculture is mostly based on finfish production. According to KOSIS (2018), total value of the fishery production hit a record of 8,614 million dollars in 2017, of which main portion came from inshore catch, followed by mariculture and offshore catch, while inland fishery contributed the least for the record (Table 1).

Table 1. Value (million USD) by fishery production category (KOSIS, 2018)

Year	2016		2017		(B-A)	RI*
	(A)	%	(B)	%		
Total	7,477.1	100.0	8,613.8	100.0	1,136.7	15.2
Inshore C.	3,636.2	48.6	4,014.1	46.6	377.8	10.4
Mariculture	2,345.5	31.4	2,951.5	34.3	606.0	25.8
Offshore C.	1,077.8	14.4	1,192.2	13.8	114.4	10.6
Inland fishery	41.8	5.6	45.6	5.3	3.84	9.2

*Relative increase (%) = (B-A)/A x 100

Aquaculture Species and Production

In 2017, total fishery landings reached 3,743,000 MT, of which 61.7% (2,310,000 MT) was provided by mariculture corresponding to 34.3% in terms of total value. Inland fishery production (36,000 MT) basically originated from finfish culture represented only 0.9% of total fishery landings, although it amounted to 5.3% in terms of value (Figs. 1, 2 and 3).

Seaweed aquaculture began in 1960's and sea mustard (*Undaria pinnatifida*), kelp (*Laminaria* spp.) and laver (*Porphyra tenera*) are the main cultured species in Korea. Seaweed production of 1,756,000 MT ranked first in total mariculture production in 2017. Main species of molluscs include oyster (*Crassostrea gigas*), mussel (*Mytilus edulis*) and ark shells (*Scapharca broughtonii*) which have been cultured since the 1970's. As the second most important group of mariculture, molluscs of 428,156 MT were produced in 2017. Abalone (*Haliotis discus hannai*) is now the most important species in terms of production value (Fig. 4). Finfish, the third important production group, is dominated by olive flounder (*Paralichthys olivaceus*) and rockfish (*Sebastes schlegeli*), of which artificial seed production techniques were developed in 1990 and 1992, respectively. Since then,

substantial culture practices were initiated and the main two species now consist of 80% of the total of mariculture finfish production. Even though marine finfish production of 86,400 MT is fairly lower than those of seaweed and molluscs, it de facto represents the highest production value among the mariculture groups (Fig. 5). Whiteleg shrimp (*Penaeus vannamei*) is the sole species being cultured since 2004. Although the production of 5,100 MT is negligible, it ranks seventh in terms of production value (Fig. 4). In addition, sea squirts (*Halocynthia roretzi* and *Styela clava*) are also cultured and categorized as others in the current aquaculture species in Korea.

Finfish production in freshwater accounts for more than 80% of inland fishery production. Main species include Japanese eel (*Anguilla japonica*), catfish (*Silurus asotus*) and rainbow trout (*Oncorhynchus mykiss*). It should be noted that fish farming in Korea was developed with cage culture of common carp (*Cyprinus carpio*) in artificial lakes since 1984, which was, however, totally disappeared in 2000 with increased public concerns against water pollution. In 2017, main species production was 13,000 MT, 6,300 MT and 3,700 MT for eel, catfish and rainbow trout, respectively (KOSIS, 2018).

