

ECO-FRIENDLY FISH FARMING: RESPONSIBLY- SUSTAINABLE AQUACULTURE AMONG ASEAN COUNTRIES

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Abstract

Oceans were regarded as limitless source of fish and surmised that their supply was enough for the growing population. However, the fish sustenance of the seas was transcended by the increasing population's demands. Through the decade, wild fish stocks progressively depleted. Thus, aquaculture has emerged to address capture fisheries insufficiency. This research study aimed to assess aquaculture through its sustainability and effects on the ecosystem of ASEAN countries. This study utilized a Descriptive-Quantitative research design which gathers quantifiable information to describe the object of the study and how it could improve. It also employed data mining techniques. It is determined that Vietnam has the largest aquaculture farm while Indonesia boasts the highest fish production. Most of the ASEAN countries' employment rates in aquaculture-agriculture only amount to less than 15%. The majority of the countries have good aquaculture economies, while some are dependent on the importation of aquaculture products. The five leading ASEAN countries in aquaculture are Indonesia, Vietnam, Thailand, Philippines, and Myanmar, respectively. Aquaculture reduces fishing pressure on wild stocks but uses lots of shared resources that may hinder environment. "Responsible Aquaculture Standards in Vietnam" is the proposed action plan to minimize the negative outcomes of aquaculture in the Philippines.

Keywords: Aquaculture, Sustainability, Ecosystem

1. Introduction

Historically, people viewed the oceans as an illimitable fish haven and assumed that fish supply could cater to an escalating human population. More than three billion individuals consume fish, which is considered 17% overall, a source of animal protein and almost 10% of consumed proteins worldwide (FAO, 2017). There are numerous benefits gained from fish, and it is considered one of the vital sources of food for humankind. However, the fish sustenance of the seas was transcended greatly by the increasing population's demands. As the population increases, more fishing becomes industrialized through the years, and wild fish stocks progressively depleted; therefore, fish farming has emerged promptly to address capture fisheries' insufficiency (Tidwell & Allan, 2001, as cited by Park, Weier, et al., 2017).

Food and Agriculture Organization (FAO) (n.d.) stated that aquaculture is one of the sectors of food production that thrive the fastest. It almost surpasses capture fisheries' contribution to the world's fish for food usage. The farming of fish includes other aquatic organisms, called aquaculture, which is situated in both coastal and inland areas. It involves mediation in the rearing process to improve production. Additionally, as defined by National Oceanic and Atmospheric Administration (NOAA) (n.d.), aquaculture is the overall process of breeding, rearing, and harvesting algae, fish, mollusk, and other aquatic organisms in all types of an aqueous environment. With the increase in the demand for seafood, advancements in technology improved food production growth in coastal marine waters and the ocean. Aquaculture is a way to produce sustainable food and commercial products, recover habitat and restore wild stocks, and reconstruct the threatened and endangered species population.

As stated in The Ocean Foundation's Project Sustainable Aquaculture (n.d.), aquaculture must be sustainable, for it makes a fundamental contribution to food supplies. Unfortunately, "good" aquaculture is not defined and does not have established standards. Intense analysis and denunciation from environmentalists were faced by aquaculture. It was feared that it could invoke severe environmental problems and, in worse-case scenarios, further affect threatened wild species. Over the past decades, the impact of aquaculture on the ecosystem has been a prominent topic of discussion with a negative perception. Nevertheless, aquaculture's effect on the environment is entirely dependent on the degree of production, area of the farm, and the species being farmed. The possibility of having sustainable aquaculture is high due to new strategies and technologies (Global Seafood Alliance, 2019).

The researchers chose this study because the Philippines, an archipelago, are abundant in terms of aquatic resources such as lake, river, and sea, wherein aquatic animals are ample. Though having these resources, our nation continues to decline in terms of fish production around the globe from being the 4th ranked to now 11th placed. The researchers thought that our country did not utilize the full capacity of our aquatic resources. Complemented with the data on the internet, the researchers found that other ASEAN countries, such as Indonesia, applied

aquaculture to address the decreasing fish production in their countries. Why not implement it too? Unfortunately, aquaculture needs technologies, new strategies, and, most especially, environment rehabilitation in which environmental impacts are matters of discussion. With this, the researchers sought to analyze data from ASEAN countries in terms of aquaculture's sustainability and its effects on the environment to propose an action plan for the leading countries with aquaculture.

As time passed, people steadily grew to be innovative through advancements in technology and became more aware of human activities' setbacks on the ecosystem. According to Bostock et al. (2019) and Bohnes & Laurent (2021), there is no extensive examination on assessing the impacts of fish farming activities to cope with the industry's growth. With this, the researchers would like to assess the sustainability of aquaculture and its impact on the environment. Thus, this research will open new interventions and a better conception of aquaculture that could provide convenience and efficiency in fish production without or with as minimal damage to the ecosystem as possible.

