

# Fisheries and Aquaculture

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National Aquaculture Sector Overview

Indonesia

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## Characteristics, structure and resources of the sector

### Summary

Indonesia is an archipelago with more than 17 000 islands and a coastline of about 81 000 km. The area that can potentially be used for aquaculture development is of 26 606 000 ha. Aquaculture plays an important role in reducing unemployment. In 2003 there were 2 284 208 households involved in the aquaculture industry, representing around 40 percent of the total number of people employed in the fisheries sector.

Aquaculture in Indonesia is practiced in fresh, brackish and marine water using a variety of species, production facilities and methods. Freshwater aquaculture began to develop in the late 1970s when there was a significant increase in production from freshwater aquaculture as a result of the introduction of new farming technologies which contributed to the availability of hatchery-produced seed and the development of compound feed. The most common aquaculture species are common carp (*Cyprinus carpio*), catfish (*Clarias* spp., *Pangasius* spp.) and Nile tilapia (*Oreochromis niloticus*). In 1978, brackish water pond areas increased significantly with the successful development of the eyestalk ablation technique and the rapid growth of shrimp hatcheries. In South Sumatra and Lampung Provinces brackish water pond areas were expanded by the private sector to develop large-scale pond culture using the Nucleus Estate System. Penaeid shrimps and milkfish (*Chanos chanos*) are the common commodities. Mariculture has only developed in the last ten years, and is dominated by the grouper species such as humpback grouper (*Cromileptes altivelis*) and brown-marbled grouper (*Epinephelus fuscoguttatus*) as well as seaweeds (*Eucheuma* spp. and *Gracilaria* spp.).

In 2003, the areas used for freshwater and brackish water aquaculture were 250 276 ha and 480 762 ha, respectively. Mariculture species were reared in a total of 981 ha. Aquaculture contributed 20.6 percent of the country's total fish production. About 90 percent of the country's total fish production is consumed domestically. Fish consumption per capita was about 24.67 kg/year in 2003.

Data on exports of fisheries products does not separate aquaculture products from capture fishery products. Shrimp is the prime commodity for fisheries product export, and contributed 52 percent by value and 16 percent by volume in 2003.

### History and general overview

Aquaculture is an important component of Indonesian fisheries which contributes to national food security, income and employment generation and foreign exchange earnings. Another positive impact is that it reduces the pressure on marine natural resources. Recently, aquaculture development in Indonesia has accelerated and it is considered important in supporting rural economic development.

Indonesia is an archipelago with a coastline of about 81 000 km, and as such has a vast potential for aquaculture. The estimated potential area for aquaculture is 7 231 039 ha consisting of 3 775 539 ha of mariculture (52.21 percent) (DGA, 2004), 1 225 000 ha of brackish water aquaculture (16.94 percent) (DGA, 2003), and 2 230 500 ha of freshwater aquaculture (30.85 percent). The existing area used for marine, brackish water and freshwater aquaculture is only about 0.03 percent, 39.25 percent and 11.22 percent of the potential area, respectively.

Aquaculture and inland water capture fisheries contribute 26 percent to the country's total fish production (MMAF, 2003). Total aquaculture production increased by about 10 percent per year from 600 384 tonnes in 1993 to 1 137 153 tonnes in 2002 as a result of technological innovation, area expansion and availability of suitable quality of fish seed. Aquaculture is practiced in fresh, brackish and marine waters using a variety of production facilities and methods. Culture systems range from extensive to intensive depending on the stocking density of the aquatic organisms, the level of inputs and the degree of management. The significant growth of the aquaculture sector is the result of the high priority given to aquaculture development since the 1980s, and this was in turn triggered by the greater demand for food-fish, especially in the remote hinterlands, and the imposition of a ban on trawl fishing in 1980.

