Shrimp Farming in the Philippines

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Aquaculture serves the employment and food security needs of most Asian coastal countries, such as Bangladesh, China, India, Indonesia, the Philippines, Thailand, and Vietnam, which are all aquaculture-reliant countries with large aquaculture sectors. Aquaculture is a major driver of socioeconomic development in poor rural and coastal communities, particularly in Asia, and it relieves the pressure on, and helps to maintain the sustainability of, wild-caught species from rivers, lakes, and oceans, as it provides for the shortfalls of capture fisheries. This industry has become a major source of food protein and it is predicted that it will support the seafood production as a sustainable alternative to wild-caught fish.

aquaculture | environmental impacts | PRISMA | shrimp aquaculture | shrimp diseases | socioeconomic impacts

1. Introduction

Crustaceans contribute to a significant portion of the production and value of aquaculture among the aquatic species that are developed for it [1]. Penaeid shrimps are the most preferred crustaceans in aquaculture, as is shown by the vast expansion of the land area that is being devoted to shrimp farming [2][3]. Globally, about 9.4 million metric tons (mt) of farmed crustaceans were produced in 2020. Of this, 5.7 million mt were from *Penaeus vannamei* (Pacific white shrimp) and *Penaeus monodon* (black tiger shrimp) production [4]. In the most recent years, shrimp has become the world's most valuable aquaculture species, and its production has increased from less than 75,000 mt in 1980, to over 5.7 million mt in 2020 [4]. In the Philippines, shrimp production remains a valuable export commodity, with a total production in 2019 of 66,252 mt; it ranks fourth in value, at USD 42.36 million; and it is exported to Japan, South Korea, and the United States [5].

Penaeus vannamei is one of the most popular shrimp species for culture [6]. This species became well-known in tropical countries for its desirable characteristics, such as its short culture period and fast growth, and it has made inroads in the global market [7]. Its production has grown tremendously in past years because of its high economic returns, although it has also been ravaged by diseases [8].

In the Philippines, shrimp production has been mainly located in Negros and the Panay Islands in Central and Western Visayas. Recently, this has changed, and shrimp production has been growing and increasing in other areas, such as in Central Luzon, in other parts of Central Visayas, in SOCCSKSARGEN, in Northern Mindanao, and in the Caraga and Davao regions [9][10]. Thus, *P. vannamei* production has spread in various parts of the

country, whether it is cultured alone, or in combination with other finfish species [11][12]. There are new cultivation techniques being applied and new cultivation areas that were previously nonexistent, which means that farmers have been encouraged to adapt because of the high economic returns [7][13]. Despite what happened because of the *P. monodon* crises in the mid-to-late 1990s, shrimp farmers and investors have high hopes and expectations for better market demands in local and overseas markets [7][9][14][15].

Before the importation of *P. vannamei, P. monodon* was the only species being exported abroad [7]. *Penaeus. monodon* is indigenous to the Philippines and can be grown in freshwater, brackish water, and marine water [15], and throughout northern Luzon to the southernmost parts of Mindanao [7]. During the continuous growth and expansion of shrimp culture in the Philippines, the shrimp industry reached its highest peak in 1992, when it produced about 120,000 mt [16].

Beyond the year 2000 shows the lack of a clear industry roadmap for reinvigorating the shrimp industry in the Philippines, despite the availability of all the relevant technologies to expand and to increase its existing capacity. While Republic Act 8550, which is otherwise known as the “Philippine Fisheries Code of 1998”, was enacted to law, it contained vague references on incentivizing the fisheries and the aquaculture industry. For instance, Section Two (2), Objective three (3), argues for the *“Improvement of productivity of aquaculture within ecological limits”.* This law only argues for increasing the aquaculture production; it does not specify how to protect the ecosystem; for example, the mangrove ecosystem during forest clearing and pond construction, and protection against the release of wastewater in the case of milkfish and shrimp production. It also does not state nor specify whether the state can solely decide the terms for putting up ecological limits on the basis of the best available scientific expertise. Even the more specific provisions contained in Article Three (3), Section Eight (8) of the same law, which provides for incentives and disincentives for the proper cultivation or culture of species, do not properly discuss the process for attaining the proper method of culturing species in all the stages, such that it reduces the possible environmental impacts. Furthermore, the implementation of the rules and regulations of RA 8550, the act of the reforestation of bays, shores, and dikes, and the building of structures to minimize water pollution by the fishpond lessee are all stated (Rule 46.2), including good aquaculture practices (Rule 47.1), which are crafted by the Bureau of Fisheries and Aquatic Resources (BFAR). Yet, a cursory visit to fishpond farms (small-scale and commercial operators) shows that these are not being followed most of the time, or that shrimp farmers are minimally fulfilling these guidelines of the law. Despite these failures to adopt sustainability practices, except for compliance certifications, when exporting shrimps and finfish to premium markets, such as Europe, Japan, and the United States, which require adherence to traceability and other food safety rules and protocols, the required compliance certificates become external motivating factors in accessing those premium markets.

