SUSTAINABLE AQUACULTURE IN INDONESIA[1)]

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ABSTRACT

Aquaculture has an important role in the development of many national economies and plays a key role in rural development in Asia Pacific including Indonesia. As the expansion of aquaculture product, there is a growing concern over the impacts of aquaculture on the environmental sustainability and also over the requirements on quality and food safety by consumers and regulators.
For this reason, it is a need to improve aquaculture technology and management system in Indonesia to address the need for eco-friendly production process and food safety concerns in the sustainability of national aquaculture. Indonesian Fisheries Act No 31 (2004) mentioned among others that the Indonesian Fisheries Management should be done for job opportunity, and for fisher, farmer and related community welfare, and also for fisheries resources and environmental sustainability. In addition, it is mentioned also that the product from both capture and aquaculture fisheries should meet quality standard and product safety. The most critical factors to achieve sustainable aquaculture in Indonesia are availability good quality seed, good practice in growing out system, aquaculture environments, fish health management, quality of product and marketing.
This paper dealt with the review of Indonesian Aquaculture related with sustainable practices and management schemes to preserve the aquaculture environment, food safety requirements for aquaculture products, and product quality and safety.

KEYWORDS: Sustainable aquaculture, product quality and safety.

INTRODUCTION

Aquaculture has an important role in the development of many national economies and plays a key role in rural development. Farmers in the Asia Pacific Region contribute over 80 percent of the world's aquaculture production, with China producing 50 percent of global production (Haylor and Bland, 2001). At the global level, aquaculture is one of the fastest growing food production sector (9.6 per cent/yr in the last decade), a fact that will ultimately change the way that fish is perceived as food (Josupeit, et al., 2001). In Indonesia, the production of Aquaculture increased from 994,962 thousand tons (2000) to 1.4 million tons (2004) or increased at the rate of 10.36% per year.
As the expansion of aquaculture product, there is a growing concern over the impacts of aquaculture on the environmental sustainability and also over the

requirements on quality and food safety by consumers and regulators. In the Asian and Pacific region, there is also increasing demand among consumers for high-quality, eco-friendly, and safe aquaculture products. The rapid expansion of marine finfish in the Asia Pacific region has led to concerns regarding its long-term sustainability.

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It has been mentioned, for example, that the major bottlenecks in the development of sustainable marine finfish are availability of fingerlings, grow-out feeds, environmental issues, disease and marketing (Rimmer and Sugama, 2005). The Conference on Aquaculture in the Third Millennium in Bangkok (February 2000), noted that there was a need to develop and adopt policies and practices that ensure environmental sustainability, and also as consumer awareness, aquaculture producers, suppliers and processors will need to improve the quality of products and enhance product safety and nutritional value (NACA/FAO, 2000).

In the consideration of Indonesian Fisheries Act No 31 (2004) it is mentioned among others that the Indonesian Fisheries Management should be done for job opportunity, and for fisher, farmer and related community welfare, and also for fisheries resources and environmental sustainability. In addition, one of the articles under Chapter 20 in that act mentioned that the product from both capture and aquaculture fisheries should meet quality standard and product safety (Indonesian Act, 2004). The most critical factors to achieve sustainable aquaculture in Indonesia are availability good quality seed, good practice in growing out system, aquaculture environments, fish health management, quality of product and marketing. For this reason, it is a need to improve aquaculture technology and management system in Indonesia to address the need for eco-friendly production process and food safety concerns in the sustainability of national aquaculture. These are parts of a holistic approach which has to be taken to achieve sustainability of Indonesian aquaculture. The holistic approach includes the culturing technologies, socio-economics, natural resources and the environment.

This paper dealt with the review of Indonesian Aquaculture related with sustainable practices and management schemes to preserve the aquaculture environment, food safety requirements for aquaculture products, and product quality and safety.

