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Developing Philippine Coastal and Oceanic Aquaculture for Food Security and Livelihood Generation

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ABSTRACT

The fisheries of the Philippines are dominated by aquaculture, the farming of animals and plants for food and other products. With declining fish stocks in marine waters because of overfishing and habitat degradation, more than 1.7 million small fisherfolk dependent on fishing for their livelihood are among the country's "poorest of the poor". More than 70% of the total aquaculture production comes from coastal aquaculture with the farming of seaweeds, oysters, and mussels in open coastal waters (<200 m deep) and milkfish and other fishes in pens and floating cages. Oceanic aquaculture, farming in the deep sea (>200 m), is still in its infancy in the country. Mariculture parks such as the Panabo City Mariculture Park in Davao del Norte are a model for an integrated approach to sustainable coastal aquaculture. Expansion of coastal aquaculture in the country requires the dissemination of improved varieties of seaweeds to farmers and management of the 'ice-ice" disease. Meanwhile, for the cage culture of milkfish and species, the establishment of more hatcheries/nurseries and the development of efficient and cost-effective feeds are needed. The creation of a Department of Fisheries and Aquatic Resources is endorsed to give more support and attention for the further development and sustainability of the country's coastal and oceanic aquaculture for food security and livelihood generation.

Keywords:
Philippines, coastal and oceanic aquaculture, food security, livelihood generation

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INTRODUCTION

We live in a "Blue Planet" that is 71% covered with oceans (Attenborough 2001). The oceans provide us with seafood, minerals, and pharmaceuticals. Serving as the transport route for 80% of the world's goods, the oceans produce 70% of our oxygen supply and absorb 25% of man-made carbon dioxide. The oceans also render ecological services such as climate regulation, energy source, and tourism. With our dwindling land resources, the oceans are the "the last and most unexplored frontier on Earth" (Nelson 2010). Azanza et al. (2017) asserted that "the ocean-based 'blue economy' is a significant part of the Philippine economy that is largely taken for granted despite its enormous potential."

The world's fisheries production was 174 million metric tons (mmt) in 2017 (FAO 2018). In 2014, 54% (93.4 mmt) of the production was from capture fisheries and 46% (73.8 mmt) was from aquaculture. The main products of aquaculture were finfish (46%), aquatic plants (25%), mollusks (15%), crustaceans (6%), and other aquatic animals (7%).

With overfishing and habitat degradation, 90% of the wild fish stocks in the world has been fully exploited and 31.4% has been overfished at a biologically unsustainable level (FAO 2018). On the other hand, aquaculture, "the fastest growing food producing sector in the world," has increased annually by 8.8% and is expected to overtake capture fisheries production by 2020. There are 580 aquatic species and/or species groups that are farmed throughout the world.

The Philippines is an archipelago of 7,641 islands with a coastline of 37,008 km (the second longest in Southeast Asia), 26.6 million hectares (ha) of coastal waters and 193.4 million ha of oceanic waters, and 30 million ha of land. In 2017, fisheries production in the country was 4.317 mmt with 51.9% from aquaculture, 26.2% from municipal capture fisheries in coastal and inland waters, and 21.9% from commercial capture fisheries in oceanic waters (PSA 2018). The major products of aquaculture were seaweeds (62.5%), milkfish (18.6%), tilapia (11.9%), shrimps (2.0%), oysters (1.0%), and green mussel (0.08%). The Philippines ranked 11th as the world's top producer of fisheries (FAO 2018).

Fish is the primary source of animal protein in the diet of Filipinos with a per capita consumption of 40 kilograms per year (kg/yr) of fish and fishery products in 2017 (Lamarca 2017). Of the estimated two million people whose livelihoods depend on the fisheries industry, 1.7 million (85%) are from the municipal fisheries sub-sector and are among the "poorest of the poor" in the country. The poverty incidence of 39.2% for small fisherfolk is higher than that of the national average (BFAR 2016).

This paper discusses the status of coastal and oceanic aquaculture in the Philippines and their potential for contributing to food security and livelihood generation especially for small fisherfolk.

