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Review Article

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Sustainable Shrimp Farming: Biosecure Systems to Prevent or Control Emerging Diseases

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In any aquaculture business, sustainability of a system improved profits. At present although biosecurity and BAqP are in place, more needed to be done. With emerging disease challenges innovated designs and operation systems are developing for sustainable production. One of the most important factors the investors, shrimp farmers and technicians need to be aware of is that whatever waste discharged into environment will come back to you in a form of disease sooner or later. Before mid1990s major threats to shrimp farming was mainly bacterial diseases. In Asia from late 1994 appearance of viral diseases such as white spot syndrome virus (WSSV) and a few others like yellow head virus (YHV), infectious myonecrosis virus (IMNV). In 2001 with availability of Specific Pathogen Free (SPF) Penaeus vannamei broodstock from Hawaii, the shrimp farming industry took off much faster.

To prevent or control emerging diseases biosecurity of a farm become essential. Biosecurity of a shrimp farm begins with farm design and construction. Followed by biosecure operation system. Before viral outbreaks in 1994 the design and operation system were very simple - no need to treat incoming or waste water discharge. Pump in water, operate and discharge. At present due to viral plus unknown disease emerging the design and operation system need to be adapted to the situation.

Shrimp Emerging Diseases

Before mid1990s major threats to shrimp farming was mainly bacterial diseases. In Asia from late 1994 appearance of viral diseases such as white spot syndrome virus (WSSV) and a few others like yellow head virus (YHV), infectious myonecrosis virus (IMNV). In 2001 with availability of Specific Pathogen Free (SPF) Penaeus vannamei broodstock from Hawaii, the shrimp farming industry took off much faster. In 2009 outbreaks of acute hepatopancreatic necrosis syndrome AHPNS (EMS) starting from China spread to Vietnam, Malaysia, Thailand, Mexico and Central America at a loss of billion dollars (USD) revenue. Again, outbreaks of WSSV at Red Sea Coast Saudi Arabia in 2013 with Penaeus indicus and in early 2017 at Gold Coast Queensland, Australia on Penaeus monodon were the examples. Very recently a decapod iridescent virus 1 (DIV1) first detected in Guangdong Province China in 2014 is now spreading to Taiwan and India impacting L vannamei and M rosenbergii causing shells to become reddish in color then soften- leading to mortality levels of around 80 percent [1]. The virus is now believed to be spreading to Southeast Asia.

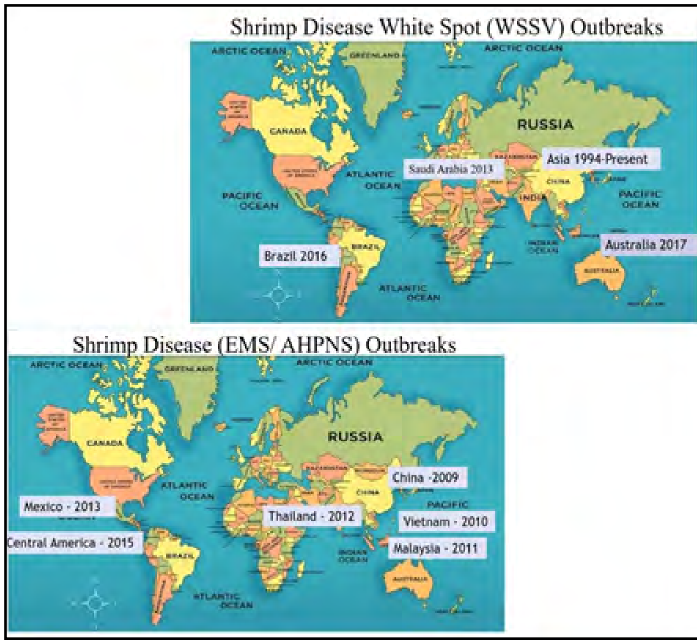


Figure 1

Farm Biosecurity

Biosecurity applied at present in shrimp farming is adapted from the basic minimum water exchange shrimp intensive culture system used in Indonesia since early late 1990s. The system then was to position aerators within culture ponds to prevent creation pond water columns and to concentrate waste (sludge) into center of ponds. The concentrated waste was then siphon out physically or through central drain system. The aerators were operated depending on sun light and Algae in the water to provide required DO for shrimps in culture water. The aerators were on during night time and during day time depending on algae producing DO through photosynthesis. However, at the time stocking density of P. monodon was low between 30 to 35 PLs per meter square only. The system creates clean well mixed water columns with pond bottom feeding area and separated sludge area.