Freshwater aquaculture started with the stocking of common carp in backyard ponds in West Java during the Dutch occupation, in the middle of the nineteenth century, and subsequently spread to other parts of Java, Sumatra and Sulawesi islands in the early twentieth century. However, it was only in the late 1970s that a remarkable increase in production from freshwater aquaculture was observed. This was a result of the introduction of new farming technologies which contributed to the availability of hatchery-produced seed, and the development of compound feeds. The most common culture species are common carp (*Cyprinus carpio*), Nile tilapia (*Oreochromis niloticus*) and giant gourami (*Osphronemus goramy*). Common carp is the most dominant species, with production comprising about half of the total freshwater aquaculture output. The rapid increase in the importance of common carp followed the development of floating cage culture in the Citarum river system where a series of reservoirs is located. Another species, Nile tilapia, which was first introduced in Indonesia in 1969, is becoming important with production growing from 31 217 tonnes in 1999 to 71 789 tonnes in 2003 (DGA, 2004). The culture of ornamental freshwater fish has also been expanding, triggered by huge export demand and strong government support. This industry, comprised of a wide range of producers from small backyard operators to large-scale commercial producers, earns over US\$ 20 million a year from the export of 30-40 million fish. With the outbreak of KHV (Koi herpes virus) disease affecting carp farming, many common carp hatchery, nursery and grow-out farmers and operators have been shifting to the production of ornamental fish species for the export market.

Meanwhile, the culture of fish in brackish water ponds, mostly on Java Island, is an ancient tradition in Indonesia which has been practiced on a subsistence basis for more than 400 years. Milkfish (*Chanos chanos*) and mullet (*Mugil* spp.) were the traditional species reared. In terms of value, penaeid shrimps are the prime commodity, contributing 80 percent to total fisheries exports. However, due to outbreaks of white spot virus, which resulted in mass mortalities in ponds, tiger shrimp production virtually stagnated at around 90 000 tonnes from 1997 to 2001. To compensate for the drop, whiteleg shrimp (*Penaeus vannamei*) and blue shrimp (*Penaeus stylirostris*), which are more resistant than the tiger shrimp, were introduced by the Government and are now successfully farmed in East Java, Lampung and Bali (Ablaza, 2003).

The main mariculture species in Indonesia are various finfish, shellfish, seaweeds and other species, including sea cucumber. Finfish, such as seabass, groupers and snappers, with a production of 8 760 tonnes in 2002 (DGA, 2004), are highly valued and command good prices on the export market. Fingerlings of humpback and tiger grouper are produced in hatcheries and nurseries in Bali until they reach 3-10 cm in length and are sold to grow-out farms in other parts of Indonesia or overseas.

Four species of seaweeds (*Eucheuma cottonii*, *E. spinosum*, *Gracilaria* spp. and *Gelidium* spp.) are farmed and sold fresh, or dried and processed for the pharmaceutical, food processing and cosmetic industries. Seaweed production has shown higher growth rates than shrimp, increasing from about 58 217 tonnes in 1985 to 115 764 tonnes in 1990 and 223 080 in 2002 (DGA, 2003). At least 70 percent of seaweed production is exported as raw material (dried seaweed), while the remaining 30 percent is processed into carageenan, producing approximately 1 000-2 000 tonnes/year.

#### Human Resources

In general, fish farmers' skill in fish culture has existed for many years. Technologies for this activity were achieved through experience and transfer of technology among themselves. Labour participation in fish culture is the most important input. In 2003, aquaculture directly employed about 2 284 208 persons, consisting of those working on freshwater ponds (54 percent), paddy fields (24 percent), brackish water ponds (16 percent), mariculture (4 percent) and floating cage culture (2 percent).

In brackish water culture, most (55 percent) of the households involved in fish farming have less than 2 ha, while 27 percent have 2-5 ha, 12 percent have 5-10 ha and only 6 percent have more than 10 ha of land. In freshwater culture, 64 percent of households in fish farming owned less than 0.1 ha, 22 percent owned between 0.1-0.5 ha, 9 percent owned between 0.3-0.5 ha and only 5 percent owned more than 0.5 ha.

The prominent role played by women in production, processing and marketing in artisanal fisheries has been recognized and efforts have been made to improve their living conditions and to redress the imbalance between men and women. The basic objective of involving women in fisheries development is to make them equal partners to men, which will also enable them to improve their family's nutritional and living standards through increasing productivity and self-reliance. If women's needs for adequate skills and appropriate knowledge and technologies are met, they would also be in a better position to contribute to their community's welfare, socially and economically.

#### Farming systems distribution and characteristics

In 2003, the area for brackish water development was 480 762 ha or 53 percent of the potential area for shrimp culture (40 percent), milkfish (30 percent) and polyculture of shrimp and milkfish (30 percent). About 75 percent of the farms used traditional (extensive) technology; others used semi-intensive (15 percent) and intensive (10 percent) technologies. The average production of brackish water aquaculture steadily increased by 5 percent per year, reaching 501 977 tonnes in 2003. The main producers are South Sulawesi (19 percent), followed by East Java (17 percent), West Java (14 percent), Central Java (13 percent) and Lampung (8 percent).

