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Cluster Management to Prevent Transmision of White Spot Syndrome Virus in Extensive Giant Tiger Shrimp Farming

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Abstrak

Manajemen Klaster Tambak Udang Windu Untuk Mencegah Penularan Virus White Spot Syndrome

Telah dilakukan kajian terhadap efektifitas managemen model klaster dengan tambak non-udang sebagai tambak penyanggah untuk mencegah transmisi penyakit bercak putih viral (WSSV) pada budidaya udang windu skala tradisional. Kajian dilakukan di tambak udang tradisional di wilayah kabupaten Demak, provinsi Jawa Tengah. Penelitian dilakukan pada lima petak tambak perlakuan dan tujuh petak tambak sebagai kontrol. Tambak udang pada kelompok perlakuan menerapkan sistem klaster, yaitu tambak dikelilingi dengan petak berisi ikan sebagai komponen biosekuriti untuk mencegah penularan WSSV dari tambak sekitarnya. Tambak kontrol tidak menggunakan petak non-udang sebagai komponen biosekuriti, dan dikelola dengan teknologi yang biasa dilakukan oleh pembudidaya setempat. Hasil penelitian menunjukkan bahwa tambak yang dikelilingi dengan tambak non-udang dapat dipanen dalam waktu pemeliharaan 105,6±4,5 hari lebih lama secara nyata dibanding tambak kontrol yang dipanen pada hari ke 60,9±16,0 karena wabah penyakit, sintasan (survival rate) yang diperoleh adalah 77,6±3,6 %, lebih besar secara nyata dibandingkan kontrol yang hanya 22,6±15,8 %, serta produksi udang 425,1±146,6 kg.ha^{-1} jauh lebih tinggi dibandingkan kontrol yang hanya 54,5±47,6 kg.ha^{-1}. Pada kajian tersebut tambak non-udang ditebari dengan tilapia dan kakap. Hasil penelitian menunjukkan bahwa melalui penerapan Better Management Practices (BMP) dengan cara tambak udang dalam model klaster yang dikelilingi dengan tambak non-udang terbukti efektif mencegah penularan WSSV dari tambak tradisional sekitarnya.

Kata kunci: *budidaya udang tradisional, windu, biosekuriti, manajemen klaster*

Abstract

White spot syndrome virus (WSSV) has become epidemic in Indonesia and affecting shrimp production lost in shrimp farm. Virus has transmitted from one to other ponds, mostly by crustacean, but more often transmit through water from affected pond. A cluster model, consist of two and three ponds surrounded by non-shrimp growing pond as biosecurity has developed. The model aim to prevent white spot virus transmission in giant shrimp extensive pond. The study was conducted in two sites at Demak district, Central Java province. Cluster consist of three shrimp ponds in site I, and cluster consist of two shrimp ponds, each surrounded by non-shrimp growing ponds. As control we also compare to 5 extensive shrimp ponds in site I and other three shrimp grow out ponds in site II, with neither no cluster system nor surrounded by non-shrimp pond as biosecurity. Result of the study shown that cluster of shrimp ponds surrounded by non-shrimp pond harvested at DOC 105,6±4,5 days significantly longer than that of control that harvested at 60,9±16,0 days because of outbreak, survival rate at 77,6±3,6 %, significantly higher than that of control at 22,6±15,8 % and shrimp production of 425,1±146,6 kg.ha^{-1} significantly higher than that of control at 54,5±47,6 kg.ha^{-1}. These results suggest that implementation of Better Management Practices (BMP) by arranging shrimp ponds in cluster and surrounding by non-shrimp ponds proven effectively prevent WSSV transmission from traditional shrimp ponds in surrounding area.