COASTAL AQUACULTURE

Aquaculture in coastal waters (<200 m deep) or mariculture contributes more than 70% to the total aquaculture production of the Philippines. The main products produced are seaweeds, oysters, and mussels in open waters and finfish such as milkfish in pens and floating cages. Seaweed farming in coastal waters of the country began in the 1960s. About 100,000 small fisherfolk grow the red seaweeds (*Kappaphycus* and *Eucheuma*) in an estimated 50,000 ha of sea farms throughout the country with an annual production of 2.7 mmt (wet weight). A hectare of seaweed farm that requires only stakes, polyethylene monoclines, seaweed cuttings tied to the lines and labor, can provide a gross income of PHP 428.571 per year to the farmers who operate farms that are 0.25-1 ha each. There is still a potential area of 200,000 ha available for seaweed culture in the country (NAST PHL 2012).

Coastal seaweed farms in the country have generally low productivity and are affected by "ice-ice", a disease caused by adverse environmental conditions (high temperature, salinity, and pH). There is a need for the propagation and

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dissemination of quality planting materials, as well as the improvement of farming practices including the management of "ice-ice."

The culture of milkfish (*Chanos chanos*) in coastal waters of the Philippines began in 1995 with the initiative of the private sector in Lingayen Gulf, Pangasinan. Floating cages made of bamboo rafts with suspended net enclosures or circular PVC-framed cages with net enclosures were stocked with juveniles and raised with artificial feeds (The Milkfish Technical Committee 2016). With its commercial success, the concept of mariculture parks, similar to industrial parks on land, was adopted by the Bureau of Fisheries and Aquatic Resources (BFAR) of the Department of Agriculture and was first implemented in the coastal waters of Samal Island, Davao del Norte in 2001. In a mariculture park, "the government regulates the number and sizes of cages, which are established by the location of the mooring buoys, and stocking densities can be regulated based on the carrying capacity of the area" (BFAR 2006).

In 2006, the Panabo City Mariculture Park (PCMP) was established in the coastal waters (617 ha) of Davao del Norte by the BFAR in partnership with the local government unit (LGU) of Panabo City. The LGU provided counterpart funds and personnel for the management of the PCMP while the BFAR took care of technical/advisory services and provided initial funds for the facilities. To attract private investors (locators), infrastructure facilities such as a mooring (anchoring) system for the floating cages, fish landing, cold storage, and support services for fish processing and transport were also provided.

From 2006 to 2013, the PCMP produced 8,390 mt of milkfish with a value of PHP 839M and generated 514 jobs for small fisherfolk. This initiative was made possible through a total investment of PHP 467.6M, 7.6% of which was from the BFAR, 4.6% from the LGU, and 73% from the private sector (Ventura pers. comm.). In 2015, the BFAR established the National Mariculture Center in Panabo City with the PCMP as a model for an "integrated approach to sustainable mariculture" in the country (BFAR 2006).

In 2017, there were 495 fish cages in the PCMP that produced 2,505 mt of milkfish, rabbitfish (*Siganus* sp.), and saline red tilapia (*Oreochromis* sp.) valued at PHP 239M. The operation provided jobs for 126 small fisherfolk working as cage caretakers (69), fish processors (38), and harvesters (19).

In the PCMP, a bamboo floating cage (10 x 10 x 4 m), stocked with 15,000 milkfish fingerlings (PHP 6/pc) and 2,000 rabbitfish fingerlings (PHP 4/pc) and cultured for 120 days on commercial feeds, produced 6.5 mt of fish valued at PHP 733,508. Deducting the costs for the fingerlings (PHP 98,000), feeds (PHP 405,000), labor for one caretaker (PHP 16,000), maintenance/harvesting/market (PHP 20,000) and cage depreciation (PHP 11,008), the net income per cage per cycle is PHP 85,000 for a return on investment (ROI) of 16% (Guerrero 2018).

Commercial feeds comprise 60-80% of the total cost for producing milkfish in coastal cages. The high cost of feeds is attributed to imported ingredients like fish meal and soybean meal. Apines-Amar et al. (2015) showed that 56% of soybean meal can be replaced with 20% of locally produced fermented copra meal in the diet of milkfish. More studies are needed for the development of efficient and cost-effective feeds using fish meal and soybean meal substitutes that are locally available to lower the cost of feeding, reduce imports, and support feed-ingredient producing industries in the country.

The proliferation of fish cages in mariculture areas and poor management practices such as overstocking and overfeeding of fish have caused fish kills due to oxygen depletion and toxic compounds (e.g., ammonia, nitrite, and hydrogen sulfide) in the water with the accumulation of fish excreta and excess feeds at the bottom.