SUSTAINABLE PRACTICES AND MANAGEMENT SCHEMES TO PRESERVE THE AQUACULTURE ENVIRONMENT

The guidance of sustainable aquaculture especially on shrimp pond culture has been issued by Directorate General of Aquaculture in 2004 and socialized throughout the country. The objectives of this guideline are to provide good operation of shrimp culture in sustainable and eco-friendly manner and to produce good quality and safety harvest. Management practices in this guideline include water management, pond preparation, how to provide good quality seed, feed and feeding management, restriction on the utilization of chemicals and drugs, solid waste and effluent management, and handling or harvest management (DGAQ, 2004).

Fish Health Management

Based on the experience of farmers under Shrimp Club of Lampung, they left already disease treatment with all the negative environmental impacts and other consequences, and move to a future of disease prevention. Disease control in their farm focused first on preventive measures related to good management practices that maintain good water quality, with better or certified seed, less stress, and high-quality feeds. All of farmers in Lampung as a member of Shrimp Club applied this preventive approach. They apply probiotic routinely in the pond water preparation, and hold the water in the pond or not to change the water at the first two months culture period, and always use SPF seed even though the price of SPF seed is twice more expensive than that of non SPF seed. They allocated 10 -30% of their farm area for making reservoir and applied probiotic to maintain good water quality and to avoid deadly fish diseases. Biosecurity applied with making fence to avoid crab or other disease carrier animals entering the ponds, using filter device in the inlet pipe, and eradicating all disease carriers like wild shrimp and fish at the water preparation phase.

If there is a suspicious disease in the water, sterilization of water using chlorine is made before flushing the water to the environment. Effluent standard quality has been made and included in the guidance of sustainable aquaculture, however, its implementation in smallscale ponds or tambaks is still need to be more socialized. The depth and length of time of aerating the water is managed based on the shrimp density in the pond (Sutanto, 2005).

The awareness of many farmers on the ecological function of mangrove ecosystem has already well developed. In several area of shrimp farms, local community based management have been initiated and reforestation of mangrove is one of their objectives. This activity will help to create better environment condition of shrimp farms. In general, the major activities for the success of shrimp culture especially in white shrimp, L. vannamei culture are the availability of good quality seed (SPF seed), good feeds with appropriate use of protein level, good management practice, farmer attitude toward ready to change and get a new technology, access to information and technology, and applied the strategy of appropriate stocking based on pond carrying capacity and partial harvest.

There is a good harvest from shrimp pond where there is a good local organization like Shrimp Club Lampung and the farmer followed best management practices which is socialized through the club. However, the rapid extension of white shrimp culture has led to concerns regarding its long term sustainability. Farmers in East Java are hampered by the disease outbreaks in their ponds. Even though SPF seeds have been imported from good hatcheries in Hawaii and Florida, Taura Syndrome Virus (TSV) has been detected in many shrimp farms in East Java, and white shrimp is also not resistance to White Spot Syndrome Virus (WSSV) and Infectious Hypodermal and Hematopoietic Necrosis Virus (IHHNV) (Tauhid et al., 2006). The socialization of Best Management Practice of Aquaculture is needed and strengthened through good farmer groups. Rapid and early diagnostic on brood stock, and on seed until growing shrimp in ponds to detect harmful diseases is also required.

Freshwater aquaculture is hampered by Koi Herves Virus (KHV), a contagious disease which infecting common carp (Cyprinus carpio) and koi carp (C. carpio koi) occurred since 2002. The disease occurred in on-growing fish of all ages and in all culture system. Some of alternative strategies have been developed by Fish Health Research Laboratory, and disseminated to fish farmers in Indonesia with the aim to minimize losses, i.e.: (i) integrated fish health management, (ii) using specific pathogen free (SPF)-KHV fish and strictly quarantine system, (iii) applying immunopropilactic (e.g. feed additive) to increase halt status of fish, (iv) induce specific immunity “vaccination” by cohabitation technique, (v) stress factors avoidance, (vi) disinfectant, (vii) treatment against secondary infections, (viii) biosecurity application, (ix) poly-culture system, (x) avoidance of macroclimate affect (good and bad season or dry and rainy season), and (xi) alternating commodities (non-susceptible species) (Tauhid et al., 2005). The most practical way operated by farmers is to change culture species from common carp to tilapia. It is believed that other than common carps such as tilapia, gouramy, and catfish are not the appropriate host or carriers for KHV.