In 2003, the locations where major proportions of potential area were being used for aquaculture were in Java (43.18 percent) and Sulawesi (20.86 percent). Similarly, the main area for mariculture was Sulawesi (65.59 percent) comprising Gorontalo, South Sulawesi and North Sulawesi, while Bali and Nusa Tenggara together accounted for about 23.82 percent. Beside these, the main areas for brackish water ponds were in Java (32.39 percent), Sulawesi (28.16 percent) and Sumatra (22.66 percent). Sumatra Island had the highest area for freshwater ponds (73.15 percent) and cage culture (85.47 percent), but Java had more floating cage net farms (68.14 percent) and paddy fields (71.67 percent).

In 2003 the total area for freshwater aquaculture reached 250 276 ha with an annual growth of 2.05 percent. The contribution of paddy fields was the highest (60 percent) with an area of 151 414 ha, followed by ponds (39 percent) reaching 97 821 ha. Freshwater aquaculture produced 472 973 tonnes in 2003 compared to 334 085 tonnes in 1999, an increase of 9.09 percent per year. The growth in production is assumed to be a result of the expansion of pond culture area by using derelict ponds and excavating new ones, while increased productivity was mainly a result of technological innovations. The five provinces that were the main producers of freshwater fish were West Java (34 percent), East Java (13 percent), West Sumatra (8 percent), Central Java (7 percent) and South Sumatra (5 percent).

In 2003, the main producers of mariculture products were the provinces of West Java (19 percent), East Java (12 percent), East Sulawesi (11 percent) and Bali (10 percent), reaching a total production of 249 242 tonnes with a growth rate of 17.37 percent per year. Region-wise, Bali reached the highest mariculture production (44 percent), followed by South Sulawesi (14 percent) and West Nusa Tenggara (13 percent).

#### Cultured species

Species contributing most of the production value (more than 75 percent of the total) are: products from mariculture, namely, grouper (US\$ 74 208) and pearl (US\$ 47 660); tiger shrimp (US\$ 662 594), milkfish (US\$ 166 987) and banana prawn (US\$ 105 294) in brackish water; and common carp (US\$ 181 908), catfish (US\$ 41 241) and Nile tilapia (US\$ 23 653) in freshwater.

At the beginning of aquaculture development in brackish water, especially in East Java, milkfish was the species chosen for production. In line with the development of culture technology for tiger and whiteleg shrimps due to their high price, milkfish culture was replaced by polyculture of shrimp and fish or shrimp alone. Pond culture commodities are common carp, tilapias, tawes, walking catfish, giant gourami, sepat siam and mujair. Through the domestication of river fish species, many fish farmers diversified their cultured species, particularly giant river prawn (*Macrobrachium rosenbergii*) and patin catfish (*Pseudopangasius nasutus*) as they command better prices. With the expansion of demand, the fish species produced in freshwater floating cage culture have been diversified from common carp as the main species to include Nile tilapia and catfish. Compared to other cultures, mariculture is the most recently adopted, and is still being practiced only on a small scale, except for pearl oyster culture which has developed to an industrial scale in some areas such as West Nusa Tenggara, East Nusa Tenggara, Southeast Sulawesi and Maluku, and seaweed in Bali and South Sulawesi. The economic commodities developed through mariculture are groupers, pearl oyster, seaweed, seabass and even coloured rosary shell.

In addition, in order to diversify the cultured species, the government has introduced some exotic species such as grass carp from China, hybrid tilapia from Taiwan Province of China, red tilapia and GIFT tilapia strain from the Philippines and freshwater ornamental fishes from Africa and South America. At present, the species cultured are numerous and there are several others such as pearl cockle, seabass, seaweed and sea-cucumber, the production of which is difficult to measure.

