Assessment of Aquaculture Biosecurity Measures in Bataan, Philippines

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***Abstract*—An assessment of the biosecurity strategies of selected fishponds in Bataan was conducted to determine the present status of biosecurity measures being practiced by selected fishpond operators in Bataan, Philippines. It aims to evaluate the extent of implementation of the three thematic areas of biosecurity namely—physical facilities and pond design (1), biosecure aquaculture management (2), and disease control and prevention program (3) Forty (40) pond operators participated in the survey. The present study revealed an alarming deprived knowledge of the respondents regarding the aforementioned issue. Likewise, the compliance of most of the fish farmers in different biosecurity standards was observed to be *poor* (44.64%) to *fair* (12.61%). This study, however, was able to recognize risk areas that can still be further developed, and was able to identify stakeholders whom require capacity-building regarding the principles and measures of biosecurity for improved aquaculture production.**

Index Terms*—aquaculture, biosecurity, disease, fishponds, *Penaeus monodon

I. Introduction

Biosecurity in aquaculture is an important preventive measure to avoid the introduction of diseases to aquaculture facilities, and eventually in farmed species [1]. Outbreak and spreading of diseases may happen as a repercussion of non-compliance in a biosecured production system. Moreover, it may cause significant decreased in the yield of infected fish, and ultimately, loss of income to affected operators [2].

Aquaculture is one of the most important industries in Bataan, Philippines. There are 4,266.19 hectares devoted to brackish water fish farming and 115.73 hectares of fresh water ponds. The main aquaculture grow-out cultured commodities are shrimps (*Penaeus monodon* and *P. vannamei*), milkfish, crabs (*Scylla serrata*), and bivalves (mussels and oysters). The total aquaculture production reached 11,784.96 mt in 2012 with production value of about $1.3 million [3].

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Although the production has been gradually grown since 2008 in the province, disease outbreaks and natural calamities pose threats to the industry. These concerns become more likely to happen mainly due to intensification in aquaculture, particularly in shrimp farming. To forestall the potential threat and economic losses, it is imperative to initially recognize risks, and implement risk limitation measures in an aquaculture production unit [4].

This study evaluated the existing biosecurity strategies currently being adopted and implemented in selected fishponds in Bataan in order to have an initial data of the various system of safeguarding cultured organism against possible diseases.

II. Materials and Methods

This study was conducted in the province of Bataan, Philippines (14°52-25'N, 120°32-33' E). Five fishponds in every municipality (i.e. Dinalupihan, Hermosa, Orani, Samal, Abucay, Balanga, Pilar, and Mariveles) were selected to participate in the biosecurity survey and inspection, and were done on June 2013 to July 2014. Overall, forty (N = 40) fishponds that are used for the grow-out polyculture of milkfish, shrimps, and crabs were assessed.

The participants were requested to accomplish the survey questionnaires. The questionnaire is composed of three thematic areas in biosecurity—physical facilities and pond design (1), biosecured aquaculture management (2), and disease control and prevention program (3). Each thematic area has related subjects concerning on biosecurity strategies for pond location, constructed perimeters, facilities and equipment, entry of personnel and inputs, seed stocks, pond preparation and management, disposal, soil and water treatment, vaccination, disease prevention, and control program.

Data were analyzed through the use of simple descriptive statistics, such as frequency distribution, percentages, mean, and ranking.

III. Results and Discussion

Fishpond Location: Although accessible, the distance of the surveyed ponds to other adjacent fishponds, source of waters, households, and communities (town-proper) was *very close* (Table I), which does not conform to the recommended distance of at least 1.0 km from the communities [4]. The ideal distance must be met to prevent horizontal transmission of diseases from one source to other unaffected areas.