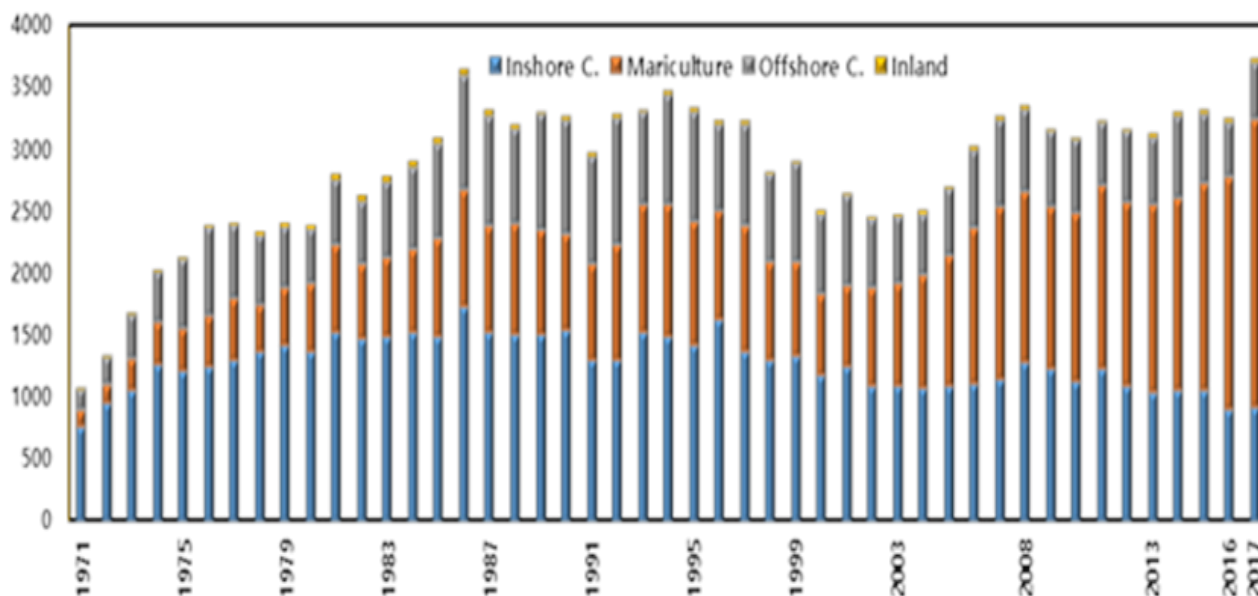


Figure 1 Total Landings (1,000 MT) of Capture and Culture Fisheries in Korea (1972-2017) (KOSIS, 2018);

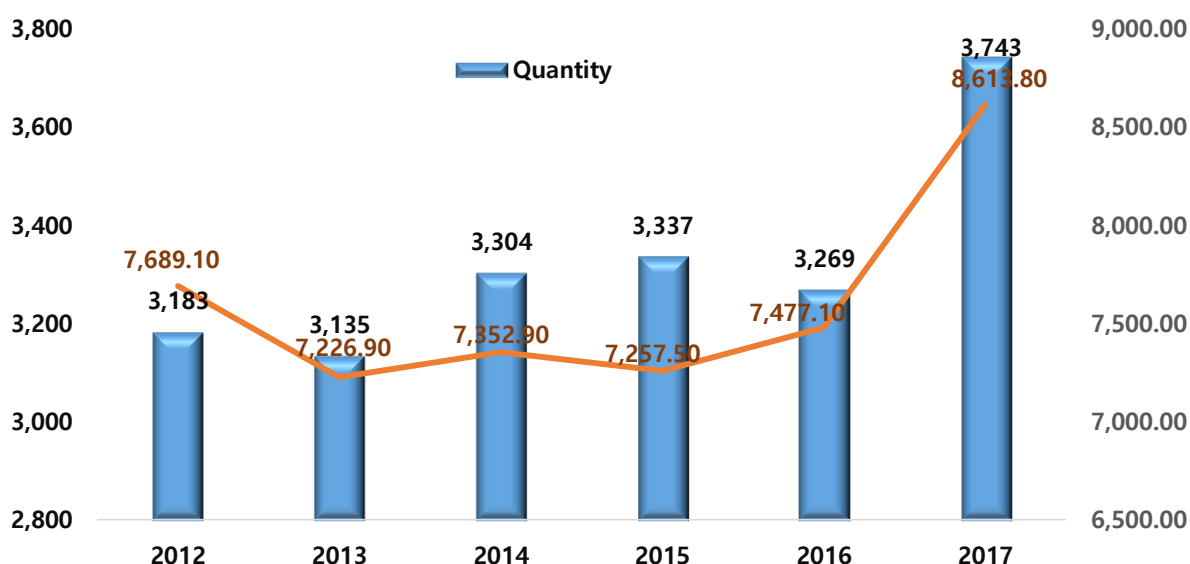


Figure 2 Total Fisheries Landings: quantity (1,000 MT) and value (million USD) (KOSIS, 2012-2017).