Since 1993, the decline in giant tiger prawn (*Penaeus monodon*) culture in Indonesia has stimulated some shrimp farmers to import new shrimp species, such as whiteleg shrimp (*Penaeus vannamei*) and blue shrimp (*Penaeus stylirostris*), claimed to have better performance than tiger shrimp. *P. vannamei* was introduced in Indonesia from Hawaii in 2000 and in July 2001 the Government declared it a superior quality of shrimp which could be cultured with greater success by using intensive technology that would result in greater resistance to disease, faster growth and improved tolerance of environmental fluctuation. Started through trial cultures which later developed to commercial levels, *P. vannamei* culture was practiced in almost all the intensive ponds in Lampung, East Java and Bali, with a productivity of about 8-10 tonnes/ha/year. However, despite its success, this shrimp is an 'organism carrier' of the Tauro Syndrome Virus (TSV) which discouraged all shrimp farmers. Besides this, another constraint is the increased demand for its seed which is faster than the growth rate of broodstock. As a result, the use of local broodstock from shrimp culture cannot be avoided, particularly since producing broodstock from shrimp culture is easier and the local broodstock is cheaper than the imported one. Blue shrimp (*Penaeus stylirstris*) also imported from Hawaii in 2000 was also declared a superior shrimp by the government in May 2002. However

shrimp (*Penaeus stylirostris*), also imported from Taiwan in 2000, has also secured a superior shrimp by the government in May 2002. However, unlike *P. vannamei*, farmers did not respond so well to it and blue shrimp culture grew very slowly and in some areas did not develop at all. Technically, blue shrimp cannot be cultured in as high density as whiteleg shrimp (more than 70 pcs/m<sup>2</sup>), but it has a very fast growth of 3.5-4 g/week compared to that of whiteleg shrimp, which is 1.37 g.

To support aquaculture development, especially on the Aquaculture Intensification Program, sufficient sources of broodstock and seed are needed to fulfil the demand in quantity and quality. In response to this need, the Government has established the National Broodstock Centre (NBC) and Regional Broodstock Centres (RBC) for shrimp, grouper, tilapias and seaweed, the main activities of which are collection of broodstock and pre-broodstock from the entire territorial waters of Indonesia, production of pre-broodstock and implementation of the breeding programme. For tiger shrimp, this has been achieved by characterization of existing tiger shrimp and preliminary work for the programme to develop the national broodstock of tiger shrimp, while for grouper it is done through the national strategy for research which will be implemented by related institutions such as Colleges and Research Institutes. The NBC and RBC have produced pre-broodstocks of *P. vannamei*, *P. stylirostris*, *P. merguensis* and YY supermale of tilapias.

#### Practices/Systems of culture

Given the high potential in terms of areas where it can be cultured, the government is committed to promoting the production of shrimp, as it has high economic value and competitiveness in the world market. Technology used for tiger shrimp culture consists of low (extensive), middle (semi-intensive) and high (intensive) levels, according to differences in pond construction, density, water and feeding management.

**Pond culture** is usually done traditionally, in backyards or nearby ponds. With a size of around 1 000 m<sup>2</sup>, 5-10 pieces/m<sup>2</sup> fish density, 8-12 cm size of seed, and 3-4 months culture period, the pond shows an 80 percent survival rate, 1.2 feed conversion ratio and 2 tonnes/crop production with a size of 250-300 g/piece. Since 1960, the running water system, adopted from Japan, has been developed in Indonesia. Generally, in this system, the concrete pond is square or trilateral in form, with sizes of 50-100 m<sup>2</sup>/unit, and 100 g seed density of 5-10 pieces/m<sup>2</sup>. Common carp is the main commodity, and production is about 1 tonne/unit/crop, or more.

**Cage culture** is a more commercial effort and a main livelihood for those involved in it. In the rivers or canals which are generally found in Java, the size of the cage is about 4x2x1 m/unit, while in Sumatra and Kalimantan, the size is larger, at 4x2x2 m/unit. Floating net cage culture has been developed in lakes and reservoirs. The cages are put down adrift in territorial water using a construction of bamboo or iron bars, and a net is bound to form a floating cage containing drums/containers/styrofoam. The cage is made from polyethylene net with a size of 4 units of 7x7x2.5 m/unit, a density of 50-70 pieces/m<sup>3</sup> and seed size of 30-50 g/piece. After 3-4 months, the production is 5-6 tonnes/unit/crop.

**Paddy field culture** involves establishing a nursery of seed before these are cultured in cages or floating net cages. Culture species vary according to the requirement of fish farmers, i.e. common carp, tawes, sepat siam, even tilapias, and the rearing period is 30 days. Paddy field culture is differentiated into three types: 'Penyelang' (before paddy planting), 'Tumpang Sari' (at the same time as paddy planting) and 'Palawija' (between 2 seasons of paddy planting).