Utilization of non-commercial fish to feed farm fishes

Non- commercial fish or by catch species or “trash fish”, is commonly used for feeding in marine finfish culture. Small scale grouper culture is usually use trash fish for feeding. The availability of trash fish is seasonal, and even though the knowledge of stock condition of trash fish is not well understood, there is evidence that a decreasing production of small pelagic and demersal fish occurred in Malaka Straits (Sumiono, 2006). For the bigger scale of marine culture farm like baramundi/seabass culture has already applied commercial pellet feed. Commercial diets for marine finfish are available in Indonesia, including diets for milkfish (Chanos chanos), baramundi/seabass (Lates calcarifer) and groupers. Most of the fish meals (70 – 80%) needed by feed factory are imported from Chili and Peru.

It is worthy that feed wastage is much higher in open sea cage culture systems where trash fish is used as feed (Wu, 1999). Because of this feeding loss is higher, local pollution in the vicinity of sea cages is increasing. To mitigate this impact from feeding by trash fish, the development of feeding by commercial pellet feed is strengthened. However, there is still reluctant to use this commercial pellet amongst farmers because of its high price consideration. Under the colaborative research between ACIAR and CRIA-Indonesia, the study on grow-out diet development was to develop compounded pelleted grouper feeds as a more sustainable, lower-polluting and cost effective alternative to the feeding of fresh fishery bycatch (“trash fish”). The result of nutrient requirement studies indicated that juvenile groupers require diets that are high in digestible CP (around 45%), moderately low in lipid (around 10%) and contain not less than 1.0% and preferably 1.5% of n-3 HUFA (Rimmer and Sugama, 2005). Because sea-weed has a function ecologically to make better marine environment condition, the culture of sea weed in many areas in Indonesia is developed. Seaweed farming can play a significant role in nutrient recycling, in fact of any waste nitrogen and phosphorus, not only from aquaculture farms (Sorgeloos, 2001). The production of sea weed was 397,964 tons in 2004 (Sukadi, 2006).

Contamination of harmful wastes and industrial drugs and chemicals in open waters

Chapter 8 Indonesian Act No 31/2004: Owner of aquaculture farm, representative of the owner, and/or responsible person who run aquaculture business is not allowed to use chemicals, biological agents, explosive materials, equipments and/or methods and/or constructions which may be harmful and/or threatening the sustainability of fish resources and/or its environments of fisheries management area in the Republic of Indonesia.
To prevent farmers using prohibited and restricted drugs and chemicals at the production level is accommodated in Manual of Good Aquaculture Practice. A program to monitor the use of antibiotics (especially Chloramphenicol) in shrimp farming and during processing has been established. The contamination of such drugs in feed and open water is also monitored.
Monitoring of water quality is conducted and prioritized in the area where mollusk culture likes mussel (Perna viridis) culture operated. Aquaculture Development Centers under Directorate of Aquaculture as an Implementing Technical Units are the major institutions who implementing the monitoring programs. Trace heavy metals, poisoning plankton, harmful pathogenic bacteria are the important parameters which should be observed. Development of mollusk culture or mussel culture is not allowed in the area where the excessive level of trace heavy metal or potential poisoning plankton occurred. Important parameters which are observed both in the waters and meat of mollusks are faecal coliform, E. coli, Salmonella, HG, Pb, Cu, Zn and Paralytic Shellfish Poisoning (PSP).
Government regulation No 24 – 1991 to avoid the pollution in sea water environment is used for the best site selection of mollusk culture.