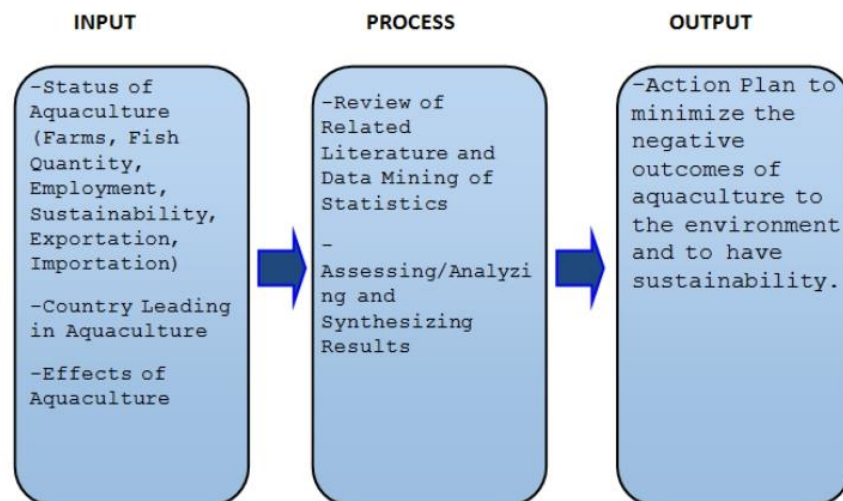
This study aimed to assess aquaculture through its sustainability and effects on the ecosystem of ASEAN countries.

Specifically, this study determined:

1. How may the status of aquaculture in ASEAN countries be described in terms of:
 - 1.1 Number of Farms
 - 1.2 Rate of Fish Quantity
 - 1.3 Employment Rate of Aquaculture-Agriculture
 - 1.4 Exportation of Aquaculture Products
 - 1.5 Importation of Aquaculture Products
2. Which ASEAN countries are leading in terms of aquaculture?
3. What are the advantages and disadvantages of aquaculture in the ecosystem?
4. What action plan can be proposed to minimize the negative outcomes of aquaculture in the Philippines?

2. Analysis Framework

Figure 1 Paradigm of the Study



The conceptual framework was the groundwork for determining the key concepts and the relationship between variables that need to be analyzed. This type of framework was preferred to represent the relevant inputs, appropriate procedure, and possible outputs to help the researchers conclude. The inputs aided the researchers in finding a focal point and extent from academic research and data statistics collected utilizing an internet-based data gathering method. The information from websites, articles, journals, and news was this study's data. Outputs were analyzed and synthesized from the data platforms to yield results and conclusions. The analysis of the gathered information helped deduce the research problems and, thus, concluded that environmental-friendly aquaculture with sustainability among ASEAN countries is possible.

3. Research Method

The researchers sought to know the sustainability of aquaculture by assessing its status and effect on the environment with the help of quantifiable data. The researchers used a quantitative research design in which numerical data was gathered and analyzed. Specifically, descriptive was chosen among the quantitative research designs. Descriptive research aims to gather information to describe the object of study and critique the object to identify ways to improve it. According to Antonio (2015), in his article *Descriptive Research*, descriptive research is used to expound on the characteristics and components of a population or a phenomenon used to make statistical calculations for frequencies, averages, etc. It aimed to determine how the research could be improved.

This research utilized internet-based data gathering or data mining, the practice of analyzing databases to generate a new idea as defined by Salkind (2010) in his article in *Encyclopedia of Research Design*; data mining is a procedure of extracting relevant information from large data sets through the use of any relevant data analysis techniques developed to help people make sound decisions. The researchers thoroughly checked the websites where the data was gathered to ensure validity.

The researchers employed the process of data science. There are four processes in this procedure: Data, Information, Insights, and Imperatives. *Data* is the most crucial step for it incorporates data gathering, wherein the researchers create and generate data from a trusted source. Consolidation of relevant data through outcome interpretation and data visualization such as tabular and visual representation created *information*. The information is analyzed to illustrate important data. *Insights* are the process in which the significant data were concluded then, followed by *imperatives*, developing various recommendations for the research problem.

Description of the status of aquaculture in ASEAN countries utilized frequency count and ranking. Average between the data from websites and data on the status of aquaculture were used to rank the countries to know the leading ASEAN countries in terms of aquaculture. Data mining from reliable sources such as research studies and

articles was used to determine aquaculture's positive and negative outcomes in the ecosystem.