Keywords: *extensive shrimp pond, giant tiger prawn, biosecurity, cluster management*

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Introduction

In Indonesia and some Asian countries, smallholder farmer take the largest proportion as shrimp aquaculture producer (Subasinghe *et al.,* 2005; Walker and Mohan, 2009). Practice of extensive shrimp is typically very simple, pond is prepared in very simple manner, water entering the pond wihout prior treatment as to eliminate pathogen and it's carrier, stock with low stocking density of 1 up to 5 Pl's.sqm^{-1}, without aeration, almost no feed given to shrimp. Tiger shrimp is considered as the most preferent species grow in extensive pond's because of it gaining high value of income. Shrimp has also taken high priority in Indonesian aquaculture to get capital inflow, and the government of Indonesia through Ministry of Marine Affairs and Fisheries put special attention to this commodity (Soebjakto, 2012). Several programs to increase shrimp production include introduction of good quality of seed through broodstock selection programme for indigineus species such as tiger shrimp (*Penaeus mondon* Fab.) and importing of vanamei shrimp (*Litopenaus vannamei*).

White spot syndrome virus (WSSV) has the main pathogen affecting big loss in shrimp aquaculture up to present (Kasornchandra *et al.,* 1998; Waikhom *et al.,* 2006). Disease outbreak due to WSSV commonly occure during 1st–2nd month of growout period affecting mass mortality on shrimp, where shrimp size usually still very small and economically has no profit. As an epidemic area, source of WSSV presumably from shrimp farm and sorrounding waters, and also seed come from hatchery.

Extensive ponds lay out that usually lay side by side affecting disease transmission more easy either through carrier such as crabs (Waikhom e*t al.,* 2006), many species of shrimp (Hameed *et al.,* 2002) that escape from one outbreak pond to neighbouring pond or water passing through the dike because of seepage. Virus release to water during pond outbreak has reported by many authors (Esparza-Leal e*t al.,* 2009; Hoa *et al.,* 2011) to induce replicate outbreak to many ponds around affecting pond.

Management practices that has been formulated under scientific evident, promoted by FAO, that have been adopted worldwidely and proven effectively to reduce the risk due to disease in shrimp growout pond. However, adoption of practice has still low among farmers especially smallholder farmers. In some aspects adoption were limit due to lack of information, lack of capital among extensive shrimp farmers, farmer organization and complication of the method (Corsin *et al*., 2007). Introducing Better Management Practices (BMP) shrimp smallholder farmers is nescessary, however, some modification of BMP protocols is need to be considered to simplify the methods, to match with farmer's ability in relation to socioeconomic conditions, lack of farm infrastructure and limitation of availabel extensionist worker. This present study evaluates the effectiveness of cluster shrimp surrounding with non-shrimp ponds to prevent WSSV transmission from extensive shrimp ponds area.

Materials and Methods

Shrimp ponds, size vary from 3.000 and 10.000 sq.m were used in this study. The study was conducted in Demak district, Central Java Province. Before stock, pond bottom soil is prepared by drying for at least 7 days, tilting to expose 30 cm depth underneath soil to be oxygenated, liming until soil pH meet criteria of standard quality for growing shrimp pond, which is above 5.5, and organic content reduced up to less than 12%. Before pumping out water into shrimp pond, water is pumping from inlet and screened using green screen (mesh size 700 μm) to prevent intoduction of wild crustacea and let settling in non-shrimp pond for minimum 3 days. Water media is then screened using white screen (300 μm) into shrimp growing ponds. When water colour has change to greenish, pond then stock with PCR screened post larvae stadia Pl 15-25 at five Pl's. sqm^{-1}. Water quality is monitore during grow out periods such as dissolved oxygen, temperature, pH, alkalinity, salinity and water transparency by secchi disc. Water exchange were performed at maximum 10%/week to dilute water when phytoplantkon is become over bloom or when pH is too fluctuate.

Five shrimp extensive growing ponds in site I and other three in site II has selected as control ponds. The pond hasn't implemented BMP, instead of just operated as usual practices by farmer. Pond is prepared as minimum standard, neither no drying nor tilting. Water is just pumped into ponds without prior screened. Stocking Pl's at density of 3–5 pcs.sqm^{-1}.

Shrimp health status are monitored daily in line with water quality monitoring to see any abnormal condition. When shrimp mortality is observed increase drastically from day one to next consequtive days is considered as crash. White spots viral disease (WSVD) is diagnosed in either field observation and confirmed by PCR. If shrimp emerging of white patch on carapace following death, it's presumed as white spots viral disease followed up by confirmatory test by PCR and histopathology.

