MARINE FARMING COUNTRY ANALYSIS – REPUBLIC OF KOREA

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Korea is a peninsula with a coastline of almost 9,000 kilometers and an archipelago of some 3,000 islands. Consequently, fishing has always been a national industry of major economic importance. However, a continuous decrease in capture production in recent years has led to an increased attention to aquaculture with an attendant increase in culture production. The total national fisheries production in 2003 was 2,492,545 metric tons, comprising capture and culture production of 1,652,700 and 839,845 metric tons, respectively. This indicates a shift towards aquaculture when compared with the capture and culture production quantities of 1,838,018 and 667,883 metric tons, respectively in 2000. Korean aquaculture is dominated by the marine species. Marine aquaculture contributed 98% (826,245 metric tons) of the total aquaculture production of 839,845 metric tons in 2003.

Despite the decline in capture production, the demand for aquatic products has been on the increase. Korea recorded a trade deficit in fishery products for the first time in 2001. To meet the demand for aquatic products, there is the need to further develop the aquaculture sector, especially the marine sub-sector which produces most of the aquatic foods.

Marine Aquaculture Products Demand, Trade and Markets

An analysis of marine aquaculture products demand, trade and markets trend locally and nationally

Since Korea is a peninsula, marine products have been a major constituent of the food of the people. However, there has been a marked increase in consumption of marine foods in line with the general increase in consumption of aquatic products in recent years. This trend is attributed to the concern for health; consumers now prefer eating aquatic products as alternatives to red meats due to the health benefits of consuming these aquatic products. As a result of improved purchasing powers of consumers with concomitant improved standard of living, the demand for high-value species has also increased. There is an increased demand for high-value fish species such as Korean rockfish and olive flounder. Demand for shrimps has equally increased.

Imports and exports of fishery products by major countries and the trends of export, import and trade balance of fishery in Korea are shown in Tables 1 and 2, respectively. Unfortunately, data on mariculture trade flows are not available, as trade figures are reported for total fishery products and not individually for the various sub-sectors. From the tables, it can be seen that there has been a continuous increase in trade deficits (in quantity and value) in recent years. Korea recorded the first trade deficit (in value) in 2001. But with the government's policies to encourage aquaculture production and the shift towards production of high-value marine species as Korean rockfish, olive flounder, oysters and fleshy shrimp, it is expected that the trend in balance of trade for marine aquaculture as well as total aquaculture will be reversed.

Role of aquaculture versus fisheries as supply

Capture and aquaculture production quantities in two decades and year 2003 in Korea are summarized in Table 3. The total national production in 2003 was 2,492,545 metric tons, comprising capture and culture production of 1,652,700 and 839,845 metric tons, respectively. This indicates a shift towards aquaculture when compared with the capture and culture production quantities of 1,838,018 and 667,883 metric tons, respectively in 2000. The increase was as a result of the government's aquaculture promotion policy and fleet reduction program. The 2003 aquaculture production figure comprised marine

production of 826,245 metric tons and freshwater production of 13,600 metric tons. The total aquaculture production value was 1.06 billion US dollars.

The consumer trends, preferences and buying patterns

As previously mentioned, there has been an increase in demand for aquatic products including marine foods. Similarly, the demand for high-value species among the marine products has been on the increase. This increase is due to increased purchasing power of consumers, concern for health, popular beliefs and other factors. For instance, many consumers go for raw fish mainly made of olive flounder for the nutritional value of the product. In the same manner, many Koreans eat Japanese eel, one of the popular species, for the purported aphrodisiac properties of the species.

Besides the preference for high-value species of fish, there has also been a trend towards selection of value-added products. To respond to the buying pattern of consumers, efforts are now made to establish a consumer-oriented cultivated marine products supply to develop the processing method to produce high value-added products.

The market chain organization, (i.e., trade flows/market chains, particularly issues for smaller scattered producers), and market trends and vulnerability

Distinctions are hardly made between culture and capture marine products in analysis of marketing channels of fishery products. As most of the marine aquaculture farms are located in the coastal areas due to their reliance on natural seawater, it can be seen that marine aquaculture products basically follow the same distribution systems as fishery products, which are also available in these areas. Marketing and distribution of the products at landing ports takes place through fishery co-operative auction markets and the Busan common fish markets, which are always located at water fronts, but distribution to consumption areas is made through whole sale markets, inland joint sale and direct-sale markets and retailers. The final consumers usually get their supplies from conventional markets, supermarkets, discount stores, department stores and seafood wholesale markets.