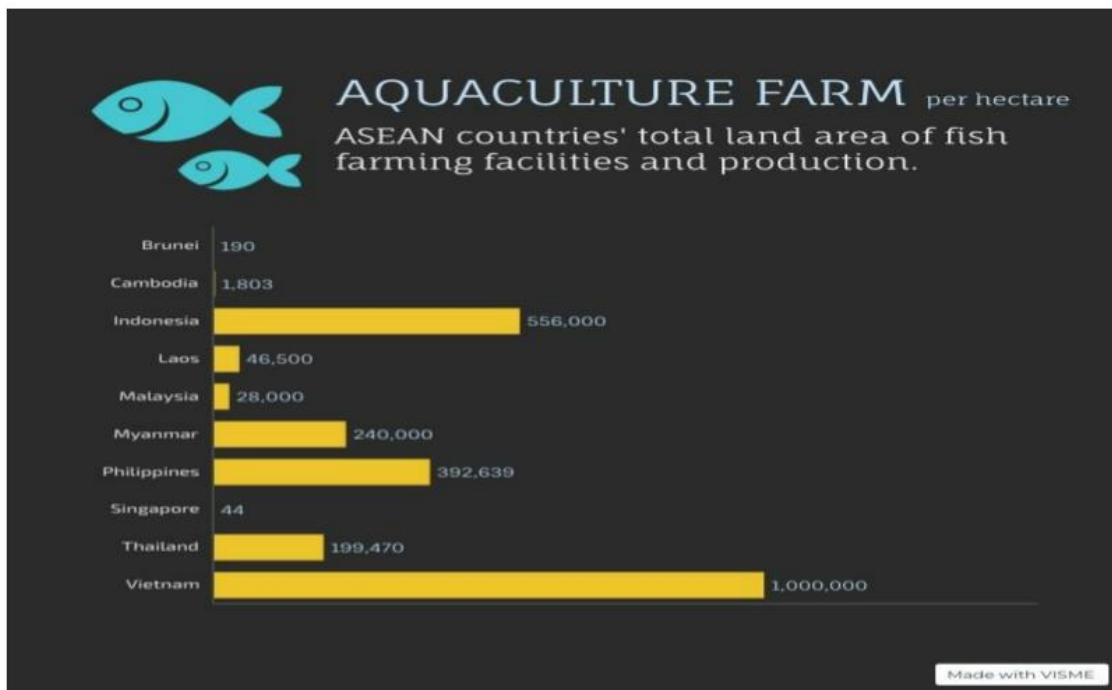
4. Discussion

As stated in Earth Systems and Environmental Sciences, aquaculture produces aquatic organisms in a maintained and partially controlled environment. Developing nations' rural farmers conduct aquaculture as the food supply for their households. It is also done to produce aquatic organisms such as fish for local and global markets (Boyd, 2013). To assess aquaculture through its sustainability and effects on the ecosystem, the researchers determined:

4.1 Status of Aquaculture:

4.1.1 Number of Farms among ASEAN Countries

Figure 2 Number of Aquaculture Farms per hectares among ASEAN Countries



Source: thefishsite.com, researchgate.net,Repository.seafdec.org.ph, seafdec.org, pemsea.org,and fao.org, 2018

Figure 2 shows the data of aquaculture farms in the ASEAN countries by hectares. According to the data, Vietnam had the largest area of aquaculture farms, with a total of one million hectares. The second-largest farm was from Indonesia with 556 000 ha, only more than half of Vietnam. Philippines and Myanmar had aquaculture farms with 392 639 ha and 240 000 ha, respectively.

Thailand's aquaculture had an area of 199 470 ha. Other ASEAN countries had less than 50 000 ha for their farm, and among those, Singapore, with 44 ha, had the least area of aquaculture.

According to Informa PLC (2021), Vietnam had a large potential for aquaculture, with a total water surface area estimated above 1.7 million hectares, of which about 1 million hectares have now been exploited for aquaculture. Vietnam's key aquaculture sectors include pangasius, shrimp, tilapia, and increasingly also bivalves and marine fishes such as cobia, seabass, and grouper. In opposition, based to Heng, N.C. (2015), Singapore is a small country state with a demographic profile of over 5 million in population. With limited land for agricultural purposes and sea space available for fish farming, Singapore depended heavily on the importation of fresh seafood.

The researchers conclude that aquaculture potential was relatively affected by the accessible land area. The data shows that Vietnam has the largest aquaculture farm and poses great potential for fish farming.

4.1.2 Rate of Fish Quantity

Figure 3 Rate of Fish Quantity among ASEAN Countries



Source: data.worldbank.org 2018.

Figure 3 illustrates the fish quantity rate or fish production per metric ton of the countries from ASEAN. The country with the highest fish production was Indonesia, with 14,772,104 MT. Vietnam came in second-highest rate with 4,153,323 MT, only 28% of Indonesia's. The Philippines and Myanmar had a considerable rate of fish quantity with 2,304,361 MT and 1,131,706 MT,

respectively. Other countries from ASEAN had less than a million metric tons for their fish production. Consequently, Singapore and Brunei had the least rate of fish quantity having Singapore with 5,702 MT and Brunei with 1,117 MT.

According to Ariansyach (2017), since the late 1970s, the aquaculture production of Indonesia, which made use of either traditional, semi-intensive, or intensive methods, has significantly increased. The country's production from aquaculture indicated a steady growth between 2011 and 2015 that mainly came from mariculture. In 2015, its total production from aquaculture was about 15 million M.T., dominated by seaweeds. Having a small territory, the country of Brunei had limited natural water resources available within and surrounding it. This limitation was an impetus for further expansion and investment in aquaculture (Estrebillo & Hiramoto, 2021).