**Mariculture** is generally done by using rafts to culture either fish or seaweed. The rafts are constructed as square cages 8x8 m in size, consisting of 4 units of 3x3x3 m each. The cage frames are made using bamboo, wood, steel or plastic pipes, and are equipped with floats. The fish species commonly grown are brown-marbled grouper (*Epinephelus fuscoguttatus*) and humpback grouper (*Cromileptes altivelis*). For brown-marbled grouper, seed density is 150-200 pieces/m<sup>3</sup> at 5-25 g size. After 7 months, the fish achieves 95 percent survival, production of 1 000 kg/raft/cycle with a harvest size of 400-500 g. For mouse grouper, with the same density and seed size, after a 12-month culture period, the fish gains 90 percent survival and production of 1 000 kg/raft/cycle, with 400-500 g harvest size.

**Seaweed culture** is usually done by four methods, i.e. free base method applied in sandy base territorial areas or sandy mud, floating method (rafting) in composit territorial and wavy areas, longline method which is the most common due to its greater durability and easy availability of appliances and materials, and a combination of floating and longline methods. Each application depends on the condition of the territorial water where the culture is practiced.

## Sector performance

#### Production

In the period 1999-2003, total aquaculture production increased from 882 989 tonnes in 1999 to 1 228 559 tonnes, valued at US\$ 1 715 901 000 in 2003 (FAO, 2005), with an incremental growth of 8.5 percent per year. This growth was the result of innovations in technology, expansion of aquaculture area and availability of suitable quality fish seeds.

The graph below shows total aquaculture production in Indonesia according to FAO statistics:

(Source: FAO Fishery Statistics, Aquaculture production)

#### Market and trade

The expansion of international trade in fishery products has exceeded the growth in total fish production in the world. Indonesia's share in the total world production of 37 851 356 tonnes in 2003 is 3 percent. It is the third major fish producer country, after China (60.2 percent) and India (5.82 percent).

Export of fisheries products (including export from capture and culture fisheries) increased steadily during the period 1999-2003. The total volume increased by 10.53 percent per year, from 644 604 tonnes in 1999 to 857 783 tonnes in 2003. By value, the annual growth rate was about 0.66 percent, from US\$ 1 605 421 thousands in 1999 to US\$ 1 643 542 thousands in 2003.

The export market can be further developed because Indonesia has various fish species and processed products which are in high demand abroad. For example, the main exports from aquaculture are shrimp (unfrozen, frozen and canned), crabs (unfrozen, frozen and canned), frog legs (fresh or chilled), seaweed (dried), ornamental fish (freshwater and mariculture), molluscs (scallops and snails), pearls and others, including capture products such as tuna, jelly fish and coral fish as well as fish fat/oil and shrimp crackers.

In 2003, Indonesia exported fisheries products to more than 210 countries of destination. The main importing countries were Japan, Hong Kong, Singapore, Malaysia, USA, France, Taiwan Province of China, South Korea, Australia, China, Germany, United Kingdom, Netherlands and Thailand.

Shrimp from both aquaculture and capture fisheries plays an important role in exports, contributing 52 percent by value and 16 percent by volume in

2003. The volume exported increased by 6 percent per year, from 109 651 tonnes in 1999 up to 137 636 tonnes in 2003. In fact, the average price for Indonesian shrimp exports decreased by 6.24 percent per year, from US\$ 8.11 per kg in 1999 down to US\$ 6.18 per kg in 2003.

Grouper is the most expensive of the coral fishes. Local demand is rather limited. Nowadays, production from ASEAN countries such as Indonesia, Thailand, Philippines and Malaysia is exported live by air. Within Asian countries, Japan is the most important market for live fish. Grouper is also popular in Hong Kong, Taiwan Province of China, Korea and Singapore. Transporting live fish to markets that are sometimes a hundred miles away may cause stress in fish, which requires special attention. For this purpose, basic considerations for efficient transport and marketing of live groupers should be planned and implemented.

The growth in seaweed exports was relatively high, reaching 40 162 tonnes or US\$ 20 511 000 in 2003. The main countries of destination were China, Hong Kong, Denmark, Philippines and Spain. Although its share in value (US\$ 20 511) of total Indonesian fisheries exports was relatively small, contributing only 1.25 percent, there is scope for further development of this commodity.

Traditional fish marketing channels dominate in the rural areas. Most fish products, whether fresh or dried (processed) are distributed through the traditional marketing system and usually end up in the domestic market. Producers for export have functional links to large-scale, industrial-type seafood companies which operate under a vertical integration of sales, with all activities handled by the companies. Shrimp companies operate under a nucleus estate scheme, with joint venture agreements with fish farmers whose produce is purchased by the companies for export.