Biosecurity begins with farm designs where the incoming water is treated before used. The waste water is also treated before discharging back to environment. Bio-secure pond designs with HDPE liners, covered ponds, secured inlet and outlet gates emerged. For these reasons a module system with water treatment reservoirs are essential - to control and prevent from spreading if should there be disease outbreak. Main incoming water and ponds need to be treat before stocking post larvae. Waste water also need to be treated before discharge. Since at present due to economic reason the shrimp species has changed to L vannamei which can be stock in very density of over 100-300 Pls /m2 for much high higher production of 15 to 30 mt/ha.

The farm need to be bio-secured modular system to control and contain if outbreak occur to prevent from spreading (Fig 2). All other facilities - post larvae, feed, equipment, human, etc., etc. need to be treated. If should be a biosecurity breach the action must be taken without delay. The steps need to take is given in tables 2 & 3. The steps recommended were for WSSV but these has been used for other diseases with success.

In Malaysia at Blue Archipelago shrimp farm project bio-secure modular RAS system has been applied successfully (Figure 3) [2-5].

Basic requirements of a bio-secured module (Table 1)

1. **Reservoirs** 2 units for water treatment to prevent raw water entering culture ponds
2. **Secured inlet & outlets** to prevent disease spreading during outbreaks
3. **Water levels** - prevent cross contaminations
4. **Central drains** at each ponds to increase pond carrying capacity
5. **Spill ways** at main and sub supply canal to prevent flooding and overflow which could contaminate culture ponds
6. **Road for each row** to reduce contamination by human – maintenance, supply and harvest teams
7. **Wastewater treatment system** – disease control

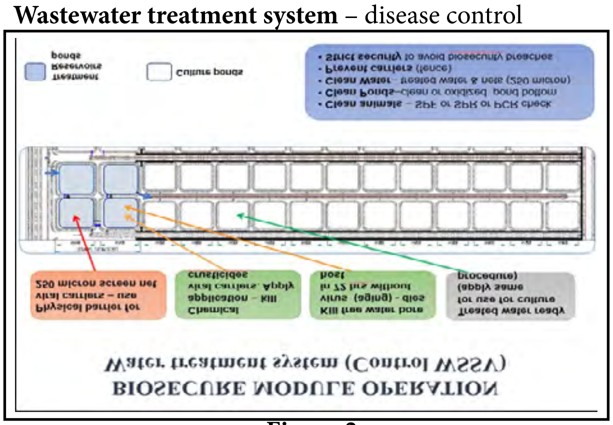


Figure 2

Table 2

FARM BIOSECURITY

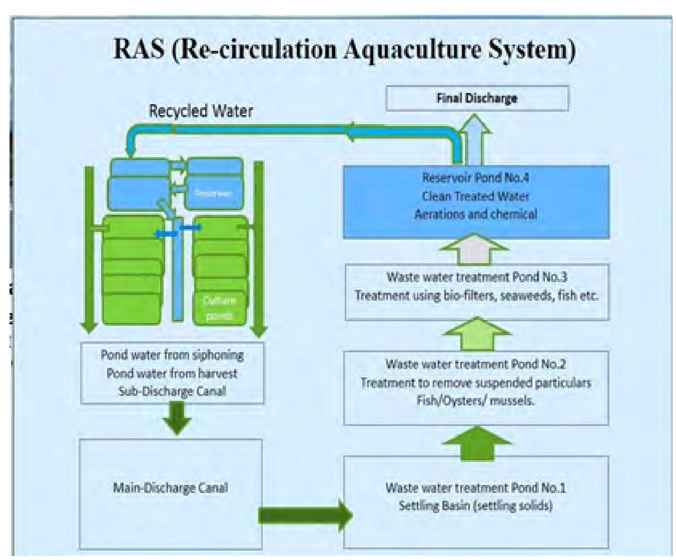
Basic WSSV Characters	Implementation
1. Mass mortality: DOC <45 days	1. Use SPF post larvae (PL)
2. Temperature >30 less prone; <29 more prone; <26 dangerous.	2. Use reservoir module system- water treatment system, operate as SOP
3. Onset of heavy rain (season) with low temperature trigger outbreaks. Seasonal occurrence is well document.	3. Use bird scare lines – all in place
	4. Use crab fence - all in place
4. Virus dies in free water in 72 hours	5. Control workers' movement – farm/farm; module/module, row/row
5. Crustacean are carrier (crabs) – lives with virus.	6. No handling (touching) unnecessary – only person responsible can handle.
6. Virus lives in freshly dead, indefinitely in fresh processed frozen condition	7. Minimize workers – minimum worker team: stocking, harvest, sampling.
7. Virus can live and a very few can survive after mass mortality	8. Use chemical (sun drying) to disinfect all equipment– screen net, cast net, etc.
8. No evident of wind carrying WSSV from pond to pond	9. All equipment in operation – eg. PWAs, water pumps, siphon equipment, etc.
9. Bacteria white patch (spots) on carapace can be mistaken as WSSV spots.	10. Educate people on biosecurity
	11. Environmental cleanliness – Car dip, pond, water, housing, etc.
	12. Control Human traffic– guest, workers, technicians, Management personal, etc

Table 3

Steps to be taken when WSSV (Viral) out-break is suspected.