Success definition is based on duration of culture (DOC in days) and survival rate of shrimp within duration of culture. Duration of culture, starting from postlave stock is accounting at least 90 days in growout pond without any disease symptom. Survival rate is how many shrimp still live during duration of culture divided by total stock time 100%. Succesfull crop is determined when survival rate SR greater than 60%

Result and Discussion

Crop duration, survival rate and production

During disease outbreak, most of extensive ponds, do mature harvest less than 60 days, and survival rate is less than 30% due to WSSV. In this trial, by implementing cluster system and introduction of non-shrimp ponds surrounding cluster shrimp pond, duration of crop can be maintained at 105,6±4,5 days and significantly different at confident level 1% and 5% compare to control at 60,9±16 days. In control ponds, farmer harvest their pond due to WSSV outbreak (Table 1). Survival rate in trial ponds are also significantly higher than that of control ponds. In trial ponds average survival rate is 77,6±3,6% significantly higher than that of control ponds of 22,6±15,8%. Shrimp production in trial pond also higher than that of control ponds. Average rate of shrimp production in BMP implementing ponds is 425,1±146,6 kg/ha significantly different than that of control that only produced 54,5±146,6 kg.ha^{-1}. Higher of shrimp production in BMP ponds are either due to higher survival rate and duration of crop.

Success rate achieved by application of trial ponds mainly due to transmission of the virus can be avoided by the presence of non-shrimp ponds surrounding cluster shrimp ponds. Local pond with no biosecurity measure are vulnerable for disease transmission from the surrounding traditional shrimp ponds, resulting in outbreak more early, with low production due to low survival rate of shrimp.

Water quality monitoring

Water quality was monitored during implementation of the research to see some unusual trend that may affect on shrip. Flucutation of some parameters also be analysed wheter it is suitable for shrimp.Water quality monitoring, mainly in trial pond (BMP pond), shown in Table 2. Water quality in BMP trial ponds, represent pond condition in local area.

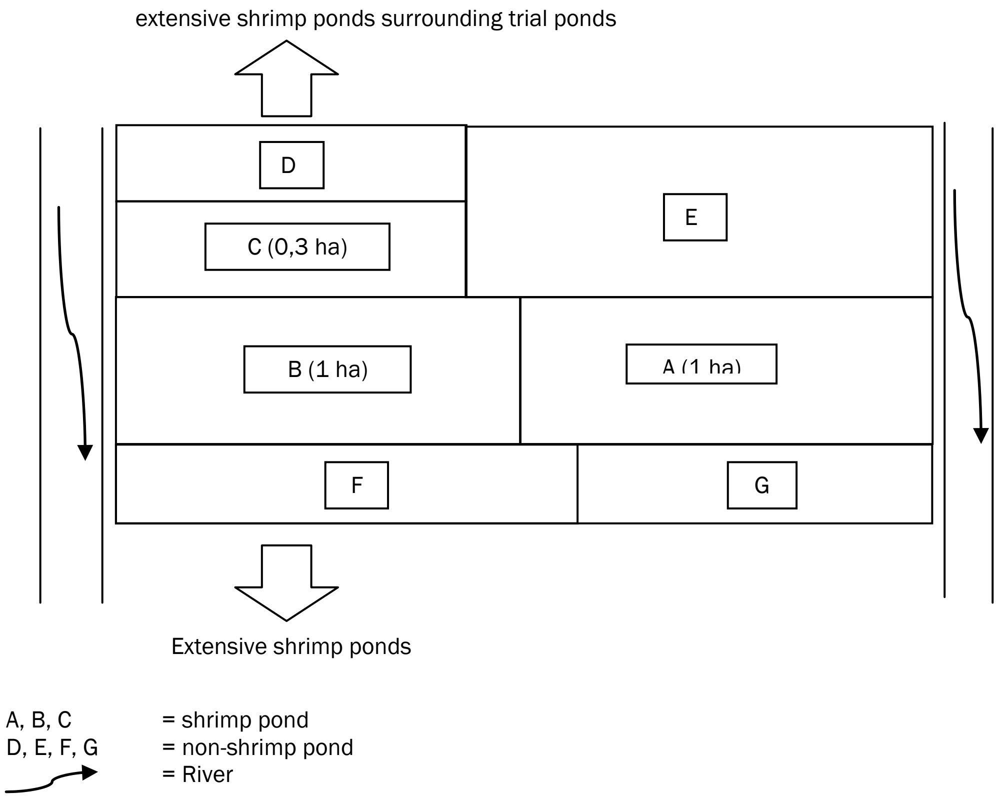

Figure 1. Trial area in site I, diagrammatic pond layout in site I, located at Sidorejo village, Demak district