Accordingly, the researchers inferred that the larger the area for aquaculture (as shown in Figure 2), the higher the rate of fish quantity. There was a huge gap in the rate of fish quantity between countries with large aquaculture farms and those with small aquaculture areas.

4.1.3 Employment Rate of Aquaculture-Agriculture

Figure 4 Employment Rate of Aquaculture based on Agriculture



Source: data.worldbank.org, nationmaster.com, and stats.oecd.org 2018.

In Figure 4, the data shown is about the employment rate of aquaculture with regard to the agriculture sector. The employment rate is obtained by the percentage of aquaculture employment the agriculture employment. The country with the highest employment rate was Singapore, with a total of 72%, 1,510 out of 2,096. Brunei had the second-highest rate, with 40% employment obtained from 915 out of 2,289. Out of 39,408,034 from agriculture, 4,206,287 were from aquaculture Indonesia amounting to an 11% employment rate. Vietnam had 1,716,117 employments in aquaculture out of 21,479,207 in agriculture resulting to 8% employment rate. Other ASEAN countries had an employment rate of less than 5%. Among those, Cambodia had the lowest employment rate with .30%, 9,521 out of 3,302,226.

For ASEAN countries, fish was a hugely important source of nutrition, also providing income, opening up employment opportunities, and alleviating poverty. Due to the late emergence of aquaculture, employment was slowly increasing especially in the transition of the employed from agriculture to aquaculture (Ralte, 2017).

In conclusion, the data showed that most of the ASEAN countries' employment rate in aquaculture only amounts to less than 15% with regard to agriculture. The researchers also concluded that the employment rate of ASEAN countries centers on agriculture than aquaculture.

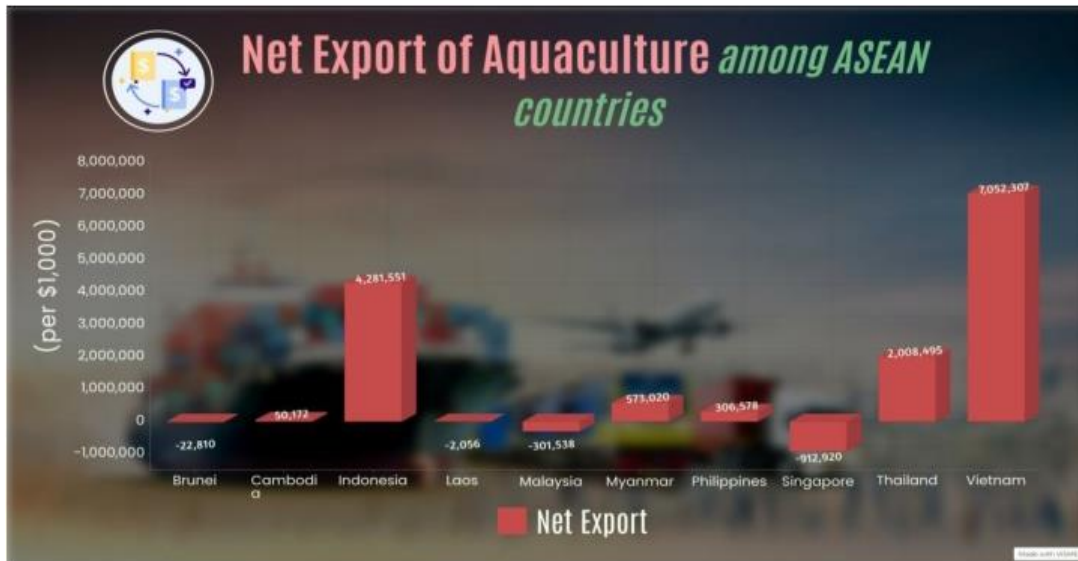
4.1.4 Exportation and Importation Rate of Aquaculture Products

Figure 5 Exportation and Importation Rate of Aquaculture among ASEAN Countries



Source: stats.oecd.org, www.seafdec.org, www.asean.jp.or, and www.singstat.gov.sg 2018.

Figure 6 Net Export of Aquaculture among ASEAN Countries



Source: Figure 5(Net Export=Export-Import)