In the traditional fish marketing system, fish products change hands several times until the point of last sale. A lot of people are involved in the purchase and distribution, from fresh fish, to processed fish products, to the retailer. In the remote areas, access to fresh fish distribution channels is limited, so fish is marketed in some processed form, for example traditional salting and sun-drying or boiling in water with large quantities of salt.

In most cases, small fish farmers do not have access to a wide range of possible buyers and processing opportunities. Private traders, collectors or agents market most of the aquaculture products, including fish fry or fingerlings, with little involvement of women in processing. Local collectors have been playing the role of marketing from production site to processing plants and supermarkets; village-based collectors who usually belong to the village themselves work as local agents who supply fish as raw material to regional collectors. The latter usually provide loans to the processing unit to pay for the raw materials, or extend small-scale credit, or advance money to small farmers to ensure that they sell to them.

In most district capitals, there are public markets with areas specifically designated for fish. The fish retailers usually sell their products to the market. In the big cities, the public markets cater to the day-to-day needs of the public for seafood, particularly for the middle- to low-income consumers. Modern supermarket chains have been established throughout the cities and are mostly for the middle-to high-income classes. There are concerns regarding hygiene and sanitation in the fresh or wet supply of fish.

There are several government decrees that address issues of labelling and certification and the agencies responsible for these activities. Based on the Ministerial Decree of Agriculture Ministry, number 752/Kpts/OT.210/10/1994 of October 2, 1994 and No. 562/Kpts/OT.210/6/97 dated 6 June 1997, the Environmental Management Effort and Environmental Monitoring Effort are prepared after the production company gets the location permit or principal approval before starting construction work. Besides this, government regulation number 752/Kpts/ OT.210/10/1994 provides the Technical Guideline on Environmental Monitoring Effort.

Infrastructure to support handling and processing of products is the responsibility of the government, except in the case of large-scale companies. The purpose of this is to ensure that quality control and supervision, handling and processing technology, performing of extension and monitoring and supporting environmental protection is in the hands of a responsible body.

In order to protect consumers at home and abroad, the Indonesian Government has launched a regulation related to quality supervision and the control of fishery products, the Government regulation implementation of Decree No.41/Kpts/IK.210/1998 re Integrated Fish Product Quality Management System and No.14128/Kpts/IK.130/1998 re Implementation Guidelines on Integrated Fish Product Quality Management System.

The main points mentioned in these decrees are that each processing unit has to apply for a: (i) Processing Properly Certificate (ii) Fish Processing Certificate, and (iii) Integrated Quality Management Programme based on HACCP (or Hazard Analysis Critical Control Point, a process control system designed to identify and prevent microbial and other hazards in food production). In addition, every fisheries export is required to possess the Integrated Quality Certificate and or Health Certificate issued by the Laboratory of Fish Inspection and Quality Control. It also stipulates that a Fish Inspector and Provincial Fisheries should supervise implementation of this regulation throughout Indonesia.

Regulations on quality supervision and control by the Indonesian Government have been accepted by several countries such as those of the European Union, with Commission Decision No.324/94/EC dated 19 May 1994 regarding the "laying down [of] special conditions for importing fish and fishery products originating in Indonesia"; the same applies to fish and fishery products from Canada and USA, by a similar MOU.

#### Contribution to the economy

Indonesia is currently the ninth largest fish producer in the world. During 1999-2003, fish production increased by an average of 8.5 percent per year, from 4 952 thousand tonnes in 1999 to an estimated 5 961 thousand tonnes in 2003, with one-fifth of the production coming from aquaculture. Aquaculture is an important source of employment, providing livelihoods to an estimated 2 384 208 households involved in fish culture in marine areas, brackish water ponds, freshwater ponds, freshwater cages and paddy fields (MMAF, 2004).

Production from aquaculture has increased dramatically since the late 1980s, particularly for the major commodities (shrimp, milkfish, tilapia and carp) some of which have doubled and others grown fourfold. In 2003, the total aquaculture output of about 1 228 thousand tonnes comprised about 20.63 percent of the country's total fish production. In the same year, penaeid shrimps, crabs and seaweeds contributed 16.05 percent, 1.40 percent and 4.68 percent, respectively, to Indonesia's total exports of fish and aquatic products and generated foreign exchange earnings of over US\$ 1 643 542 thousands in one year alone (ADB, 2004).