1. When viral out-break is suspected you need to quarantine the suspected pond. At the same time you need to implement the following:
   a. Stop all traffic – people, trucks, cars, motorcycles passing across the pond
   b. Stop sampling - cast nets for shrimp size, environmental data (DO, Temp, etc).
   c. Make the remaining ponds increase the carrying capacity – increase DO by operating longer or more numbers to maximum capacity.
   d. You could start with ponds near-by or ponds stocked from same hatchery.
   e. For WSSV or viral – pay more attention to young ponds.
   f. Check biosecurity system for biosecurity breaches- correct if necessary.
   g. Do not wait for PCR result.
2. Quarantine the suspected pond. (for DOC <45)
   a. Assign a person to be stationed at pond site (24 hours).
   b. Fence off the pond – put signs (do not enter)
   c. Make sure all inlet and discharge gates are secured – no leakages.
   d. Cull the pond with chlorine – keep paddle wheel aerators running for mixing.
   e. After shrimps are killed, stop the paddle wheel aerators. Do not take paddle wheels out of the pond.
   f. Leave the pond with water for at least 7 days – until the dead shrimps become red.
   g. Pick up dead shrimps and burn or bury.
   h. Water level will drop.
   i. Leave for another few days – 2 or 3 days.
   j. Now pick up red shrimps and can discharge the water. Could use chlorine again before draining water out and use chlorinated water to clean PWAs within pond.
   k. Leave the pond and paddle wheel aerators in the pond to dry for a week or so.
3. Make sure all people and equipment involved in the quarantine process to follow the biosecurity protocol.

Figure 3



Biofloc System

Biofloc is defined as macroaggregates-diatoms, macroalgae, fecal pellets, exoskeleton, remains of dead organisms, bacteria, protest and invertebrates. Biofloc as biosecure systems offer stable and sustainable production because they support self-nitrification within fish or shrimp culture ponds with zero water exchange [6]. Biofloc technology is a very promising for stable and sustainable production as the system has self-nitrification process within culture ponds with zero water exchange [6, 7]. The technology has been successfully applied commercially with shrimp (L. vannamei) in Belize. It also has been applied with success in shrimp farming in Indonesia, Malaysia [3, 4, 8, 9, 10]. The effect of bioflocs on growth and immunity on P. vannamei has been studied by Jang, InKwon, Kim, Su-Kyoung, et al, Julie E, et al, [11, 12].

Biofloc systems reduce the risk of shrimp disease because the low rates of water exchange support pathogen exclusion and biosecurity, the continuous aeration provides stable water quality (DO and pH), a diverse and stable microbial community stimulates the non-specific immune system of cultured animals and limits development of opportunistic species like Vibrios, and the regular removal of accumulated sludge controls biofloc concentration to moderate levels. Biofloc system can be also considered as RAS as the system is self-nitrification with a culture pond with zero water exchange (figure 4) [5].

Bioflocs with unicellular protein (CP 30-50%) is natural extra nutritious feed for the shrimps. Although heterothrophic bacteria play the most import role in biofloc formation, the floc also contains microalgae and these might be important for nutritional quality of biofloc and moreover the ability of certain microalgae to interfere with bacteria cell-cell communication could serve to prevent pathogenic bacteria from expressing their virulence genes, thereby preventing infection [13]. Biofloc showed positive effects on shrimp immunity and disease resistance [12]. Recently, according to Aninakwah challenging Penaeus vannamei post larvae with AHPND in biofloc water had higher survival rates [14]. Main economic benefits of shrimp biofloc system are - better biosecurity (zero water exchange - RAS), stable water quality (DO & pH), low FCR (1.0 to 1.2), higher energy efficiency (680- 1,000 kg/hp), maximum production of 50.0mt/ha in 0.25 ha ponds to 12 kg/m3 in Raceways. Probiotic bacteria produced in situ (better immunity) leads to sustainable production

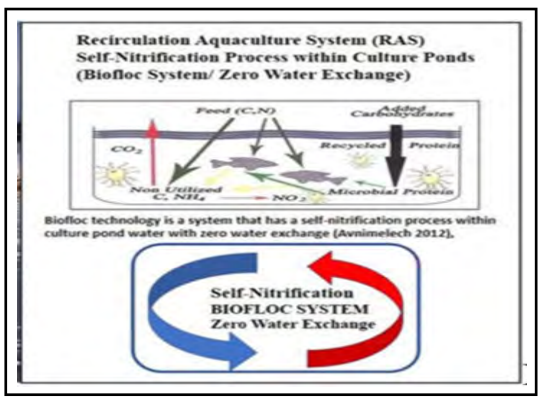


Figure 4 Biofloc RAS system [5, 15-22].