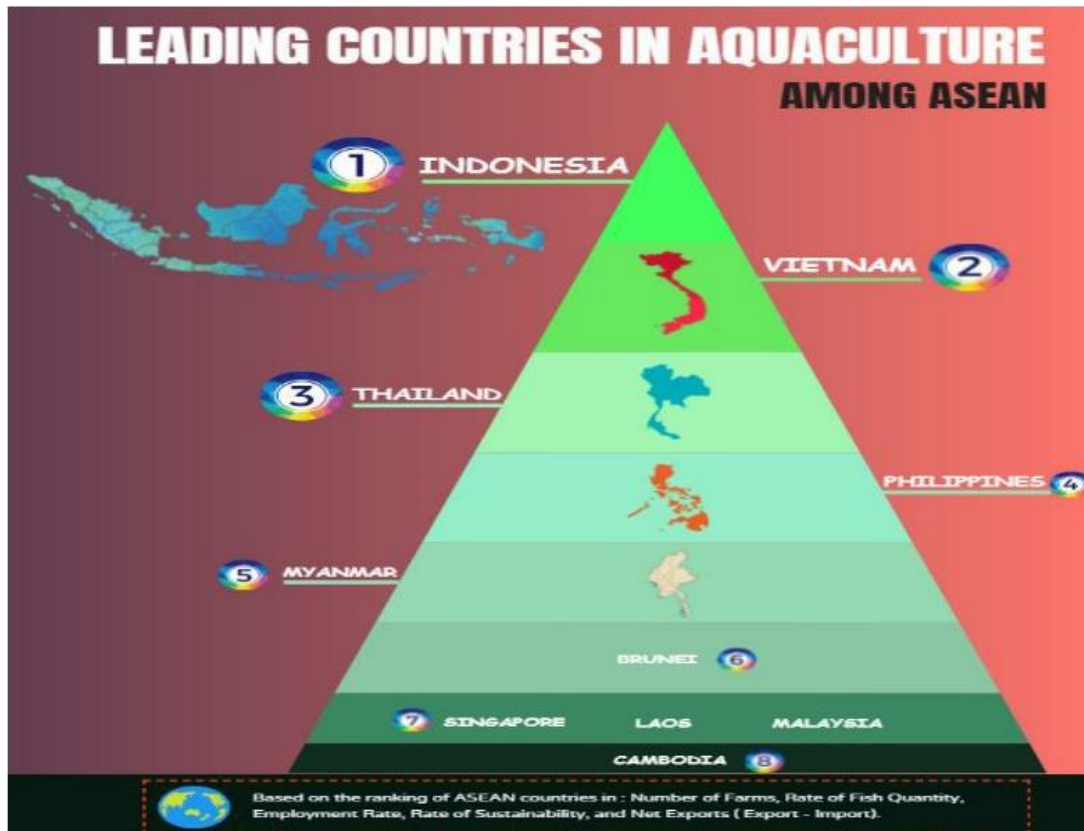
Exportation and importation rates of aquaculture per \$1,000 in the ASEAN region were shown in Figure 5, while the net export based on Figure 5 is shown in Figure 6. The highest net export among ASEAN countries was Vietnam amounting to \$7,052,307, with the export of \$8,911,638 and import of \$1,859,331. Second to Vietnam was Indonesia, with the export of \$4,705,215 and import of \$423,664, total net export of \$4,281,551. Thailand had a net export of \$2,008,495 consisting of a \$6,077,436 export and a \$4,068,941 import. With a net export of \$573,020, resulting from \$711,720 export and \$138,700 import, Myanmar came in fourth highest. Other ASEAN countries had less than \$500,000. Among those, Singapore had a \$912,920 net export, consisting of \$157,080 export and \$1,070,000 import.

According to Vu Thi Phuong Thanh (2019), in recent years, Vietnam's seafood export turnover ranked fourth among the major export products, which are textiles, footwear, and crude oil. Moreover, Viet Nam ranked among the top ten seafood exporters in the world. The overexploitation of fishery resources led to the low supply of raw materials for fisheries processing. Thus, the imported products were intended to augment the raw materials. Singapore is a small country state with a demographic profile of over 5 million in population. With limited land for agricultural purposes and sea space available for fish farming, Singapore depended heavily on the importation of fresh seafood (Heng N.C., 2015).

The researchers inferred that Vietnam is the country leading in aquaculture exports while Singapore greatly depended on aquaculture imports from other countries. Six out of ten countries had positive net export indicating a trade surplus, while four countries had negative net export indicating a trade deficit.

4.2 Leading ASEAN Countries in Terms of Aquaculture

Figure 7 Leading ASEAN Countries in Aquaculture



Source: data.worldbank.org (2018) and Status of Aquaculture Table 1, 2, 3, 4 & 5.

Figure 7 shows the ranking of ASEAN countries in terms of aquaculture based on the World Bank and the status of aquaculture in this research. Indonesia was the leading country in terms of aquaculture. The second in the ranking was Vietnam, followed by Thailand in the third rank. Philippines and Myanmar were fourth and fifth rank, respectively, in terms of aquaculture. Brunei ranked sixth, while Singapore, Laos, and Malaysia tied in seventh place. The last in rank was Cambodia.

According to Global Business Guide (2014), owing to its location in fish-rich waters and a long fishing tradition, Indonesia is one of the biggest seafood producers in the world. The archipelago also ranked among the most productive countries in aquaculture, and as wild stocks in the earth's seas are dwindling, Indonesia's importance in global markets is set to increase further. In contrast to the data, Food and Agricultural Organization (2016) stated that Singapore was the 84th place and Laos was in 33rd place among the countries in the world; Singapore was the least in rank in ASEAN, and Laos was second to last.

The researchers concluded that the three biggest contributors of aquaculture products among ASEAN countries were Indonesia, Vietnam, and Thailand. The data revealed that these three countries were to be the basis of the action plan for sustainable aquaculture.