Land capability and carrying capacity assessment for aquaculture planning:

The operation of mariculture should minimize its affects on coastal resources, environment and other activities. Hence, mariculture and also its related land-based supporting facilities in shore planning should be based on carrying capacity estimation in a broad range of habitat types. The development of land capability classification schemes which needed for sustainable brackish-water pond industries will support this type of mariculture planning. In Indonesia, those two activities include carrying capacity estimation for fish cage culture and land capability assessments are now considered a high priority to be carried out. Research Institute for Coastal Aquaculture in Maros, South Sulawesi in collaboration with Australian Centre for International Agricultural Research (ACIAR) is now conducting the research activities relating with those two topics (Project Document FIS/2002/076 and Project Document FIS 2003/027). Mitigation of environmental impacts of marine fish farming may be achieved by keeping stocking density (and hence, pollution loading) well below the carrying capacity of the water body. Computer simulation and hydraulic models can be applied to estimate its maximum stocking density. Improvement of feed formulation and operate integrated culture (using macro algae, filter-feeders and deposit feeders) are also ways to reduce significantly pollution loading and environmental effects from marine fish farming (Wu, 2001). For example, Rachmansyah (2004) estimated the carrying capacity of Awarange Bay in South Sulawesi around 36 ton of fish biomass under 28 ha potential area for marine fish farming.

There is a problem in the aquaculture development planning especially that in the remote area. The development of aquaculture zone in the remote area is usually hampered by lack of good infrastructure like good irrigation channels, access road, electricity, ice-making plant in the area nearby. Without these good infrastructures it will be difficult to achieve more efficient aquaculture operation. Hence, marketing of aquaculture product in global perspective will always be less competes with other exporter countries. For these reason, the result of land capability and carrying capacity assessment which is used for aquaculture planning should be followed by the investment and construction of such infrastructures. Rural aquaculture development approach is appropriate to be made to develop aquaculture zone in that area.

FOOD SAFETY REQUIREMENTS FOR AQUACULTURE PRODUCTS

In chapter 20 of Indonesian Act No 31/2004 it is mentioned that Fish processing and fish product should meet “pre-requisites” and quality assurance and food safety. Quality assurance system and food safety has three subsystems i.e.: (i) quality control and surveillance, (ii) the development and application of pre-requisites or standard on raw materials, sanitation, handling and processing techniques, product quality, facilities and infrastructure, testing methods, and (iii) certification.

Hazard Critical Control Point (HACCP) Standard

The use of Hazard and Critical Control Point (HACCP) system for aquaculture has been already commonly implemented in aquaculture production in big-scale integrated farms like shrimp and tilapia farms. The use of HACCP system in the operation of small scale of farm is still difficult to be implemented. HACCP system was introduced since 1992, and applied voluntarily in 1993/1994, and now is mandatory since 1998 (Mangunsong, Director of Standardization-MMOF,

personal communication). Mandatory of HACCP has strong complemented with the mandatory of Good Manufacturing Practiced (GMP) and Sanitation Standard Operating Procedures (SSOP). The HACCP system is used as a base for the implementation of Integrated Quality Management Program.
Under the application of Integrated Quality Management Program, Certification Program on Shrimp Culture has been initiated since 2003 to provide the quality assurance and safety food of Indonesian aquaculture products.

Traceability

Traceability, as a means to ensure product safety has also commonly developed in big-scale integrated aquaculture farms. In the big farm industries like Central Pertiwi Bahari, Dipasena, Aquafarms and others, individual batches of shrimps or fish could be traced back to the pond where it were produced. The development of traceability is also hampered by small-scale farm sizes which are the most dominant farms in Indonesia. However, the shrimp or fish from collectors or brokers generally has already coded in processing plant in order to be able to trace back to the places or villages where the broker collected the shrimps. At the level of broker activity, it is difficult to trace back to the pond where each individual batches of shrimp or fish has been produced since the broker mixed up all the batches and graded them according to the shrimp or fish size. As a common issues in ASEAN Countries, the establishment of such system is also hampered by small farm size, the large number of farms, lack of effective farm registration systems, monitoring capacity (and the costs involved) as well as the diversified nature of farm harvesting collection and transport to the processors (RAP, 2004)