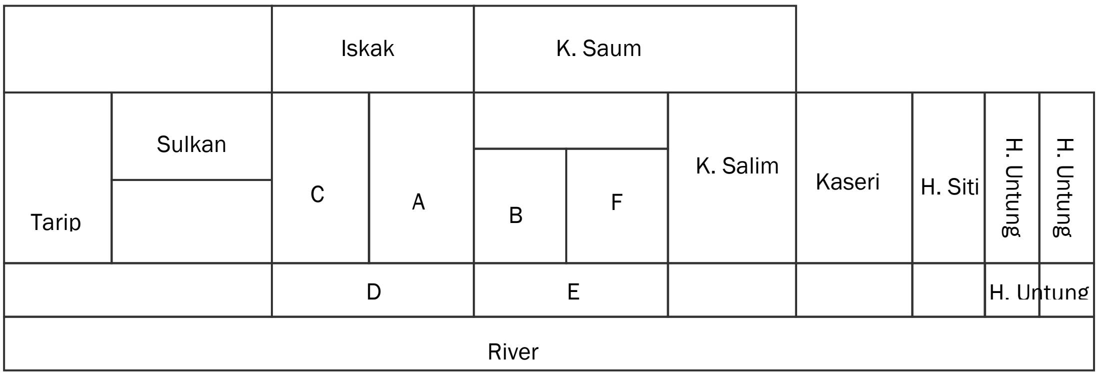

Figure 2. Trial area in site II, diagrammatic pond layout at Serangan village, Demak district

As general temperature during grow out is considered in the optimal range. In the morning, lowest temperature is 24ºC, and the afternoon the highest temperature is 33ºC. White Spot Syndrome Virus is temperature dependant, outbreak always happened during temperature drop below 25ºC, and WSSV multiply efficiently at temperature 23ºC to 28ºC (Guan *et al.,* 2003). Temperature 33ºC is considered effective to prevent WSSV to multiply (Rahman *et al.,* 2007) The lowest temperature was recorded during midcrop. Given temperature range, as average measurement, we may assumed that temperature is suitable for crop. Many author considered that outbreak followed by mass mortality was due to temperature drop. The onset of outbreak was due to virus multiplicate more fast in low temperature.

Salinity is one problems in certain area like in South Sulawesi that some time rise to 35–45 ppt that may affect on shrimp production (Gunarto *et al.* (2006). Salinity in this trial ponds ponds is considered in optimal range that of within range of 15–25 ppt. Low salinity has believed as safe for WSSV infection due to some evident that nearly never happened outbreak in freshwater farming eventhough Macrobrachium can be infected by WSSV. In contrast, Carbajal-Sanchez *et al.* (2008) found that in relation to WSSV infection, there is no safe salinity to avoid WSSV. Dissolved oxygen during crop in site II more fluctuated than site I. Difference in DO may cause by different algae growth in the two location, where in site II, is dominated by pytoplankton and in site I is dominated by macroalge. Dissolved oxigen in the morning, concentration is between 2 and 4 $mg.L^{-1}$ and in the afternoon between 4 $mg.L^{-1}$ and 12 $mg.L^{-1}$ in site I, 2 $mg.L^{-1}$ and 8 $mg.L^{-1}$. Macro algae seem to give better condition in the ponds rather than phytoplankton. Daily fluctuation pH is less than 0,5 either in site I or site II. High fluctuation was observed in the mid crop. Average pH at site II is relatively lower than that of in site I. At site I lowest pH in the morning is 8,4, and highest pH is in afternoon at 9,6. At site II, lowest pH is in the morning at 7 and highest is in the afternoon at 8,8.