4.3. Advantages and Disadvantages of Aquaculture in the Ecosystem

Table 1 Advantage and Disadvantage of Aquaculture in the Ecosystem

ADVANTAGES	Conserve Energy Future	NOAA	Global Seafood Alliance	Ecosystem United	Innovate-Eco	Pinduoduo	KQED
Reduces Fishing Pressure on Wild Stocks	√	√	√	√	√	√	√
Creates a Barrier Against Pollution	√		√		√		√
Conservation of Biodiversity	√	√				√	
Efficient Protein Production	√	√	√	√	√		
Water Usage	√						√
DISADVANTAGES							
Uses Lots of Shared Resources	√	√	√	√	√	√	√
Nutrient Build-Up		√	√	√	√	√	√
Fish Exploitation		√		√		√	√
Transmission of Disease	√		√	√	√		√
Threat of Invasive Species	√			√	√	√	

Source: conserve-energy-future.com, www.fisheries.noaa.gov, www.globalseafood.org, ecosystemsunitd.com, innovate-eco.com, stories.pinduoduo-global.com, kqed.org

In Table 1, the data about the advantages and disadvantages of aquaculture in the ecosystem were gathered from six reliable websites. There were advantages of aquaculture to the ecosystem. Aquaculture reduces fishing pressure on wild stocks, which allows for alternative sources of food instead of fishing aquatic animals in their natural habitat. Aquaculture also created a barrier against pollution with mollusk and seaweeds, which are filter-feeders, both environmental and economic. Aquacultures also protected biodiversity by reducing the fishing activities on the wild stock in their ecosystems. By providing alternatives to fishing, there was a reduced attack on the wild populations of the various species in the sea. In terms of protein production, it was efficient to produce protein through aquaculture due to the low feed conversion ratio rather than other sources of protein like cattle and chicken. Aquaculture usually uses runoffs, surface water, and stormwater.

According to Wreglesworth (2012), considering approximately 1 billion people on earth look to fish as a primary source of protein (World Health Organization), aquaculture reduces the drive for wild fish and the overexploitation of

this highly vulnerable resource. Rinkesh (2022) stated that mollusks are filter feeders, while seaweed acts a lot like the grass of the sea. Both these organisms sift the water that flows through them as brought in by the current and clean the water.

On the contrary, there were disadvantages of aquaculture to the ecosystem. It took a lot of shared resources to facilitate aquaculture and indirectly affected the locals by dominantly disrupting the natural resources in an area. Aquaculture was prone to nutrient build-up due to dead fish, food that isn't eaten, and feces of fish which can cause algal bloom. Although aquaculture served as an alternative source of fish produce, smaller fish that is used as feeds are exploited. Transmission of disease was another disadvantage of aquaculture; diseases within the farm can be transferred to the nearby natural habitats. Lastly, aquaculture could introduce an invasive species that could threaten the fish population on the farm.

Layne (2021) said that aqua farms utilize a lot of resources from surrounding environments. This sometimes created a problem with the local ecosystem. Some aqua farms were so dominant that they sucked up many natural resources within an area. This is why they can sometimes indirectly do damage to the habitats where they're located. Aquaculture could also pollute water systems with excess nutrients and fecal matter due to the large numbers and concentrations of farmed fish (Sencer, 2017).

In conclusion, there were positive and negative outcome of aquaculture. It helped the environment by being an alternative source of fish and conserving the biodiversity of captured fisheries. On the other hand, it was inevitable to have disadvantages in the process. The disadvantages of aquaculture to the environment were focused on the maintenance and managing of the aquaculture itself.

4.4 Action Plan to Promote Responsibly-Sustainable Aquaculture in Dingalan, Aurora:

Table 2 Acronyms and Abbreviations Used in the Action Plan

ABBREVIATIONS	FULLNAME
ASC	Aquaculture Stewardship Council
Aurora PPC	Aurora Provincial People's Committee
BAP	Best Aquaculture Practices
BFAR	Bureau of Fisheries and Aquatic Resources
BSP	Banko Sentral ng Pilipinas]
CITEM	Center for International Trade Expositions and Missions
DA	Department of Agriculture
DBP	Development Bank of The Philippines
DENR	Department of Environment and Natural Resources
DOF	Department of Finance
DTI	Department of Trade and Industry
IDH	IDH, The Sustainable Trade Initiative
NEDA	The National Economic and Development Authority
PAPP	Philippine Association of Fish Producers

Table 3 Action Plan to Promote Responsibly-Sustainable Aquaculture in Dingalan, Aurora