Since marine aquaculture products basically follow the same distribution systems as the capture products, trends in marketing of capture and aquaculture products are the same. Several measures are being taken by the Korean Government to ensure stable

market prices for fishery products through the establishment of the “Price Stabilization Fund”. The fund is intended to cover ten items of the fishery products, including the dry seaweed, frozen squid and frozen hair-tail fish. Fishery marketing systems have been improved through the expansion of market facilities and the up-grading of the consignment system on landing sites and of the distribution capacity at areas with large consumer population. Since October 1997, the government has liberalized the consignment system at landing sites. This policy has been a part of a two-stage free market system first introduced in 1996. Five direct-sale market facilities have been established at large urban areas to strengthen the distribution and handling capacity in areas where large populations of consumers are found. The improvement includes the reduction of distribution and handling steps and marketing margins, and the promotion of direct shipping to consumers by fishermen's cooperatives.

Korea imports aquatic products from China, Russia, the United States, Japan and Vietnam for domestic consumption and re-export. Difference is never made between imported products and domestically cultured products while reporting the total export quantities and values. In 2003 a total of 424,785 metric tons of fishery products, valued at $1.13 billion was exported while the import was 1,238,603 metric tons, yielding $1.96 billion (Table 1). Korea exports processed aquatic products to Japan, the United States and Europe.

Livelihood Opportunities related to Mariculture Development

- Information on coastal communities, poverty status, livelihoods, trends, vulnerability, identify key target communities
- Current experiences and better practice in sustainable economic
- The role of mariculture in poverty reduction in coastal areas, and as an alternative to potentially destructive extractive fisheries
- Successful, and un-successful, examples of introductions of mariculture into coastal communities
- Markets and coastal community development linkages

Since 1975 coastal communities have been allowed to have license for aquaculture in fishery sites. Coastal communities began actively participating in finfish aquaculture in the late 1990’s. At that time finfish aquaculture was seen as a high-profit business in fisheries but personal licenses were not easily available to private farmers rather than coastal communities. In addition, fisheries agreement between Korea, Japan and China

adversely affected coastal communities. Part of government's efforts at reviving participation of the coastal communities with approval of licenses to coastal communities induced explosive growth of finfish aquaculture. But such a growth caused a decrease in market price of live fish due to over production and importation of low-cost live fish from China. As a result of such developments many coastal community farmers became bankrupt.

According to Korea National Statistical Office (KNSO, 2004), the number of persons employed in the aquaculture industry in 2004 was 63,570 and they constitute around 33.2 % of the total number of fishermen employed in the fishery sector. These people are concentrated around the major production cities, including Busan, Incheon, Ulsan, Kyonggi, Kangwon, Chungnam, Chonbuk, Chonnam, Kyongbuk, Kyongnam and Jeju. Three of these cities are the highest employers of labor in the aquaculture industry; these are Chonnam, Kyongnam and Chungnam in that order. Mariculture makes the highest contribution to employment of labor. About 92% of people employed in the aquaculture industry in 2004 were involved in mariculture while only 8% of the people were in the freshwater aquaculture. Of those employed in marine aquaculture, 49.7 were engaged in production of mollusks. Seaweed, finfish and crustacean production contributed 29.1, 9.05 and 0.3%, respectively. About 1.5% of the people were employed in hatcheries. Apart from these people that are directly involved in aquaculture many others are engaged in subsidiary industries, including feed manufacturing, product processing, transportation, sales and export, and research and development.

Currently, there are 1,951 coastal communities around the country, and the annual income per house is US$ 21200, less than those of stockbreeders and farm workers (US$ 50000 and US$ 35000, respectively). It is necessary that actions be taken to improve the income of these communities engaged in aquaculture. Loans and grants should be made available to the farmers. Low-cost, high-efficiency and low pollution feeds should be developed. Programs to increase competitiveness of culture of strategic species should be established. Recess years for farming sites should be established and formulated feeds should be subsidized to discourage farmers from using raw fish-based feeds.