Effectiveness of cluster system of shrimp and biosecurity model

Transmission of disease in shrimp farming areas generally occur in succession, one pond get disease outbreak, a few days later the pond next to affected pond get outbreak. The virus transmit from an affected pond to other neighbour ponds mainly by water seepage route (Flegel, 1997). Kautsky *et al.,* (2000) considered spreading pathogen in shrimp aquaculture based on ecological perspective, is relevant to densities of shrimp grow out activities in farm, as when pond densities is high will fascilitate the spread of pathogens between ponds. In this study, the application of biosecurity in extensive shrimp ponds by adding of non-shrimp ponds surrounding shrimp grow out ponds has proven effectively prevent pathogen transmission from adjacent pond. Pond with this biosequrity model success to maintain shrimp until 110 days for ponds at site I and 102 days for pond at site II, and it is much longer than the ponds in the local farm area vicinity, which are only survive at 57 days. Most of the ponds in the vicinity harvest premature due to WSSV outbreak. The presence of surrounding non-shrimp ponds to shrimp ponds have effectively reduce disease transmission, or delaying the onset of disease from the affected extensive shrimp ponds surrounding the trial ponds.

Biosecurity may only one solution to control disease cause by WSSV, where other method such as use chemical and antibiotic proven not effective to control the disease. Biosecurity has also implement in India in include in shrimp farming plan (Mohan *et al.,* 2008). Daily fluctuation pH is less than 0,5 either in site I or site II. High fluctuation was observed in the mid crop. Average pH at site II is relatively lower than that of in site I. At site I lowest pH in the morning is 8,4, and highest pH is in afternoon at 9,6. At site II, lowest pH is in the morning at 7 and highest is in the afternoon at 8,8.

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Table 2. Soil and water quality monitoring during grow out

	Parameter			Pond site				
				Serangan A	Serangan B	Sidorejo A	Sidorejo B	Sidorejo C
Soil								
Texture				Liat berlempung	Liat berlempug	Liat berdebu	Liat berdebu	Liat berdebu
pH	Trench			7	7,13	7	NA	NA
	Central plateau			NA	7,26	7	NA	NA
Organic material	Trench		%	9,43	7,27	12,05	12,05	TA
	Cental plateau			8,27	6,27	12,05	TA	TA
Water								
Salinity		Minimum	$g.L^{-1}$	18	17	7	7	15
		Maximum		41	42	15	15	21
		Mean±SD		26,6±6,7	27,9±7,2	14,2±1,8	14,2±1,8	15,5±1
Temperature	Morning	Minimum	oC	23,6	23,4	24	24	24
		Maximum		27,3	28,4	27	27	27
		Mean±SD		26,3±0,9	26,3±1	25±1	25±1	26±1
	Afternoon	Minimum		27,5	27,1	28	28	28
		Maximum		32,6	32,9	31	31	32
		Mean±SD		30,4±1,0	30,4±1	29,8±0,7	29,8±0,7	30±0,6
DO	Morning	Minimum	$mg.L^{-1}$	1,84	1,43	1,6	1,6	2,3
		Maximum		4,45	4,46	5,6	5,6	5,1
		Mean ±SD		2,9±0,5	2,9±0,5	3,8±0,7	NA	3,5±0,7
	Afternoon	Minimum		1,89	1,97	2,7	NA	4,2
		Maximum		8,59	6,67	11,2	NA	12,2
		mean±SD		5,26±1,4	5,6± 1,6	7,3±2	NA	6,82±1,7
pH	Pagi	Minimum		6,9	7,1	8,5	NA	8,3
		Maksimum		7	8,6	9,3	NA	9,1
		Rerata±SD		8,6±0,4	5,8± 1,6	8,8±0,2	NA	8,8±0,2
	Sore	Minimum		7,2	7,4	8,8	NA	8,6
		Maximum		8,9	8,6	9,8	NA	9,5
		Mean±SD		8,8±0,4	7,8± 0,4	9,3±0,3	NA	9,2±0,3

NA: not analyzed

Most of the ponds in the vicinity of the study harvest premature due to WSSV outbreak. The presence of surrounding non-shrimp ponds to shrimp ponds have effectively reduce disease transmission, or delaying the onset of disease from the affected extensive shrimp ponds surrounding the trial ponds. Biosecurity is may only one solution to control disease cause by WSSV, where other method such as use chemical and antibiotic proven not effective to control the disease. Bioasecurity has also implement in India in include in shrimp farming plan (Mohan *et al.,* 2008).