2. Farm Management

Awareness about the need to reduce the impacts of shrimp farming has been a global issue. Farm and health management practices that focus on disease prevention rather than treatment, the maintenance of hygiene and biosecurity measures, and the responsible and effective use of chemicals could be the keys to the sustainability of aquaculture [17].

3. Disease

The presence of viral diseases, such as White Spot Syndrome Virus (WSSV), Monodon Baculovirus (MBV), Infectious Hypodermal and Hematopoietic Necrosis Virus (IHHNV), Hepatopancreatic Parvovirus (HPV), and Yellow Head Virus (YHV), has been identified in several provinces in the Philippines. They have now occurred in Pampanga, Bataan, Batangas, Bulacan, Camarines Norte, and in Mindoro Oriental and Palawan in Luzon; in Capiz, Bohol, and Negros Oriental in Visayas; and in General Santos and Sarangani Province in Mindanao [18][19]. In the 1980s, the intensive monoculture of *Penaeus monodon*, which is commonly known as “black tiger shrimp”, was introduced and gained wide acceptance in the Philippines. Later, this shrimp species was affected by infectious diseases, which caused its aquaculture and economic decline. In the Philippines, intensive shrimp farmers have reduced their culture runs because of viral and bacterial disease outbreaks [18][19]. The diseases of penaeid shrimps may be caused by living agents, such as bacteria, fungi, parasites, and viruses, and nonliving factors, such as nutritional deficiencies, toxic substances, and environmental problems. *Penaeus monodon*, *Penaeus merguiensis*, and *Penaeus indicus* were the major species that are cultivated in the Philippines that were affected by diseases [20]. Diseases are the topmost issues and challenges in shrimp aquaculture worldwide [21][8]. According to Andrino-Felarca et al. (2015), the major viral pathogens that affect the Philippines’ shrimp industry include White Spot Syndrome Virus (WSSV), Monodon Baculovirus (MBV), Infectious Hypodermal and Hematopoietic Necrosis Virus (IHHNV), Hepatopancreatic Parvovirus (HPV), Yellow Head Virus (YHV), and Taura Syndrome Virus (TSV). The principal hosts for TSV are *Penaeus vannamei* and *Penaeus stylirostris.* However, the outbreak of virus diseases, such as the White Spot Syndrome Virus (WSSV) in the early 1990s, resulted in a significant decline in shrimp production in Asia [8][20]. Upon further investigation, WSSV was found to have originated from Chinese hatcheries, where infected hatchery-produced *Penaeus japonicus* was imported to Japan in 1993 [9][22], and was later spread to other countries, such as the Philippines [23]. There were also other widespread diseases, such as vibriosis and luminous bacterial (Lumbac) infections. They had the same impact as WSSV, which contributed to significant economic losses among shrimp growers [7][24]. Because of the WSSV pandemic, the Philippine government decided to ban the importation of live shrimp, except for scientific or educational purposes following the attainment of the required permission. This was to prevent the spread of the diseases [7][22]. Technically, *Penaeus vannamei* was first introduced in the Philippines in 1978, but the production was unsuccessful. Since there was a prohibition on importing live shrimp, the private sector illegally imported *P. vannamei* from Taiwan in 1997, which was labeled as “milkfish fry”. Later, in 2001, because of this incidence, the government also prohibited the culture of this shrimp species with corresponding penalties [7][24]. Despite this early setback in the culture of *P. vannamei* in the Philippines, by 2006, the Philippines had become one of the main producer countries of *P. vannamei* in the FAO’s fishery statistics in 2006. The illegal shipments of the shrimp remain uncontrolled, and the possibility of the contamination of TSV remains [25][26]. The viral disease appears to be more widespread during the dry season than during the wet season. The presence of TSV had also been detected in *P. monodon* adults. This disease has increased the social impacts associated with shrimp farming, which include poverty and landlessness, food insecurity, and impacts on the health and education of shrimp farmers and their families. One of the main issues in the recent expansion of shrimp culture is the social conflict with other resource users. This usually happens when coastal lands are leased or bought for the use of large