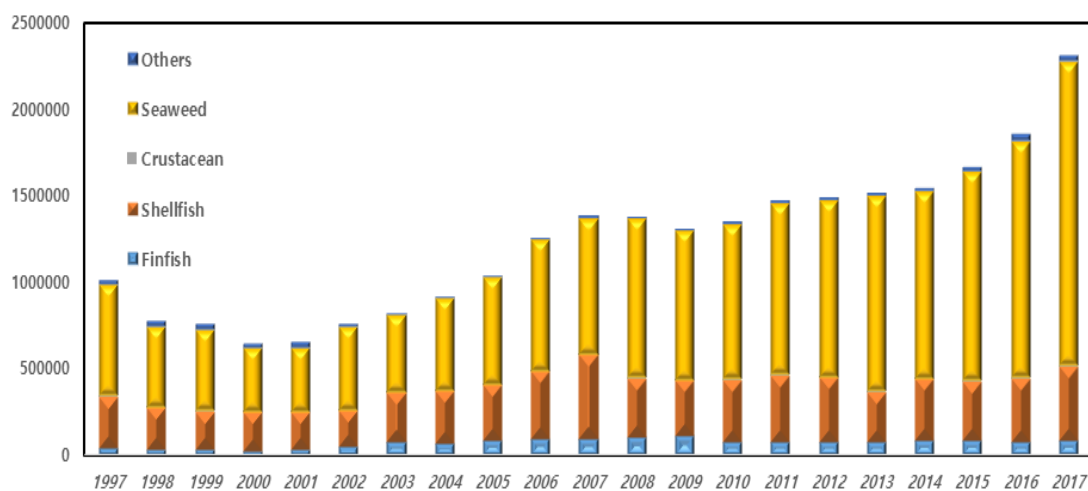


Figure 3 Mariculture Production (MT) in Korea (MOF, 2018).

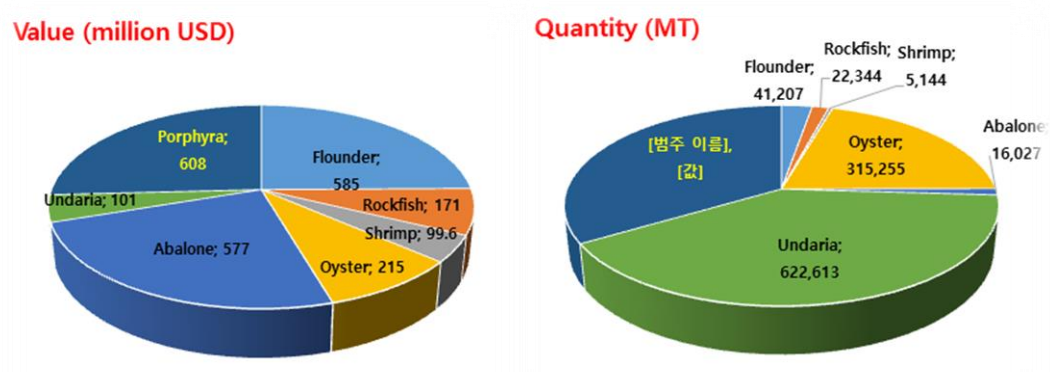


Figure 4 Top 7 species in terms of production value (million USD) and their quantity (MT) in 2017 (KOSIS, 2018).