References

1. Mutter R (2020) A new virus is decimating shrimp farms in China's Guangdong province, with India shrimp producers also being put on high alert. IntraFish.
2. Taw N, Umar Saleh MS, Bujang Slamat (2013) Malaysia Shrimp Project Scales Up For Production In Biosecure In Biofloc Modules. Global Aquaculture Advocate.
3. Taw N (2014) Shrimp Farming with Biofloc Technology: Commercial Experience and Approaches to Disease Control. World Aquaculture.
4. Taw N, Surijo Setio (2014) Intensive Farm In Bali, Indonesia. Produces Shrimp In Biofloc System. Global Aquaculture Advocate.
5. Taw N (2017) A look at various intensive shrimp farming systems in Asia: Commercial implementation of biofloc and RAS production systems help control shrimp farming diseases. Aquaculture Advocate.
6. Avnimelech Y, Peter De Schryver, Mauricio Emmereciano, David Kuhn, Andrew Ray, et al. (2012) Biofloc Technology: A Practical Guide Book (2nd Edition). The World Aquaculture Society, Baton Rouge, Louisiana, United States.
7. Avnimelech Y, Taw N (2015) Biofloc Technology: A Practical Guide Book (3nd Edition). The World Aquaculture Society, Baton Rouge, Louisiana, United States.
8. Taw N (2005) Shrimp Farming in Indonesia: Evolving Industry Responds to Varied Issues. Global Aquaculture Advocate August/September.
9. Taw N (2010) Biosecurity For Shrimp Farms. Planning, Prevention Minimize Effects of Viral Outbreaks. Global Aquaculture Advocate.
10. Taw N (2010) Biofloc Technology Expending. At White Shrimp Farms. Biofloc Systems Deliver High Productivity with Sustainability. Global Aquaculture Advocate.
11. Su Kyoung Kim, Zhenguo, Hyung-Chel Seo, Yeong-Rok Cho, Tzachi Samocha, et al. (2014) Effectof biofloc on growth and immune activity of Pacific shrimp, Litopenaeus vannamei post larvae. Global Research 45: 362-371.
12. Dauda, Akeem Babatunde , Nicholas Romano, Mahdi Ebrahimi, Murni Karim, et al. (2017) Different carbon sources affects biofloc volume, water quality and the survival and phys-

iology of African catfish Clarias gariepinus fingerlings reared in an intensive biofloc technology system. Fisheries Science 83: 1037-1048.
13. Natrah Fatin Mohd Ikhsan, Ain Yahya, Nurarina Ghazali, Aishatul Izzah, Murni Karim, , et al. (2014) Quorum sensing inhibitors from Microalgae as Disease Control in Aquaculture. Department of Aquaculture, Faculty of Agriculture Laboratory of Marine Biotechnology, Institute of Bioscience Universiti Putra Malaysia.
14. Aninakwah Rachel (2019) How to tackle major shrimp diseases. FishVet Group.
15. Taw N (2018) Intensive shrimp farming systems in Asia: Commercial implementation of biosecure and biofloc production systems to help control shrimp farming diseases. Scholars' Press.
16. Taw N (2015) Biofloc Technology: Possible Prevention for Shrimp Diseases. Global Aquaculture Advocate.
17. Taw N (2015) Shrimp biofloc technology-efficient and biosecure operation system: For sustainable and efficient intensive shrimp farming, consider these three major factors: farm biosecurity, energy efficiency and biofloc technology. AQUA Culture Asia Pacific Magazine.
18. Taw N (2012) Recent Development in Biofloc Technology. Biosecure Systems Improve Economics, Sustainability. Global Aquaculture Advocate.
19. Taw N, Poh Young Thoung, Ling Teck Ming, Chatree Thanabatra, Kamel Zikry Salleh, et al. (2011) Malaysia Shrimp Farm Redesign Successfully. Combines Biosecurity. Biofloc Technology. Global Aquaculture Advocate.
20. Taw N, Sarayut Srisombat, Saenphon Chandaeng (2002) L vannamei Trials in Indonesia. Global Aquaculture Advocate.
21. Taw N (2001) Alternative Strategy for Sustainable Shrimp Farming. Aquaculture Asia VI 3.
22. Taw N, Wartono Yohanes Slamet, Pangesti Tomo (2007) Re-engineering Dispasena, Huge Plasma Shrimp Farm Adopts Biosecure Modules. Global Aquaculture Advocate.