Existing and Potential Mechanisms for Technology Transfer

Training centers of excellence

Eighteen fisheries subsidiary organizations, including several branch offices of the Ministry of Maritime Affairs and Fisheries (MOMAF) exist in rural areas, mostly located along the coastal areas. The role of the organizations is to support fishermen with information, training and government funding. The major government aquaculture research institutes are the National Fisheries Research Development Institute (NFRDI) and Pukyong National University

Existing mechanisms for technology transfer and mechanisms for effective dissemination of R & D to farmers and other stakeholders

For workers in the industry to remain relevant in this information age 13,890 people were trained in 2004. In future, intermediate and high courses will be held to educate fisherman thoroughly. Computers, connected to the Internet, together with printers and other accessories were installed in the homes of fish farmers in 100 model fishing villages. The information-sharing systems constructed in 31 different locations (Ministry of Maritime Affairs and Fisheries, National Fisheries Research and Development Institute, and local governmental agencies) allow fisherman to have remote access to essential information about fisheries. Fishermen can communicate effectively through a specialized homepage (www.badaro21.net).

Books providing culture standards for each aquaculture species have been published by National Fisheries Research and Development Institute (NFRDI). Furthermore, Fisheries Outlook Review, providing general information on the status, prospects, monthly market prices, production, exports and imports of Japanese flounder and laver, is published by Korea Maritime Institute and Fisheries Outlook Center.

Present training activities and likely future requirements

Wando Maritime and Fisheries Office, one of the branch offices of Mokpo Regional Maritime Affairs and Fisheries Office, organized a seminar, inviting CEO of SAMYANG Co. Ltd. as the guest speaker to enlighten seaweed farmers, and train them on how to collect seeds of laver under indoor culture condition in 2004.

Buan Fisheries Technology Institute, one of the branch offices of Gunsan Regional Maritime Affairs and Fisheries Office, established test farms for clam (*Meretrix lusoria*) aquaculture in four locations around Buan area. Education of local aquaculture farmers on optimum management systems, activation and resource enhancement of clam, and development of locally specialized products for Buan area was carried out from 2003 to 2004.

Pohang Regional Maritime Affairs and Fisheries office carried out two projects with local aquaculture farmers. One of the projects was a polyculture of Japanese flounder and abalone in land-based tanks. A continuous decrease in market price of flounder, a high-value species, led to the search for a new technique to produce high-value added species. An experiment for the production of flounder and abalone, another high-value species, in a polyculture system was carried out by the office and the local aquaculture farmers in a test farm. Results from the test farm showed the possibility of making profits with polyculture. Another project was the establishment of a new aquaculture farm for the production of sea squirt (*Halocynthia roretzi*) in 22 – 30 m deep sea. Saturation of sea squirt farms in 10 – 20 m deep sea resulted in low productivity and limited use of the farms. High productivity of sea squirt was recorded following the establishment of new farms.

Programs to raise work efficiency for mariculture are carried out with other parts of fisheries by the governmental agencies and national institutes.

Due to industrialization and development of the service industry, the majority of youths are not interested in the fisheries industry; they prefer taking up white-collar jobs in the urban areas, leading to a reduction in workforce in the fisheries sector. This calls for measures to be taken to attract the population to the fisheries sector in order to increase the productivity of the sector. The governmental agencies introduced programs to provide support to students to take care of their educational needs and to help them establish in the aquaculture industry. A total of US$ 360 million was disbursed; 16,029 people were supported and specially trained by local governmental agencies and the division of human resources development of the National Fisheries Research and Development Institute (NFRDI) from 1981 to 2004.

As part of measures to reduce deficiency of work force in the fisheries industry US$ 95000 was distributed to four of the fisheries high schools by the governmental agencies to support entrance and tuition fees in 2004.

Existing Major Mariculture Species and Farming Technologies

Status of Farming of Selected Species

Total mariculture production by major product groups in Korea for two decades and the year 2003 is shown in Table 4. Seaweed has always topped the total mariculture production in Korea, followed by mollusks and finfish in that order while crustacean is the least important group in terms of production quantity. Seaweed contributed 55% (452,054 metric tons) of the total mariculture production of 826,245 metric tons in 2003. Of interest, however, is the sharp increase in finfish and crustacean production in this millennium.

Table 5 shows the seaweed mariculture production by species in Korea in 2003. Sea mustard and laver made up 44% and 43%, respectively of the total seaweed production of 452,054 metric tons in 2003. Other species cultured include fusiforme and kelp. These species are cultured using fixed and semi-floating culture systems in Korea.