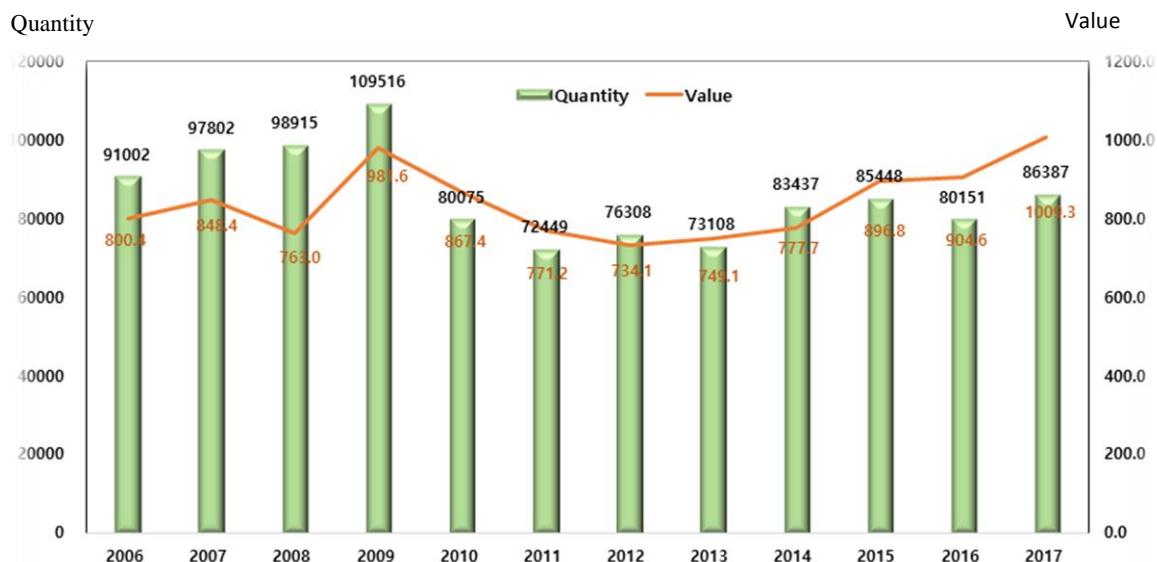


Fig. 5. Mariculture finfish production in Korea (2006 – 2017): quantity (MT) and value (million USD) (KOSIS, 2017, 2018)

Aquafeed Production

Aquafeed development was initially made for freshwater species including carp, rainbow trout, and eel along with advanced fish farming practices. The highest feed production (94,846 MT) for freshwater species was achieved in 1995, of which 61% (58,069 MT) were fed to carp. In accordance with an increase in public concerns on carp farming practice against water pollution, most cage farms started taking away from artificial lakes and freshwater feed production, leading to a significant decrease such as 47,948 MT in 1999 with carp diet of only 6,907 MT. Feed production for mariculture fish and shrimp increased from 28,123 MT in 1995 to 52,948 MT in 1999. Since 1999, the feed production for mariculture overtook that for freshwater fish culture. On the other hand, unexpected increase in feed production for eel since 2014 was mainly due to the change in harvesting size from 4–5 fish to 1-2 fish/kg and recorded 28,899 MT in 2017. In 2018, however, it is anticipated that the production would be decreased to 14,500 MT due to a recent sharp decrease in elver catch. As a whole, total aquafeed production amounted to 151,150 MT in 2017, which were divided into 66.9% and 33.1% for marine and freshwater species, respectively (Table 2). On the other hand, aquafeed occupied only 0.78% of total animal feed production (18,910,000 MT) in 2017.

All diets for cultured fish and shrimp are manufactured to extruded pellet (EP) using the extruder except eel feed, which is made as a powder type mixed with pregelatinized starch. Generally and 10% powder type of formul in Table 3, total feeds consumption by marine finfish species amounted to 582,776 MT in 2017, of which 85% were MP. It should be noted that the MP used to produce marine finfish of 86,400 MT corresponding to a half of the inshore catch in 2017 (Fig. 1). On the other hand, 80% of the MP were distributed to be produced for two species including olive flounder and rockfish, suggesting that mariculture of those species is still in the far distance from the sustainable farming practice. In fact, frequent disease outbreaks, as well as water pollution by wasted feeds, are the main problems raised by feeding the MP (Kim, 2018). Also, the use of the MP threatens the depletion of marine fishery stocks. For example, this phenomenon is much severe in China. According to the recent report (GEA, 2017), approximately 4.95 million MT of trash fish was used in direct feeding aquaculture, of which 66% (3.24 million MT) were used for mariculture finfish production in 2014. Such trash fish were mainly derived from marine catch fishery (GEA, 2017).

Many fish farmers are prepossessed with the idea that a hard type of EP could cause a severe digestive problem like ascites after ingested. Even though a number of the

experimental results demonstrated that the EP feeding was more advantageous than that of the MP in terms of the production cost (MOF, 2005; NIFS, 2009) as well as water pollution (Kim and Lee, 2000; Kim and Shin, 2006; Kim, 2009; Kim et al., 2011), the use of EP does not show a significant increase until now (Tables 2 and 3). When the use of MP is converted to EP (Table 4), it represents 152,400 MT. Given the dead fish and wastage by feeding are considered, an actual amount of the ingested MP would be, however, less than 200,000 MT, corresponding to 61,000 MT of EP. As MP feeding raises public concerns

against water pollution, introduction of pathogenic bacteria and depletion of marine fish stock, legal measurement is now being made to prohibit the use of MP in Korea. Recently, the national project to develop the EP is being conducted to replace the MP for the whole growing period of fish. The research is devoted to decreasing dietary fish meal using alternative protein sources like land animal by-product meal and plant protein concentrates and to increase palatability and digestibility as well as production income (Kim, 2017).