Occurence of non-shrimp pond surrounding shrimp pond can be considered as buffer. Non-shrimp ponds provided gap to prevent entering wild crab, planktonic copepods that acting as carriers (Waikhom *et al.,* 2006) into cultured shrimp. Occurence of non-shrimp pond in this trial was also to prevent any seepage of water from affected pond in surrounding trial intro shrimp pond, due to water is also considered as media for WSSV transmission (Chou *et al.*, 1998, Wu *et al.,* 2001). Thus non-shrimp pond can take important role in preventing carriers and water directly to neighbouring shrimp pond, and also can give income as fish can be harvested from this pond (Table 3).

Implementing cluster system surrounded by non-shrimp ponds as biosecurity system to prevent shrimp grow out pond from being transmitted by WSSV from extensive shrimp ponds is an effective way to achieve success in shrimp farming. However it's difficult in it's application in extensive ponds in Indonesia, because ownership of land by farmers was limited (Corsin *et al.,* 2007).The farmers generally own one or two ponds, making it difficult for them to implement the system, such as providing buffer ponds if they do individually. The system can be conducted if farmer work in cooperative with other farmers to implement cluster with biosecurity system.

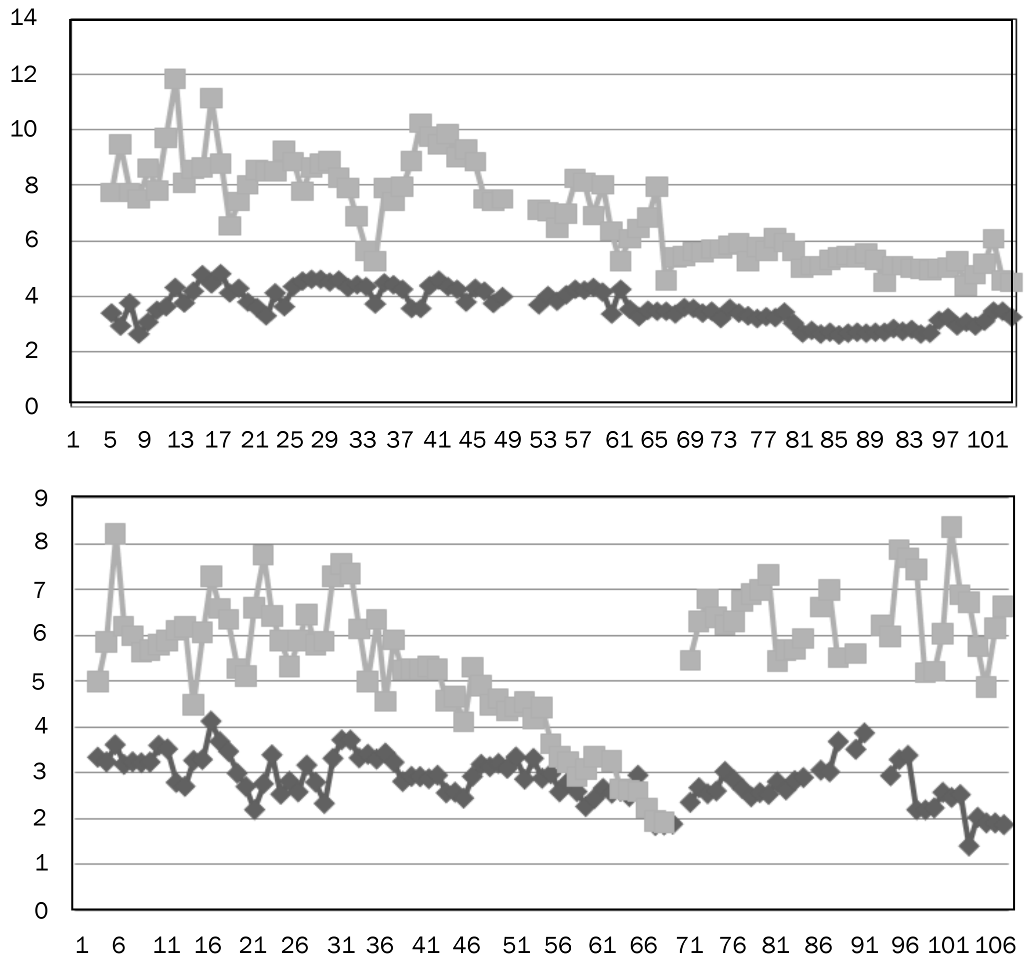

Figure 3. Dissolved oxygen in the pond at site I (Sidorejo, above) and site II (Serangan, below) during the crop period Note : Morning, : Afternoon