multinational companies or export-led companies for cultivating various aquaculture species, such as milkfish or shrimp. Coastal communities are then displaced, and their markets and livelihoods are removed. In other cases, such as in the process of pond construction and maintenance, the former occupants of the cultivated area are given priority during the hiring of workers. Nonetheless, worldwide shrimp aquaculture production has been depressed by diseases, particularly those caused by luminous vibrio and/or viruses [8][20][27].

4. Marine Pollution

More than 100 chemicals and biological products are used in aquaculture in the Philippines, from pond preparation to the culture period, and for disease prevention and control [17][28]. The practice of polyculture and extensive farming did not pose any major problems; however, when the farm methods shifted to semi-intensive and intensive systems, high stocking densities and formulated feeds were used. The culture intensification resulted in the production of shrimps that are susceptible to several infectious diseases, and, consequently, the use of chemical and biological products became mandatory to prevent and treat these diseases [20]. Water management became difficult as a result of the culture intensification, which led to uncontrolled feed wastes, and the release of effluents into the marine environment, which affected the diversity of the phytoplankton, the spawning grounds, and the nursery habitats, as well as of the seagrass and mangrove ecosystems [9]. The use of feeds and the continued release of effluents into nearby waters cause water quality deterioration in the ponds, and by receiving water overtime as the total nitrogen (N) and phosphorus (P), nitrite, silicate, orthophosphate, dissolved oxygen, and biological oxygen demands increase, the water visibility also decreases in intensive culture, which often leads to cases of massive fish kills and economic losses in the industry [29][30][31][32]. This is mainly because of high nutrient deposits in the sediment and the water column from fish feed wastes, which can trigger algal blooms that affect shellfishes, and that may pose a threat to mariculture activities, such as the farming of milkfish (*Chanos chanos*) and tilapia (*Oreochromis niloticus*) [31][32]. For instance, various factors have been implicated in the occurrence of fish kills in Taal Lake, which is a known aquaculture site, and most fish cage operators and fish farmers attribute these to environmental and anthropogenic causes, which arise from milkfish and tilapia aquaculture effluents [31]. Vista et al. (2006) attribute this water quality deterioration to high stocking densities and feed inputs from the fish farmers [32]. In addition, Primavera and co-workers suggest that chemical effluents in shrimp farming are a concern, as well as their possible impacts on the environment and on human health, and that they will continue to be a subject for future debates because of insufficient knowledge regarding waste management [9][33][34][35]. The negative impacts of marine pollution on capture fisheries and aquaculture are becoming more apparent. Even the municipal fishery subsector, which has traditionally been the main source of fish for domestic consumption, has been declining steadily over the past several years [36][37]. Because most ponds used for shrimp culture are located in brackish water, with mangroves converted for their use, mangrove forests have declined to only 120,000 ha, while fish/shrimp culture ponds have increased to 232,000 ha [34][35]. The ecological services lost because of this mangrove conversion include the shoreline protection from tsunamis and the impacts of typhoons, and it leads to the impairment of the function of the mangrove forests, which act as carbon sinks, and to the destruction of the nursery and spawning grounds of fish, shellfish, and other aquatic life [35][38]. Along with mangrove decline is the ecosystem's susceptibility to climate change, particularly in terms of the rising sea levels, which can lead to higher

risks of flooding, tsunamis, cyclones, and storm surges [39]. Fortunately, over the last few years, aquacultural activity in the Philippines has been largely directed towards the production of milkfish, tilapia, seaweeds, and mudcrabs, and it has not reverted back to an aggressive shrimp culture, particularly for the giant tiger prawn, *Penaeus monodon*. *P. vannamei* is currently the culture of choice among shrimp farmers, despite the challenges that affect shrimp farming.