Monitoring of pathogenic bacteria, chemical contaminations and drug residues

Every province in Indonesia has laboratory for food safety testing and that for quarantine. The decentralized management of food safety laboratory in each province has developed and administered directly under the related governor through its Dinas Perikanan or Fisheries Province Agency. The reference laboratory is located centralized in Jakarta and has a function to develop harmonization testing method and to increase institutional capacity of all provincial laboratories. Several parameters have been observed routinely in these laboratories to check chemical contaminations and drug residues. However, there is still need capacity for the observation of special parameters which is emerging as a new requirement or demand from importing country.
Fish quarantine laboratory is still managed centralized under the Secretary General of Ministry of Marine Affairs and Fisheries (MOMAF). Inter insular and export-import fish transportation and trading should follow quarantine regulation and the fish should be checked whether or not it is infected by quarantine diseases. Fish health laboratory in each province is still developing. The function of this laboratory is to help farmer to check the health condition of seed or fish/shrimp in growing pond. There are 31 fish health laboratories equipped by

PCR has been developed throughout the country. The function of these laboratories is also as a facility to check health condition of fish/shrimp which will be moved enterring other provincial area. Harmonization of methods used and increase the capacity including human resources development to operate these laboratories are needed.

Utilization and distribution of drugs for aquaculture is regulated through Directorate General of Aquaculture. Special commission for testing and evaluating for the new drug registration has been established. The function of this commission is to help Director General of Aquaculture on the evaluation of a new drug before giving a register number and distribution license to that new drug. DG of Aquaculture usually issues the permits of new registered drug distribution and provides information how to utilize the drugs in safety mode.

PRODUCT QUALITY AND SAFETY IN AQUACULTURE

Breeding and genetics

Brood stock availability and its management are key factors in the process of production of good quality seed. For this reason, important brood stock centers have been established to multiply brood stocks for its distribution to interest hatcheries. Brood stock center for shrimp is located in Jepara (Mid Java), Situbondo (East Java), Takalar (South Sulawesi) and Ujung Batee (Aceh). The mentioned last center has been broken by last Tsunami disaster in December 2004, and now is being reconstructed or rebuilt. Gondol Research Institute for Marine Culture nowadays is conducting breeding programs of white shrimp, L. vanamei. Brood stock center for tilapia is developed in Sukabumi (West Java), Jambi, Mandiangin (South Kalimantan) and Tatelu (North Sulawesi). Common carps, tilapia, and freshwater giant prawn are the priority species for national breeding programs. Seaweed center is developed in Lombok and Grouper Center in Lampung. The species which are important for culture development and have been developed are milkfish (Chanos chanos), grouper (Epinephelus sp., Plectrophomus sp., Cromileptes altivelis), freshwater prawn (Macrobrachium rosenbergii), mud crab (Scylla sp.), catfish (Clarias batrachus, Pangasius sp.), sea cucumber (Holothuria scabra), seaweed (Gracilaria sp and Euchema sp) and some ornamental fishes (Sugama, 2005). Shrimp (P. monodon and L. vanamei) are the priority species to be developed under Indonesian Aquaculture Revitalization Program. Eight other major commodities like tilapia, grouper, milkfish, catfish, gouramy, abalone and ornamental fish are also included in the aquacylture revitalization program.

Small scale hatcheries or backyard hatcheries are developed in many coastal areas to produce milkfish fry, grouper and post larvae (PL) of tiger prawn (Penaeus monodon). Milkfish and grouper seed production is the main activity of backyard hatcheries located in Gondol (Bali), while tiger prawn PL is produced by those in South Lampung, Northern part of Mid Java, and Barru (South Sulawesi). However, the sustainability of shrimp backyard hatcheries is hampered by decreasing demand of PL due to the failure of its growing out phase and also by the competition with PL produced by big scale hatcheries. In addition, since 2001 many big scale farmers use imported SPF seed for growing white shrimp, P. vanamei. Artemia is an important natural feed use in the process shrimp PL production. Indonesia imported this artemia around 100 tons every year. Artemia culture now is developing in salt production ponds in Mid Java, Madura, East Java and East Nusa Tenggara to provide domestic artemia. At least around 474 kg of Artemia Cysts has been produced in 2004 from those areas. To provide more seeds available near the area of mariculture development, certain number of provincial coastal hatcheries is being developed in several provinces.