OBJECTIVES	ACTION	ORGANIZATION INVOLVED	BUDGET PROVISION	TIME
Ensuring that aquaculture sector development is aligned with the objectives of the Green Growth Strategy and National Action Plan on Sustainable Production and Consumption	Complete the map of registered tilapia aquaculture based on the Planning on Tilapia aquaculture and processing development in Dingalan to the year 2025.	BFAR	DA, DENR and Provincial Authorities	Quarter IV 2023
	Issue a regulation (e.g., Circular) to enforce linkage between processing enterprises and tilapia aquaculture areas based on the planning on tilapia aquaculture in Dingalan to the year 2025, vision to 2030.	BFAR	DA, DENR and Provincial Authorities	Quarter IV 2023
	Organize workshop(s) to reach an agreement on how to conform to the requirements of international standards: -GlobalGap, Aquaculture Stewardship Council focus on food safety, traceability, and social, and environmental issues; - Japanese Aquaculture Standards focus on antibiotic residue; and - BAP focuses on food safety, social responsibility, and environmental protection.	Chair: DA Coordinative Bodies: DENR, DTI	DA, DENR, DTI, IDH, and Other Donors	Quarter IV 2023
	Organize workshop (s) to identify how to introduce traceability regulations into the Filipino aquaculture sector.	Chair: D-Fish Coordinative Bodies: CITEM, PAFP	DA, DENR, DTI, IDH, and Other Donors	Quarter I 2024
	Establish pilot(s) to apply the process of traceability in aquaculture.	DA	DA, DENR, DTI, IDH, and Other Donors	Quarter II 2024
	Propose a traceability process for Filipino aquaculture.	Chair: DA Coordinative Body: CITEM, DTI	DA and DTI	Quarter II 2024
	Identify the good production models to fit with objectives “reduce Green Houses Gases (GHG) and green production and sustainable consumption” of Green Growth and objectives “enhance natural resources management, reduce GHG and other negative impacts to the environment and optimize environmental use” of Agricultural Sector Restructuring Program.	Chair: DA Coordinative Body: DENR, DTI	DA, DENR, DTI, IDH, and Other Donors	Quarter II 2024
	2.1 Promote PPP at the national level			

Promoting the PPP model at the national and provincial scale to mobilize capital for the sustainable development of aquaculture	Issue a Circular to guide implementation of Decree on PPP application in general.	NEDA	NEDA	Quarter III 2023
	Based on the Circular issued by NEDA, DA issues a Circular to guide the implementation of the Decree on PPP application in Agriculture and in Aquaculture in particular.	Chair: NEDA/DA Coordinative bodies: DA and related Departments	DA	Quarter IV 2023
	2.2 Promote PPP at the provincial level			
	Identify and propose suitable PPP models for sustainable aquaculture development in general.	Chair: DA Coordinative bodies: DBP, BSP	DA, Provincial Authority, IDH	Quarter IV 2023
	Build a PPP model pilot in Aurora	Chair: DA Coordinative bodies: Aurora PPC, IDH	Co-funding by Aurora PPC, IDH	Quarter III 2023
	Implement PPP Model in Aurora	Chair: Aurora PPC, IDH, related Companies	Co-funding by Aurora PPC, IDH, Private Companies	2023 – 2024
	Upscale PPP Provincial model in Aurora to other Provinces and areas	Chair: DA Coordinative body: Aurora PPC	DA, Aurora PPC, IDH	Quarter II 2025
Facilitating access to finance	Sign an agreement with World Wide Fund for Nature (WWFN) to get financial sources to support sustainable aquaculture development.	Chair: DA Coordinative Bodies: WWFN	DA, DOF, BSP, IDH	Quarter III & IV 2023
	Sign an agreement with the Banko Sentral ng Pilipinas (BSP) and other commercial banks to help the farmer and enterprises to access credit sources in practicing responsible aquaculture.	Chair: DA Coordinative bodies: BSP, PPC of Aurora, and related Provinces, Banks	DA, related provinces	Quarter II 2024
	Promote program to build brand-name for sustainable aquaculture products of the Philippines.	Chair: CITEM Coordinative Body: DA, related Provincial Authorities	DA, DTI, IDH	Quarter IV 2023, Quarter I 2024

Stimulating trade of sustainable products	Propose a new program to seek and penetrate markets for sustainable aquaculture products in Phillipines	Chair: CITEM Coordinative Body: DA, PAFP, related Provincial Authorities, DOF	DA, DTI, IDH	Quarter IV 2023
	Organize an annual exhibition for sustainable aquaculture products in the Phillipines.	Chair: CITEM Coordinative Bodies: DA, PAFP, Processing Enterprises	DA, DTI, Processing Enterprises	Quarter I 2024
	Set up a program to help Processing Enterprises and related Bodies to participate in the international exhibition to advertise and market sustainable aquaculture products.	Chair: CITEM Coordinative Bodies: DA, PAFP, Processing Enterprises	DA, DTI, Processing Enterprises	Quarter I 2024
	Issue a new legal document to guide implementation of National Action Plan on Sustainable production and consumption up to 2025, with a vision to 2030.	DTI, DA	DATI, DA	Quarter II 2024
Developing supporting policies	Issue a Manual to guide the implementation of the policy of credit to serve for agriculture and rural development, Policy to encourage enterprises to invest into agriculture and rural development, investment following the PPP. Formulation and policy to encourage the development of co-operation, collaboration to link agricultural production. With consumption, build large fields in the aquaculture sector. This Manual will be annexed to the Circular on PPP application in Agriculture and Aquaculture, to be issued by DA.	Chair: DA Coordinative Bodies: BSP, DBP	DA, IDH, Banks	Quarter IV 2023
	Conduct policy-action research (PAR) to propose and test policies on applying international certificates/standards, including implementing research to propose policies and then establishing several pilots to verify the feasibility of the policy, based on the outcomes of the pilots; adjust the policy for other regions of similar characteristics.	Chair: DA Coordinative Bodies: DA, BSP, DBP CITEM, PAFP	DA, IDH	Quarter II 2024
	Issue a legal document (for example, a Circular or Decision of the Minister of DA) on supporting international certification/standards.	DA	DA	Quarter II 2024