5. Socioeconomic Impacts

There are several studies that report that aquaculture has been the cause of several problems, with economic and social impacts [14]. Aquaculture importation has been a worldwide practice, and *Penaeus vannamei* has been imported for more than five decades, which already raises some concern, as this adds to the cost of cultivation [40]. In addition, since 70% of most Filipinos live in coastal areas, their livelihoods are dependent on fishing, aquaculture, and the other auxiliary industries related to the fisheries, with 1.6 million of them being highly dependent on aquaculture for their livelihoods and protein requirements [5][41][42]. The marketing of seafood products in the Philippines is usually channeled to fish brokers, with profit-making taking place among the wholesalers, retailers, and brokers in the fisheries [43][44]. This causes the higher market prices for aquatic products, which puts them outside of the range of poor urban consumers [44][45]. Black tiger prawn (*Penaeus monodon*) and Pacific whiteleg shrimp (*Penaeus vannamei*) are highly traded species in the Philippines. Black tiger shrimp leads with the highest production ranges, with 45,000–50,000 mt of annual production from 2008 to 2019, and is followed by the Pacific white shrimp, with a production of nearly 2000 mt in 2008, which gradually increased to 19,000 mt in 2019. These species contributed around USD 120 million to the Philippines' export earnings in 2014, which is much higher than in 2013, when it was USD 67.5 million [12]. While there is no arguing with the increase in their production, problems arise because of the socioeconomic impacts. However, the studies are limited to food security, equity, and development. More commonly, it has been stated that aquaculture, which also applies to fish farming, has been responsible for the marginalization of coastal communities and the increased unemployment [14]. In contrast to this view, shrimp industry players, operators, feed companies, and other stakeholders and politicians that support the industry perceive that economic growth, especially in terms of livelihood opportunities, is created through the shrimp industry, even in remote areas of the country [42][45][46]. The industry has been growing by 2.4%, and it has produced an average of 65,000 mt in the past 20 years. Shrimp farming activities contribute significantly to both the local and national economies of the Philippines, and shrimp continues to be an export commodity to Japan, the United States, and South Korea, with high demand and prices, even in local and national markets [5]. Its production offers livelihood opportunities, even to rural women, and it has other value-adding activities, which provide employment and poverty alleviation for the country [47]. The role of women is very important and strategic, as they are considered to be the key determinants for the food security and nutritional statuses of their households [48][49][50]. Moreover, empowered women help to improve the nutritional statuses of their children [50]. Clearly, a balance is needed, where both the location of large-scale shrimp farms, even those of small-holder farmers, must not necessarily displace the existing artisanal fishers, gleaners, fry collectors, tourists, and other stakeholders that also utilize the mangrove and water resources of the area. Even if there are trade-offs, both livelihoods and environmental concerns (water pollution, the depletion of fry in the wild,

the spread of diseases, the biodiversity impacts, aquatic invasions) should both be addressed, as they go together in aquaculture [9][51][33][52][53].

6. Climate Change

The Philippines ranks second in terms of its global climate risk because of its vulnerability to climate change impacts [54][55], which are projected to be the key reason for the decline of the fisheries, with huge economic costs [56]. Climate change affects the targeted population range and the productivity, habitats, and costs of fisheries and aquaculture [57]. The changes in the climatic variables facilitate the increased frequencies of typhoons and the spread of disease, which cause physical damage to the farm's pond structure and the deterioration of the water quality, as well as the spread of disease and infection in shrimp ponds [55][58]. Issues and problems have arisen, and the decrease in wild-caught shrimp fry, the lack of hatcheries in strategic locations to supply shrimp farmers, and the increasing price of feeds are the major concerns [55]. Few studies have analyzed the economic impacts of climate change on aquaculture and fisheries with regard to the national economy. The Philippines is projected to decrease the GDP of its fisheries by 9% with the climate change mitigation scenario, and to decrease it by 18% with the extreme scenario without mitigation [56]. As the aquaculture industry grapples with the impacts of climate change, and particularly with heavy rains, cold months, and extreme events, which inevitably impact the growth, survival, and performance of the cultured species, which lowers their productivity, and with the possibility of higher disease transmission because of water quality deterioration, this has economic costs. The government should adopt further adaptation measures in order to prevent the catastrophic impacts of climate change and the variabilities within the aquaculture sector [59]. This may include: the climate proofing of postharvest facilities; increasing the number of aquaculture hatcheries to avoid insufficient supplies; the enforcement of regulations in terms of the number of cages, pens, cultured ponds; the regulation of the stocking density and proper land-use planning; the observance of aquaculture practices; and the proper coordination between local governments and the Bureau of Fisheries and Aquatic Resources (BFAR) for licensing and for the registration of fish cages, ponds, and operators, as well as with the Department of Environment and Natural Resources (DENR) for regular water quality monitoring [60][61][62].

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