In freshwater aquaculture, there are 13 species of pangasids have been found in several rivers in Sumatera Java and Kalimantan. Crossbreeding between P. hypopthlamus and P. jambal has been observed and its offspring has better growth than that of their parents. This P. jambal and its hybrid have been released as a good candidate species for national pangasid culture in Indonesia. Both indigenous and introduction potential species of freshwater lobster like Cherax albertisii, indigenous species of Papua and C. quadricerinatus (red claw), introduced species from Australia have been studied and found feasible as good candidate species for future culture development. These two species have been released formally on August 7, 2006. Indonesian Network for Fisheries Genetics Research and development (INFIGRAD) has been established in 1990s to facilitate communication and information exchange among scientists who interested in fish genetic research and development.

Certification program on seed production has been initiated since 2004 to assure good quality seed which are produced by hatcheries. Integrated quality management control on seed production system is applied to create more feasible aquaculture, and hence the production sustainability. Rehabilitation Program on local hatcheries and seed markets are of government concerns to strengthened local seed production and its marketing especially on freshwater aquaculture development in district area.

Feeding and nutrition

The pellet feed which its component composed by imported fish meal increased cost of culture farm and minimized the profit especially for freshwater aquaculture. Several steps are taken as a solution to minimize the use of fish meal or minimized the culture cost, i.e.: (i) increase the utilization of local fish meal, (ii) substitution of fish meal with agriculture products and wastes, and in turn to minimize the capture or stress on wild fish stock, (iii) synchronize the level inputs with the intensity level of culture technology. Marginal analysis on farm management usually indicated that maximum profit can be achieved not at a level of maximum input and output, but well below these levels, (iv) special zoning area for aquaculture to provide better facilities for input and marketing, and (v) improvement of feed composition to the feed which its nutrition value has been reduced due to fish meal use reduction. Utilization of fish meal for catfish feed has successfully decreased until the level of 10- 15% using soybean meal as a substitute component. Several trials have indicated good results on the

application of fish silage, mollusk meats, plant-based protein, and maggot harvested from palm-oil wastes.
Integrated aquaculture and poly-culture is a good culture technique in rain-fed ponds applied by farmers in Lamongan, East java. Intensive fertilization is applied to stimulate natural feed and hence minimized cost for feeds. Culture based fisheries is developing in Mid Java with the empowering community based management on small reservoir. There is no feed required for this activity, but the availability of seeds is demanded. Silvo aquaculture where mangrove area is utilized for stocking crabs or fish is also one of good example as no feeding aquaculture. Organic culture of shrimp is usually conducted by farmers at low intensity of feeding in same places in East Java and East Kalimantan.

CONCLUSIONS

Legal instrument for the sustainability of Indonesian aquaculture and hence for the quality assurance and food safety of aquaculture products has already available with the existence of Indonesian Fisheries Act No 31, 2004.
Manual of Best Management Practice of Shrimp culture and Good Aquaculture Practices which have been issued by DG of Aquaculture is continued to apply through the extension. Certification program on seed production system and on growing out pond have been initiated each in 2003 and 2004. However, this application is hampered by small scale aquaculture which is dominant in Indonesian Aquaculture structure. Fish health management has already left disease treatment with all the negative environmental impacts and other consequences, but move to a future of disease prevention with the application of best management practice supported by continuous establishment of Fish health laboratory and strengthening of quarantine system.
The availability of Good quality seed is provided with the implemented breeding program on specific species and establishment or rehabilitation hatcheries.
HACCP and traceability have been applied mostly in big scale integrated aquaculture and all in the fish processing plant. Its application is also still hampered by small scale aquaculture which is the most in the structure of Indonesian Aquaculture.
For the sustainability of Indonesian Aquaculture, there are still many tasks need to be done especially working on the empowering of small scale farmers which include to provide better quality assurance and safety food of aquaculture products to meet consumer and regulator demands, to produce product quality and safety in aquaculture like seed and feed, and to extend more the implementation of sustainable practices and management schemes to preserve the aquaculture environment.
Enhanced small and medium scale farmer production and marketing in more responsible, and also strengthened government institution which has linkages in fish health management, aquaculture product quality and safety, and preservation of environment are needed; to increase productivity and incomes of farmers in more effisient, responsible and competitive environment.

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