TABLE I. Distance of Surveyed Fishpond (km) to the Adjacent Fishponds, Waterways, Canal, River Channel, Households, Communities, and Main Road Networks

Categories	Very far (>5)	Far (3-5)	Near (1-3)	Close (0.5-1)	Very close (<0.5)
Adjacent Fishponds	12.00	0.00	4.00	4.00	80.00
Waterways, Canal, River, channel	0.00	0.00	4.00	12.00	84.00
Households	12.50	20.83	8.33	12.50	45.83
Communities	12.00	16.00	12.00	20.00	40.00
Main road network	8.33	25.00	16.67	8.33	41.67
Total	44.83	61.83	45.00	56.83	291.5
Mean	8.97	12.37	9.00	11.37	58.30
Rank	5	2	4	3	1

Presence of boundary fences, protected dikes, and driveways: It was observed that there were ca. 42.0% of the studied ponds had no boundary fences, protective dikes and driveways; ca. 54.0% had *limited* to *very limited* perimeters constructed across the ponds; only ca. 4.0% stated that they had intermittent boundary fences before, but were damaged by typhoons. Birds scarring device (also for stray animals) was *very limited* (ca. 61.0%), while 39% had no animal scarring devices. Birds and strayed animals are known as vector of diseases and can spread pathogens from pond to pond. These animals also feed on cultured species.

TABLE II. Presence of Foot or Tire Bath, Cloth Changing Area, and Showers in the Surveyed Fishponds

Categories	Very often	Often	Limited	Very limited	Not at all
Foot or tire bath	0.00	0.00	0.00	6.00	94.00
Changing area	0.00	0.00	0.00	6.25	93.75
Showers	0.00	0.00	0.00	0.00	100.00
Total	0.00	0.00	0.00	12.25	287.75
Mean	0.00	0.00	0.00	4.08	95.92
Rank	3.33	3.33	3.33	2	1

Facilities and equipment: Facilities and equipment dedicated for fish health management were lacking to nearly all of the surveyed ponds. Likewise, settling ponds, reservoirs, and treatment pond units were deficient in nearly 60% of the surveyed ponds. Furthermore, 96% of the respondents claimed that shower rooms, clothes changing areas, and foot and tire bath are not present in the facilities (Table II). Provision of sterile clothing and boots for visitors, sales agent representatives, costumers, and field workers was observed to be *lacking* (ca. 73%.0) to *very limited* (ca. 14.0%). Water filtration system was also absent in 46.32% of the fishponds.

Entry in ponds: Approximately 64% of the respondents claimed that they do not limit the entry of vehicles (e.g. delivery trucks, container vans, and the likes) in the pond vicinity. Likewise, around 88% have reported that washing and initial disinfection of incoming vehicles from contaminated ponds are not being practiced. Although there is a limited entry policy for non-workers (ca. 34.0%), disinfection of arriving equipment is not being applied (ca. 70%). Fish and crustaceans species fished outside the pond vicinity were allowed to enter (ca 22.0%) in the vicinity, and majority claimed that most of these are disposed by burying (ca. 52%).

TABLE III. Checking the Health Status of Incoming Seed Stocks (Fry/Fingerlings/Crablets).

Species	Very often	Often	Limited	Very limited	Not at all
Penaeus monodon	62.50	21.88	6.25	0.00	9.38
Scylla serrata	62.86	22.86	5.71	0.00	8.57
Chanos chanos	63.42	18.51	4.88	0.00	12.2
Oreochromis spp. and *Sarotherodon melanotheron*	71.43	14.29	7.14	0.00	7.14
Penaeus vannamei	71.43	0.00	4.76	0.00	23.81
Other species	28.57	14.29	14.29	0.00	42.86
Total	360.20	92.82	43.03	0.00	103.95
Mean	60.03	15.47	7.17	0.00	17.32
Rank	1	3	4	5	2

Seed stocks: Checking of the health status of incoming stocks was done *very often* of the respondents (60.03%) (Table III). This is being done through visual inspection of the subsampled fingerlings and or crablets. Despite of this, nearly 59% disclosed that they are not acquiring quality seeds (disease-free) from nationally-certified hatchery operators. Instead, milkfish fingerlings and crablets are largely wild-caught, whilst shrimp seed stocks are from private hatcheries in western Bataan and nearby province (Zambales). Diagnostic tests to determine viral and bacterial infection of arriving stocks are not being performed by most respondents (70.73%). As such, all fish farmers called for the need of collaboration and service of premier agencies and entities to address the issue on fish health management.