Aquaculture has been playing an increasingly significant role in the Indonesian economy by ensuring food availability, providing households food security and improving the living standards of poor rural communities. Aside from contributing about one-fifth of the country's estimated total fish production, the aquaculture sub-sector has been providing employment to some 2.2 million people, representing around 40 percent of the total number of people employed in the fisheries sector. Even if it does not generally pay well, aquaculture has been able to alleviate the economic hardship faced by people looking for gainful employment or means of livelihood to support their families.

About 90 percent of the country's total fish production is consumed domestically. Fish is a staple food item in the diet of Indonesian families, providing two-thirds of the total domestic animal protein supply. Among different sources of animal protein, fish can still be regarded as relatively inexpensive and is thus the main source of cheap protein of the poor (i.e. those who have annual per capita income of less than Rp 3.2 million/year, where 1 Indonesian Rupiah (IDR) = 0.0001067 US\$ as on February, 2006). Per capita fish consumption in the country has thus doubled, from a low of 12.8 kg/yr in 1982 (ADB, 2004) to about 23.63 kg/yr in 2002 (MMAF, 2003).

Small fish farmers usually practice extensive culture using low-yielding, low-input and low-level technology, and they lack the technical know-how or skill that would enable them to adopt new or improved production methods and techniques. Fish marketing for most fish products in the rural inland and coastal areas, whether fresh or processed, is done through traditional channels.

As the demand for fish and fish products continues to grow with the expanding human population, particularly in the rural areas, and as the production of artisanal capture fisheries is maintained at a sustained level, aquaculture is seen as an alternative source of high quality animal protein and livelihood especially for the lower income groups. It has also been predicted to dominate, if not surpass, the importance of marine capture fisheries in providing high quality animal protein, employment and export earnings.

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## Promotion and management of the sector

### The institutional framework

The Ministry of Marine Affairs and Fisheries (MMAF or Departemen Kelautan dan Perikanan or DKP) is the principal agency responsible for marine and fisheries sector planning, management and administration in Indonesia. As of February 2005, the Ministry comprised: (i) six line offices, consisting of an Agency for Marine Affairs and Fisheries and five Directorate Generals - of Aquaculture, Capture Fisheries, Coastal and Small Islands, Marine and Fisheries Resource Controls and Capacity Building and Marketing (ii) two staff offices, a Secretariat General and an Inspectorate General, and (iii) an Advisory Staff providing expertise to the Minister in specific fields.

Responsibility for local-level marine fisheries management rests with the Provincial Marine and Fisheries Service (Dinas Kelautan dan Perikanan Propinsi) which has offices at province, district and sub-district levels. With the adoption of Law No. 22/1999, the Provincial Marine and Fisheries Services have been given more responsibilities as well as greater autonomy in carrying out their functions, being no longer under the technical supervision of the MMAF.

### The governing regulations

The main fisheries authority in Indonesia is the Ministry of Marine Affairs and Fisheries (DKP). On matters related to aquaculture, the Ministry operates through the Directorate-General of Aquaculture Development.

At national level, fisheries and aquaculture are regulated by [Fisheries Law No. 31/2004 \(2004\)](#), which underscores the importance of sustainable use of aquatic resources in the development of fisheries.

Under [Law No.22/1999 on Regional Administration \(1999\)](#), and in the context of the decentralization process, Provincial Governments are held responsible for the management, use and conservation of marine resources in their own territory, within territorial waters. However, the following analysis will only focus on national legislation.

For more information on aquaculture legislation in Indonesia please click on the following link:

[National Aquaculture Legislation Overview - Indonesia](#)

### Applied Research, Education And Training

The Agency for Marine and Fisheries Research Affairs (AMFR or BRKP) is responsible to the Ministry of Marine Affairs and Fisheries, and its main task is to conduct strategic research on marine areas and fisheries. Apart from AMFR, other agencies such as the Agency for Study and Assessment of Technology (BPPT) and the Indonesian Science Institutes (LIPI) also plan and coordinate aquaculture research.

Aquaculture research priorities are derived from the policy directives and understanding of the broad environment, capacities and mandates of the different fisheries organizations. To further shape research into a 'system', problem-solving research is carried out by implementing units of the Directorate General of Aquaculture (DGA). Through these implementing units, technologies developed through research are verified, assessed and engineered, so as to arrive at those that can be applied in practice. The views and opinions of, among others, owners/operators of hatcheries and brackish water ponds (tambak), farmers, hired fish farm labourers and marketing operators as well as non-government organizations, are heard and reflected in the research planning process.