Table 2. Domestic aquafeed production (2010-2018)

(unit: MT)

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018E	17-16
FW Species total	33,361	28,316	28,666	26,516	31,703	39,163	39,173	49,994	35,900	10,821
Rainbow trout	3,552	3,862	6,305	4,437	6,383	5,435	4,876	5,290	5,440	414
Eel	16,070	12,708	10,502	8,650	13,901	16,674	18,456	28,899	14,500	10,443
Loach	1,776	1,324	974	1,123	65	1,295	938	215	300	-723
Catfish + Carp	11,252	10,093	10,706	11,406	11,314	15,127	14,693	14,742	15,100	49
Other	711	329	179	900	40	632	210	848	560	638
SW Species total	78,359	75,587	72,710	75,818	84,747	87,677	97,738	101,156	110,530	469
Shrimp	6,216	5,571	6,289	8,113	10,633	12,579	14,926	13,176	15,250	-1,750
Rockfish + Breams	19,607	26,697	25,495	26,142	26,709	26,104	31,656	36,199	36,500	4,543
Flounders	20,028	17,498	19,021	22,270	22,840	20,296	22,381	22,663	25,780	282
Other	32,508	25,821	21,905	19,293	24,565	28,698	28,775	29,118	33,000	343
Total	111,720	103,903	101,376	102,334	116,450	126,840	136,911	151,150	146,430	14,239

(Kim, 2018)

Table 3. Total feed consumption (MT) by marine fish

Species	2016			2017			2017-2016	
	Total	MP	EP	Total	MP	EP	+.-	%
Total	572,339	491,026	81,313	582,776	494,796	87,980	10,437	1.8
Flounder	251,096	230,789	20,307	246,202	226,817	19,385	-4,894	-1.9
Rockfish	178,114	161,183	16,932	189,228	168,312	20,916	11,114	6.2
Black sea bream	14,413	9,875	4,538	13,843	9,207	4,636	-570	-4.0
Red sea bream	60,196	53,106	7,091	69,793	62,736	7,057	9,597	15.9
Striped beakperch	8,497	5,402	3,095	7,440	3,850	3,590	-1,057	-12.4
Mullet	19,328	422	18,905	21,877	423	21,454	2,549	13.2
Sea bass	11,710	9,678	2,032	9,097	6,982	2,115	-2,613	-22.3
Other	28,984	20,572	8,413	25,294	16,470	8,825	-3,690	-12.7

(KOSIS, 2018)

Table 4. Y2017 MP & EP Use and EP Production Potential

(unit: MT)

Species	TFC*	MP	%	EP use	%	New EP**	Total EP
O flounder	246,202	226,817	46	19,385	22	69,860	89,245
Rockfish	189,228	168,312	34	20,916	24	51,840	72,756
Red SB	69,793	62,736	13	7,057	8	19,323	26,380
Sea bass	9,097	6,982	1	2,115	2	2,150	4,265
Black SB	13,843	9,207	2	4,636	5	2,836	7,472
S Beak P	7,440	3,850	1	3,590	4	1,186	4,776
Mullet	21,877	423	0	21,454	24	130	21,584
S flounder	4,461	441	0	4,020	5	136	4,156
Other	20,835	16,028	3	4,807	5	4,937	9,744
Total	582,776	494,796	100	87,980	100	152,397	240,377

*Total feed consumption (MT). **EP calculated from MP: personal estimation (MP x 0.28 x 1.1) (KOSIS, 2018).

Obstacles in Aquaculture Development

As aforementioned, marine finfish culture ranks first in terms of total production value of mariculture. However, the fish culture involves a lot of problems remained to be solved. First of all, the MP should be switched to the EP as soon as possible. The use of trash fish in fish farms accelerates an outbreak of diseases and water pollution as well as the safety problem. A continuous drop in farmgate price urges farmers to gather on a large scale. Urgently needed is a development of new candidate species. Recently, the growing period of flounder was significantly shortened through selective breeding technologies, while rockfish still requires more than 2 years to reach a harvest size of 500 g. Antibiotic use also should be strictly controlled for product safety, although it is still being used at most farms in Korea. Although the standard stocking density should be strictly kept, many farmers do not follow the standard because they believe that 50% of the stocked seeds are dead.

Conclusion

As one of the fast growing industry sectors, aquaculture has occupied a significant ranks first among mariculture species groups in terms of production value. However, a sustainable development of fish farming industry could not be achieved without prohibiting the use of the MP. When the MP is totally switched to the EP, the aquafeed industry could open a new market when the MP is totally replaced with EP.

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