Mollusks production is dominated by oysters, making up 82% (238,326 metric tons) of the total production of 291,116 metric tons in 2003 (Table 6). Oysters are cultured mostly in the south coast of Korea by long-line hanging culture technique. Other species of mollusks cultured in Korea are short neck, sea mussel, ark shell, scallop, pen shell, cockles, Venus clam, abalones and hard clam.

Marine finfish culture is a major sub-sector of the mariculture and overall aquaculture industry in Korea, although the contribution by the sub-sector in terms of quantity is relatively low. Furthermore, it is encouraging that the sub-sector has experienced a sharp growth in recent years in terms of total quantity and value, with the production topped by two high-value species, olive flounder and Korean rockfish as shown in Table 7. Olive flounder is cultured in onshore tank farms while rockfish is farmed in offshore floating net-pens.

Although Korea produces a number of crustaceans, only fleshy shrimp was cultured in 2003 to a significant quantity as reported by the Fisheries Association of Korea (Table 8). Fleshy shrimp is cultured in ponds, mostly along the west coast of the peninsula.

Priorities for Development and Research

Due to the dwindling capture production, efforts are made to encourage aquaculture production and there has been a positive result, with mariculture as the leading sub-sector as indicated in Table 3. However, the Korean mariculture still faces some problems and it is necessary that these be solved so that the sub-sector can grow to meet the ever-increasing demand for marine products.

One important issue is the imbalance between the level of production and the prioritization of research for the different cultured species. There are wide disparities in output of the same species between the different locations, and these need to be explained and resolved.

Cultivation of some species still relies on the collection of wild larvae and supplies can barely meet the demand. This practice in turn has a negative impact on the prevention and treatment of the common diseases such as *lymphocystis, Edwardsiella* and *Vibrio* in fish culture, *Marterioides chungmuensis* in oyster culture, and viral diseases in shrimp culture. There is the need to improve seed production technology, establish disease control centers, develop cheap and highly efficient vaccines, develop natural immunostimulants, improve culture facilities and introduce species with short production cycles and high productivity.

There are also problems in the manufacture and improvement of feeds, and there is a great need for effective environmental protection and monitoring systems.

Identification of better management practices for existing farming species and systems, to mitigate environmental impacts

Regrettably, although marine aquaculture in Korea has recorded a huge increase in recent years there has been a marked decline in the quality of the products due to the deteriorating environmental conditions of aquaculture farms. Initiatives have been taken by the government to address this issue of deteriorating product quality through the introduction of new coastal mariculture maintenance programs consisting of three components: general mariculture ground maintenance, special mariculture ground maintenance and demonstration mariculture ground maintenance.

The benefits of the coastal mariculture maintenance programs were clearly demonstrated by the regeneration of aquatic micro-organisms and increased production per unit area, as well as improved quality of products.

On 29 January 2000, the Farming Ground Management Act was enacted to build a sustainable fishery and to improve the productivity of farm sites. The Act introduced a system of recess years for the mariculture sites to increase their productivity. The act also introduced the inspection and standardization of environment of farm sites.

The Fishery Promotion Act which was enacted on 14 January 2002 enables the government to establish a framework to promote aquaculture every 5 years. One of the functions of the Act is to control and manage a fish health program that could help aquaculture farmers to control diseases. But much still has to be done to educate the farmers on early diagnosis and prevention of diseases.

Currently, efforts are being made to further develop the offshore aquaculture technology in Korea. Other technologies and techniques need to be introduced and the existing ones improved. The optimum stocking density for the existing species and systems should be established and farmers should be encouraged to adopt polyculture when necessary and applicable. At present, most Korean farmers use formulated feeds but it is necessary that farmers be encouraged to maintain the practice, stressing on the impact of the use of raw fish on the environment. High energy density feeds with high digestibility should be formulated and used so as to reduce the nutrient load in effluents.