The recognized concern on the limited number of source farms (1-3 nursery and hatchery operators) for mud crab and shrimp seed stocks was raised. Nearly 91.0% of the pond operators are only focused on grow-out production and are not engaged in integrated culture systems. According to respondents, this issue was attributed to low investment on rehabilitation and upgrade of facilities for the establishment of government-owned hatchery systems (ca. 64.0%) in Bataan. Furthermore,

current technology-based strategies developed by reputable agencies for mud crab and shrimp farming are not well-accepted by most farmers, but they are otherwise adhered in the use of the so-called "traditional farming system" (mean=72.0%). The latter does not firmly consider the optimum stocking densities (relative to the pond area), and *ad libitum* feeding strategy.

Isolation of newly stocked juveniles was done *very often* (35.08%) by the fish farmers. When performed, it was mostly carried out within less than five days (47.2%). Constraint on quarantine measure however was observed as there were no isolation, settling, and treatment pond units for most of the surveyed areas (ca. 60%). These ponds should be used to treat water prior to loading to assigned nursery and grow-out ponds. The practice of no return of personnel after exposure to contaminated ponds is not also being done by 90.24% of the pond operators.

Pond preparation and management: In comparison to technology developed and recommended by reputable institutions like SEAFDEC [5] and FAO [4], the aquaculture practices that are currently being done by the respondents are rather traditional. Even the participants accepted this fact that they are only using indigenous knowledge to culture crops. Furthermore, programmed feeding management is being not applied by most respondents (ca. 91%). Sampling materials, feeding trays, basins, and the likes are likewise not being used effectively (ca. 36%). It is noteworthy to mention that cost-effective feeding scheme can reduced organic load and pollution to aquatic environment, and the use of disinfected feeding materials and equipment can prevent pathogen contamination.

Disposal: Proper disposal of suspected diseased stock was not done by the majority of fishpond operators (64.67%) and dead stocks were not disposed by burying (81.32%) to eliminate the spread of diseases. Some respondents however stated that their dead and moribund stocks were only thrown in their waterways and to other adjacent ponds (7.2%).

TABLE IV. FREQUENCY OF SOIL AND WATER ANALYSIS IN PONDS DEDICATED FOR MONOCULTURE AND POLYCULTURE

Species	Very often	Often	Limited	Very limited	Not at all
Penaeus monodon	4.76	4.76	9.52	14.29	66.67
Scylla serrata	4.76	9.52	9.52	19.05	57.14
Chanos chanos	3.85	7.69	7.69	15.38	65.38
Oreochromis spp. and *Sarotherodon melanotheron*	9.09	0.00	0.00	45.45	45.45
Penaeus vannamei	11.11	11.11	0.00	44.44	33.33
Other species	0.00	0.00	0.00	50.00	50.00
Total	33.57	33.09	26.74	188.62	317.98
Mean	5.60	5.51	4.46	31.44	53.00
Rank	3	4	5	2	1

Soil and water treatment: Soil and water analyses were not practice by ca. 53% of the fish farmers to determine the presence of harmful microbes in the ponds as well as the available natural foods (Table IV). Evaluation of soil and water must be consistently executed to monitor the concentrations of different water variables such as pH, salinity, temperature, dissolved oxygen, and ammonia. More so, 48.02% of the fishpond operators do not treat the soil and water of their respective fishponds. The most widely use chemicals for treating the ponds are the following – probiotics (19.95%), lime (16.43%), tobacco dust (12.46%), organic fertilizers (8.45%), and chicken manure/ cow dung (9.38%).

Vaccination, disease prevention and control program: It is worthy to mention that 71.19% participants claimed that they have disinfection and vaccination program as well as prophylaxis, but disinfection is being done in a *very limited* manner (25.23%). Sodium hypochlorite is mostly used as disinfecting agent for pond equipment and materials (rate of exposure/application was not stated by the participants). The current technology for vaccination and cure of viral diseases in fish and shrimps is not hitherto implemented in the surveyed areas. Nevertheless, chemotherapy or the use of drugs to cure infection is suggested to be the method of "last resort" to control disease [6]. The shrimp farming industry in the Philippines is threatened by the outbreaks of white spot syndrome virus, and by an emerging disease, acute hepatopancreatic necrosis disease or also known as "early mortality syndrome". Without proper prevention, these viral diseases can wipe out the entire stock, and thus prevention and control program/activities must be incorporated in the routine of the farm operators [7].