Regulating the number and spacing of cages, stocking density, and feeding in accordance with the carrying capacity of the mariculture area has been stressed by Jacinto (2006). In the PCMP, only four cages (spaced 100 meters apart) per ha are allowed, and regular monitoring of water quality and bottom sediment is done (Ventura pers. comm.) Muyot et al. (2018) reported that the use of floating extruded

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feeds has reduced feed waste by as much as 30% compared to use of slow-sinking feeds in the cage culture of milkfish.

To reduce pollution and increase productivity in mariculture areas, the practice of integrated aquaculture of mollusks (e.g., oysters and mussels) and seaweeds (e.g., *Gracilaria* and *Eucheuma*) "alongside finfish cages to help absorb excess nutrients" (e.g., nitrogen and phosphorus) has been recommended (BFAR-PHILMINAQ 2007). The technology is referred to as "Integrated Multi-Trophic Aquaculture" (IMTA). The development of IMTA with milkfish, sea cucumber, abalone, sea urchin, seaweeds, and other potential species is one of the proposed strategies in the Aquaculture Workplan of the Comprehensive National Fisheries Industry Development Plan (CNFIDP) of the BFAR for 2016-2020 (BFAR 2016).

In the PCMP cages, the polyculture of milkfish and the herbivorous rabbitfish is practiced to lessen the need for changing the net enclosures that are clogged with biofouling organisms which are fed upon by the latter species from every month to every two months (Ventura pers. comm.). Largo et al. (2016) showed that growing the seaweeds *Gracilaria heteroclada* and *Eucheuma denticulatum* "side by side abalone cages serves as both feed-on-demand and as biofilter for organic wastes of the cultured species."

The proper zoning of mariculture areas is necessary to avoid conflict with other users of coastal waters such as municipal fisherfolk and marine protected areas (MPAs). Coastal aquaculture should also be integrated with the coastal resources management plans of LGUs "to harmonize uses and guidelines for restricted and allowable practices and water quality standards for particular zones" (Aliño pers. comm.). The criteria for the selection of mariculture project sites are: "(1) free of domestic, agricultural, and industrial pollution, (2) far from river systems or any freshwater tributaries, (3) water movement or current (20-40 cm/sec) to ensure significant nutrient exchange and flushing, (4) bottom must be sandy or rocky and not sulfuric mud, (5) protected cove or bay area, (6) not exposed to lowest tide level with a depth of at least 2 m, and (7) accessibility to inputs (feeds and fingerlings) and market outlets" (BFAR-PHILMINAQ 2007).

OCEANIC AQUACULTURE

Oceanic or offshore aquaculture in the open sea is still in experimental, research and commercial development phase throughout the world (Skladany et al. 2007). It requires fish-containing structures (e.g., cages) that can withstand strong winds, waves and currents, and support services (e.g., vessels) for operations that can be more costly than those for coastal aquaculture (Drumm 2010).

Aquaculture in offshore areas offer more sea space, have better water quality, and lesser competition with other users unlike in coastal areas. Designs for floating and submersible cages and other facilities for open sea fish farming have been reviewed (Chu et al. 2020).

In the Philippines, oceanic aquaculture is still in its infancy and has not been considered as an option for seafood production mainly because there are still available areas for coastal aquaculture.

CONSTRAINTS TO FUTURE DEVELOPMENT

In the CNFIDP for 2006-2025 of the BFAR, the expected growth rates for municipal fisheries, aquaculture, and commercial fisheries are 3.4%, 12%, and 4.5%, respectively. Even with such growth rates, it was estimated that there will be a deficit of 585,538 mt for fish in 2025 due to increasing demand in the country due to population growth.

However, the fisheries statistics for 2011-2016 of the Philippine Statistics Authority (PSA) showed an average decline of -2.52% for total fisheries production and a decrease by an average of -4.39% for aquaculture production in the country (Table 1).

For the same period, the statistics showed that there was an average of -6.5% decrease in seaweed production and an average of +2% increase in milkfish production (Table 2).

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Table 1. Production (mt) of total fisheries and aquaculture in the Philippines (2011-2016).