Table 1. Imports and Exports of Fishery Products by Major Countries In M/T, USD 1,000

	2000		2001		2002		2003	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value
Imports								
Total	749,191	1,410,598	1,056,252	1,648,372	1,186,400	1,884,417	1,238,603	1,961,145
China	283,420	486,841	474,045	634,449	491,315	719,314	461,971	713,538
Russia	81,265	125,031	92,856	153,756	189,464	215,638	269,918	299,252
U.S.A	75,588	145,366	93,969	158,520	89,603	173,774	82,485	152,677
Japan	67,741	185,109	69,679	139,129	74,536	146,497	69,257	148,699
Vietnam	33,374	72,240	49,107	101,486	61,504	121,733	67,416	129,878
Others	207,803	396,011	276,596	461,032	279,978	507,461	287,556	517,101
Exports								
Total	533,824	1,504,470	435,691	1,273,619	429,884	1,160,435	424,785	1,129,385
Japan	215,479	1,125,248	179,335	924,873	179,069	823,117	150,155	740,447
China	93,134	84,090	53,673	55,709	44,290	48,345	55,708	70,769
Thailand	44,805	22,691	47,256	32,943	46,295	34,492	55,304	38,354
EU	35,749	64,596	49,429	75,159	39,912	63,760	46,605	78,089
U.S.A	29,215	78,712	27,281	82,210	25,462	77,625	22,964	80,385
Others	115,442	129,133	78,717	102,725	94,856	113,096	94,049	121,341

Table 2. Trends of Export, Import and Trade Balance of Fishery in Korea. Million dollars

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Export	1,643	1,518	1,496	1,647	1,722	1,635	1,493	1,369	1,521	1,504	1,274	1,160	1,129
Import	576	506	542	726	843	1,080	1,045	587	1,179	1,411	1,648	1,884	1,961
Trade balance	1,066	1,012	954	921	879	555	447	782	342	94	-375	-724	-832

Source: FAO FISHSTAT plus statistics database (2004)

Table 3. Capture and Aquaculture Production in Korea (mt).

	1980	1985	1990	1995	2000	2003
Marine capture	1,840,938	2,268,584	2,471,584	2,333,525	1,830,878	1,647,974
Freshwater capture	22,290	34,463	25,325	8,765	7,140	4,726
Total Capture	1,863,228	2,303,047	2,496,909	2,342,290	1,838,018	1,652,700
Mariculture	544,402	787,571	772,729	996,889	654,440	826,245
Freshwater Aquaculture	731	3,198	15,836	20,365	13,443	13,600
Total Aquaculture	545,133	790,769	788,565	1,017,254	667,883	839,845
Grand total	2,408,361	3,093,816	3,285,474	3,359,544	2,505,901	2,492,545

Table 4. Total Mariculture Production in Korea (mt).

Group	1980	1985	1990	1995	2000	2003
Finfish	4,468	20,988	34,958	35,100	56,217	80,804
Crustacean	86	87	312	438	1,158	2,324
Mollusk	281,587	369,035	325,590	312,252	222,609	291,063
Seaweed	258,261	397,461	411,869	649,099	374,456	452,054
Total	544,402	787,571	772,729	996,889	654,440	826,245

Source: FAO FISHSTAT plus statistics database (2004)

Table 5. Seaweed Mariculture Production by Species in 2003 (mt).

Species	Quantity
Sea mustard	198,172
Laver	193,553
Fusiforme	33,661
Kelp	25,259
Others	1,363
Total	452,054

Source: The Fisheries Association of Korea (2004)

Table 6. Mollusk Mariculture Production by Species in 2003 (mt).

Species	Quantity
Oysters	238,326
Short neck	27,494
Hard clam	15,785
Sea mussel	13,653
Cockles	3,842
Ark shell	2,440
Others	
Total	291,116

Source: The Fisheries Association of Korea (2004)

Table 7. Finfish Mariculture Production and Species in 2003 (mt).

Species	Quantity
Flounder	34,533
Rockfish	23,771
Common sea bass	2,778
Yellow tail	114

Mullet	4,093
Red sea bream	4,417
Others	
Black sea bream, Acanthopaagrus schlegeli	1,084
Parrot fish, Oplegnathus fasciatus	
Puffer, Takifugu obscurus	14
Fill fish, Monacanthus	
Sea bass, Epinephelus septemfasciatus	39
Atka fish, Peurogrammus azonus	
Total	**72,393**

Source: The Fisheries Association of Korea (2004)

Table 8. Crustacean Mariculture Production and Species in 2003 (mt).

Species	Quantity
Fleshy shrimp	2,324
Kuruma prawn	0
Others	
Chinese mitten crab, Eriocheir sinensis	
Mitten crab, Eriocheir japonicus	
Blue Crab, Portunus trituberculatus	
Snow crab, Chionoecetes opilio	
Total	**2,324**

Source: The Fisheries Association of Korea (2004)