Aquaculture guidelines available today are based on trial and error or limited trials under experimental conditions found in research stations. On-farm trials or R&D are attempted, including participatory research and development in the farmers' fields. It is expected that research should result in technologies that are technically appropriate, environmentally-friendly and contribute to community welfare. The success of new technologies is measured by their application by hatchery operators, farmers or other stakeholders.

Research results are communicated through dissemination; promotion through seminars and workshops; reports in the electronic and printed media journals and newsletters; trainings; exhibitions and technology and science counters; libraries; and other collaborations with researchers. Verification and assessment of research and other applied technologies are communicated to farmers and related stakeholders through seminars, technical guidelines and field meetings, as well as regional and national field days.

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## Trends, issues and development

Before the 1980s the development of fisheries was focused more on capture fisheries rather than aquaculture. Anticipating the degradation of fish resources due to overexploitation, the government decided to divide fisheries development into capture and aquaculture, a policy designed to improve renewable fish resources by controlling fishing and encouraging aquaculture.

Economic crisis, triggered by monetary crisis, overwhelmed Indonesia in the middle of 1997. This disaster has highlighted the error of developing the industrial sector using high technology and imported raw material. Macro economic policy now needs to be reoriented towards a greater focus on resource-based industry. Given that two-thirds of Indonesia's territory consists of marine and inland waters with an abundance of natural resources, the development of aquaculture is believed to have the potential to be one of the paths to national economic recovery. Accordingly, it should be possible, through aquaculture development, to encourage community-based economic activities, promote foreign exchange earnings from exported aquaculture products and accelerate rural economic development.

The development of aquaculture should be able to improve the global fisheries system as expressed in the FAO 'Code of Conduct for Responsible Fisheries' by enhancing the capability of fish farmer communities in applying environment friendly technologies, including those that ensure conservation of land and water resources. Previously, the four prime commodities contributing foreign exchange earnings were shrimp, Nile tilapia, groupers and seaweeds; these have been expanded with the addition of six new ones, namely, milkfish, seabass, catfish, crabs, mussel and pearl.

Since the 1980s the government has paid more attention to aquaculture development owing to its capability to provide fish for human consumption of hinterland communities. The introduction of running water systems in 1980 was soon adopted by fish farmers. Afterwards, cage net cultures were developed rapidly, in the middle of the period 1980-1990, and fish farmers who were engaged in running water fish culture changed to the cage net fish culture system, since the latter is more efficient on investment, FCR (feed conversion ratio) and water usage.

Freshwater commodities have been used for domestic fish consumption, even though it is not forbidden to develop export commodities such as Nile tilapia, frog and ornamental fish. Therefore, priority of the freshwater commodity is of low trophic level. A recent difficulty in freshwater culture relates to the genetic deterioration of the broodstock and seeds, as seen in the slow growth rate, higher FCR and susceptibility to diseases including the Koi Herpes Virus (KHV) outbreak. To solve these problems, the government has established Broodstock Centers in several regions.

The banning of trawl fishing in 1980 through the issuance of Presidential Decree No. 39/1980 has encouraged shrimp culture development in brackish water aquaculture. In the 1980s, cultured shrimp became a prime commodity and played an important role in increasing foreign exchange earnings, resulting in large-scale growth of the shrimp business. Intensification or super intensive technology was applied without paying much attention to existing infrastructure such as reservoirs and input and output canals, causing rapid deterioration of the environment and outbreak of diseases due to waste accumulation. To solve this problem polyculture combining shrimp and *Gracilaria* spp. seaweed has been introduced in order to absorb accumulated nutrients. Genetic deterioration of broodstock and diseases especially those that are virus-borne, are other major problems which may hamper shrimp culture. Establishment of Shrimp Broodstock Centers and developing SPF (specific pathogen free) broodstock and shrimp seeds such as of *Penaeus vannamei* and *P. stylirostris* are some of the measures initiated to solve these problems.

By 1990, mariculture began to develop, even though it was limited to seaweed culture, and foreign exchange earnings increased considerably. This was followed by the successful development of pearl culture. Currently, the interest in developing mariculture is gradually increasing because mariculture, especially of groupers, has proved to be profitable and has also considerably increased Indonesia's foreign exchange earnings. In recent times, the culture of low trophic level commodities such as mussel and abalone are also being developed.

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