Year	Production (mt)	
	Fisheries	Aquaculture
2011	4,973,588	2,608,200
2012	4,865,132	2,541,965
2013	4,705,413	2,373,386
2014	4,689,085	2,337,605
2015	4,649,313	2,348,161
2016	4,355,792	2,200,913

Source: PSA (2013, 2014, 2016).

Table 2. Production (mt) of seaweed and milkfish in the Philippines (2011-2016).

Year	Production (mt)	
	Seaweed	Milkfish
2011	1,840,833	372,581
2012	1,751,071	386,729
2013	1,558,378	401,066
2014	1,549,576	390,232
2015	1,566,362	384,425
2016	1,404,519	398,088

Source: PSA (2013, 2014, 2016)

The production of farmed seaweeds in the country is limited by the lack of quality (high-yielding) planting materials and the prevalence of the “ice-ice” disease. To address these problems, there is need to mass propagate the high-yielding varieties in nurseries throughout the country and disseminate them to farmers. Improved farming practices including the management of “ice-ice” should also be done to increase productivity.

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The main limiting factor in the expansion of the PCMP and other mariculture parks is the lack of milkfish fry/fingerlings for culture in the cages. Local hatcheries are only able to supply 40% (0.9 billion) of the 2.25 billion fry required annually. The rest of the demand (60%) is imported from Indonesia (The Technical Milkfish Committee 2016). As of 2016, only 43 out of the 67 mariculture parks established by the BFAR in partnership with coastal LGUs and mariculture zones of the LGUs in the country were operational. Moreover, only 459 ha of the 15,593 ha of coastal waters identified for mariculture parks had been utilized (BFAR 2016). "The mariculture activities remain undeveloped due to inadequate investments/incentives and to limited development funds of LGUs" (BFAR 2006). Thus, there is an urgent need for the establishment of more hatcheries/ nurseries for milkfish and other fishes throughout the country and more funding support from the government and private sectors for the setting up of more mariculture parks.

National Fisheries Program

For 2016-2022, the DA-BFAR's National Fisheries Program (NFP) identified five priority aquaculture commodities, namely, seaweeds, milkfish, tilapia, shrimp, and shellfish. Among the major thrusts for aquaculture in the NFP are fish broodstock development and maintenance, fingerlings/ seedstocks production and distribution of seaweed farm implements, and establishment and maintenance of seaweed nurseries (BFAR 2016). For 2018, the NFP had a budget of PHP 4.1B (DBM 2017). However, the General Appropriations Act (GAA) budget of the BFAR for 2018 was only PHP 6.1B, representing 11.4% of the DA's budget of PHP 53.34B.

Creation of a Department of Fisheries and Aquatic Resources

Indonesia, which has the longest coastline in Southeast Asia, established its Ministry of Marine Affairs and Fisheries (MMAF) in 1999, prior to which the administration of fisheries was under its Ministry of Agriculture. In 2015, the fisheries sector of the country grew by 8.3% compared to 4.7% of its overall economy. For its outstanding performance in expanding the country's area for farmed seaweeds to more than one million hectares and providing livelihood to more than 200,000 smallholder farmers (Paul 2016), the MMAF was provided by the Indonesian government with a budget of US$ 1B in 2016 (Guerrero 2017).

It is for these reasons, among others, that the National Academy of Science and Technology Philippines is advocating for the creation of a Department of Fisheries and Aquatic Resources in the Philippine Government to give more attention and support for the sustainable development of our country's vast coastal and oceanic waters in particular and fisheries in general.

CONCLUSION AND RECOMMENDATIONS

With the vast coastal and oceanic waters of the Philippines, there is high potential for the aquaculture of seaweeds and milkfish and other species in mariculture parks and zones.

For further development of coastal and oceanic aquaculture in the country, the following are recommended:

- To increase seaweed productivity, the mass propagation of high-yielding varieties should be done in nurseries throughout the country for dissemination to farmers; improvement of farming practices including the management of the "ice-ice" disease is also needed.
- To increase production of milkfish and other species, more investments from the government and private sectors for the establishment of hatcheries/nurseries throughout the country should be provided. The development of efficient and cost-effective feeds using locally available ingredients to lower feed cost should also be done.
- The creation of a Department of Fisheries and Aquatic Resources in the Philippine

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Government, as advocated by the National Academy of Science and Technology, Philippines, is endorsed.

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