4. Conclusions and Recommendations

Vietnam had the largest area of aquaculture farms among the ASEAN countries. In contrast, Singapore had the smallest area of aquaculture farms. Half of the ASEAN countries had large aquaculture farms. One of the bases of aquaculture potential was the size/area of the farm. The larger the aquaculture farm, the higher its potential for aquaculture.

Indonesia had the highest fish production or rate of fish quantity among the ASEAN countries. Brunei, on the other hand, had the least fish production. Indonesia, Vietnam, the Philippines, and Myanmar were the top aquaculture producers in Southeast Asia. There was a huge gap in the rate of fish quantity between countries with large aquaculture farms (e.g., Indonesia) and those with small aquaculture farms (e.g., Brunei).

Most of the ASEAN countries' employment rate in aquaculture with regards to agriculture only amounted to less than 15%. Among the ASEAN countries, Singapore had the highest employment rate in aquaculture. The data showed that the ASEAN countries were more centered on agriculture than aquaculture.

Exportation rate and importation rate of aquaculture products were key factors in determining the net export of aquaculture production. The net export was one of the bases of the economic sustainability of aquaculture. Vietnam had the highest net export of aquaculture products among the ASEAN countries. Meanwhile, Singapore had the lowest net export.

Positive net exports indicated trade surplus, while negative net exports indicated trade deficits. Vietnam, Indonesia, Thailand, Myanmar, Philippines, and Cambodia had a trade surplus, while Singapore, Malaysia, Brunei, and Laos had a trade deficit. The majorities of the ASEAN countries had a good aquaculture economy and were self-sufficient, while some depended on imported aquaculture products.

The five leading ASEAN countries in aquaculture were Indonesia, Vietnam, Thailand, the Philippines, and Myanmar, respectively. These countries had large aquaculture farms, a high rate of fish quantity, and positive net exports. Among these, one of the three leading countries in aquaculture was the basis of the action plan for responsibly-sustainable aquaculture.

The advantages of aquaculture in the ecosystem were: reduces fishing pressure on wild stocks, creates a barrier against pollution, conservation of biodiversity, protein production efficiency, and water usage. The disadvantages of aquaculture in the ecosystem were: the use of lots of shared resources, nutrient build-up, fish exploitation, the transmission of disease, and the threat of invasive species.

The action plan to minimize the negative outcomes of aquaculture in the Philippines was from Vietnam entitled "Action Plan to Promote Responsible Aquaculture Standards in Vietnam." The different objectives of the action plan include 1.) Ensuring that aquaculture sector development is aligned with the objectives of the Green Growth Strategy and National Action Plan on Sustainable Production and Consumption; 2) Promoting the PPP model on the national and

provincial scale to mobilize capital for the sustainable development of aquaculture; 3) Facilitating access to finance; 4) Stimulating trade of sustainable products; and 5) Developing supporting policies.

To fully utilize the potential of aquaculture, countries should have an aquaculture master plan. It is recommended to advance the review of the aquaculture master plan and make the necessary adjustments in order to create the advantageous conditions to develop aquaculture farms and infrastructure in an efficient and sustainable way. Criteria such as energy-saving, optimal use of land and water resources, minimized pollution, and degradation of land should be included. The master plan of aquaculture should be jointly developed by the Department of Agriculture and the Department of Environment and Natural Resources to ensure that aquaculture establishes in an effective and sustainable way.

Establish concentrated farming areas to link with the aquaculture sector's processing plants closely. This would minimize the negative environmental impacts and support synchronous infrastructure development. Consequently, farmers and processors will find it easier to comply with sustainability standards. Less intensive production modalities should be introduced for the sustainable development of the sector. Department of Trade and Industry and the Department of Agriculture can guide the aquaculture producers to achieve a reasonable production scale and ensure a traceability system.

Develop an improved training policy or workshops directed at upgrading the skills of workers in the aquaculture sector. The improved training policy or workshop must take the needs of both short-term and long-term segments in aquaculture so that the highly skilled technical, managerial and operational staff are sufficiently prepared and added to the labor force. National Extension Services should play a key role in this recommendation.

Linkages in aquaculture production should be strengthened. Public-Private Partnerships should be practiced in order to create a suitable and efficient instrument for the successful implementation of responsibly-sustainable aquaculture. The organizations can sign agreements on specifying roles and responsibilities as well as detailed plans to be taken in the course of time.

To the future researchers, expand this research in terms of what aquatic organism is suitable for the responsibly-sustainable aquaculture and specify the different aquaculture systems that best suit the country's land/water areas.

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