TABLE V. MOST IMPORTANT BIOSECURITY MEASURES BASED FROM RESPONSE OF PARTICIPANTS (N=40) (IMPACT INDICATORS)

Biosecurity Strategies	Frequency	Percentage	Rank
Fishpond Location	28	70.0	8th
Presence of boundary fences, protected dikes, and driveways	38	95.0	3rd
Facilities and equipment	39	97.5	2nd
Entry in ponds	35	87.5	5th
Seed stocks	40	100.0	1st
Pond preparation and culture management	38	95.0	3rd
Disposal	32	80.0	6th
Soil and water treatment	30	75.0	7th
Vaccination, disease prevention and control program	12	30.0	9th

Table V showed the participants' perception on what are the most significant biosecurity areas/ strategies in aquaculture that can be adopted in the studied ponds. Biosecurity measures for acquisition and quarantine of quality *seeds stocks* (100%) prior to nursery or grow out phase were considered to be the most important strategy. This is closely followed by adequate *facilities and equipment*, ensuring that proper fishpond design and engineering (97.5%) can prevent the transmission and spread of diseases. Construction of *perimeter* (95%) to prevent the entry of unwanted and nuisance species and disease vectors as well as appropriate *pond preparation and culture management* (95%) are believed to be very

indispensable strategies to create a biosecure aquaculture environment.

The mean spatial biosecurity scores were rather similar in all surveyed fishponds (Fig. 1). The highest percentage of *very good* score (ca. 16%) was achieved by Orani, where the concentration of shrimp farming can be found. Overall, the aquaculture biosecurity strategies in Bataan is categorized as *poor* (mean = 42.45%; ranged = 37.0-49.0%) to *fair* (mean = 19.91%; ranged = 12.0-33.0%). This signifies that more than half of the surveyed ponds do not have suitable biosecurity measures against disease vectors and widespread disease incidence.

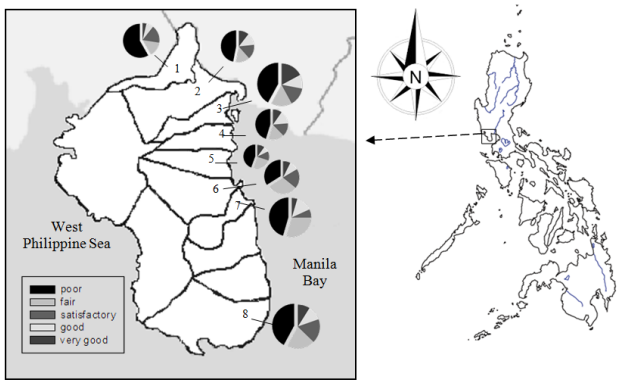

Figure 1. Map of Bataan, Philippines showing the percent representation in biosecurity scores for every studied area Dinalupihan (1), Hermosa (2), Orani (3), Abucay (4), Samal (5), Balanga (6), Limay (7), and Mariveles (8)

Conclusion and Recommendations

A recent assessment on the existing routine biosecurity measures in various fishpond operators in Bataan revealed an alarming deprived knowledge of the respondents regarding the aforementioned issue. Likewise, the compliance of most of the fish farmers in different biosecurity standards was observed to be poor. This study, however, was able to recognize risk areas that can still be further developed, and was able to identify stakeholders whom require capacity-building in the aquaculture biosecurity principles and measures for improved aquaculture production. This signifies the need in the refinement of technological interventions for fishpond operators in Bataan to improve their harvest and prevent heavy losses from potential fish disease (viral or bacterial) outbreaks.

Model biosecured fishpond(s) to showcase the science-based interventions should also be developed for the fishpond operators to recognize the positive effects of having a biosecure fish farm. There should also be a continuing training program to be implemented by the University and local government units for the pond operators to further capacitate the fish farmers in proper fish health, water, and feeding management for improved fish and shrimp farming.

Since the demand for mud crab and shrimp is incessantly increasing, the call for sustainable production is in utmost concern. From the baseline dataset generated in this study, conservation and management schemes for brackish waters and mangrove assemblages within the studied areas can be updated and coordinated into regional and national environmental policies.

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