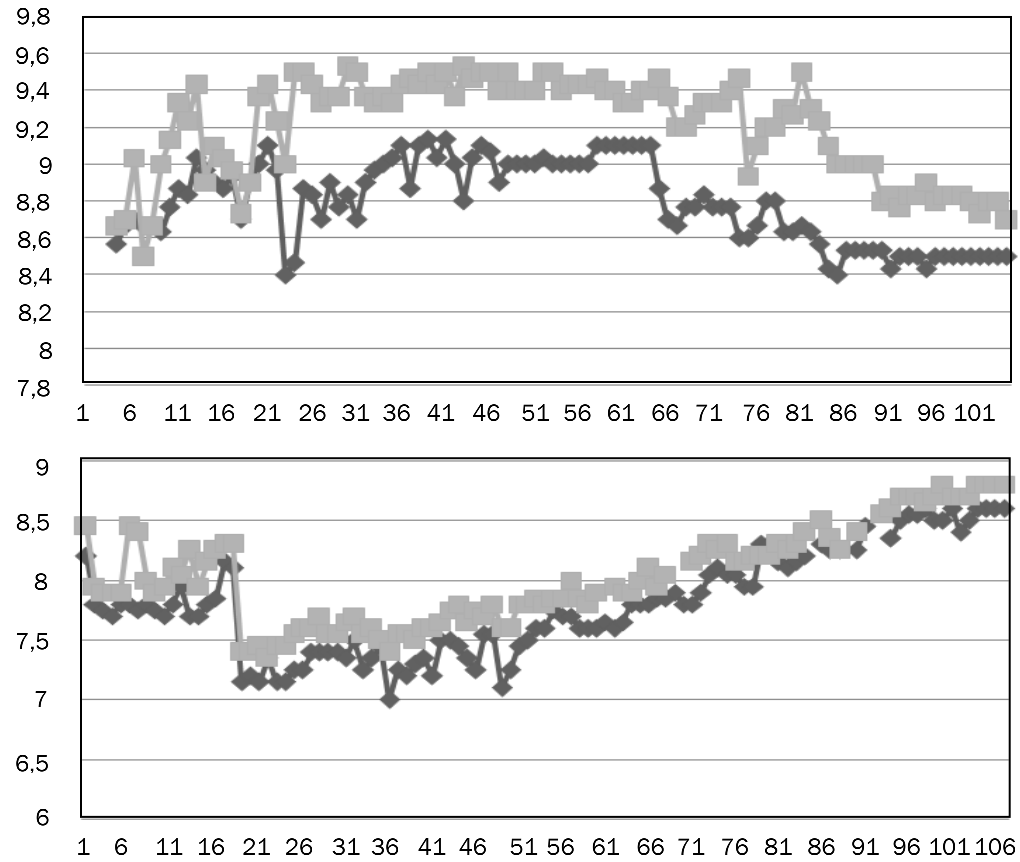

Figure 4. Daily average pH in the pond at site I (Sidorejo, above) and site II (Serangan, below) during the crop periods.Note : ◆ Morning, ■ : Afternoon

Table 3. Total fish production from buffer ponds as biosecurity measure as value added

Buffer ponds	Total fish production
Site I*	176,6 kg
Site II**	100 kg

*) fish produce mainly tilapia
**) fish produce: milkfish, tilapia, seabass

Farmers can arrange their ponds into cluster, selecting which ponds to grow out shrimp and which pond use as buffer grow only finfish. Farmer's pond selected as buffer pond can receive compensate from other farmer. In Vietnam, cluster have been proven not only sustained production among farmers but also implement BMP can be done cooperatively to sustain social and environment (Ha *et al.,* 2013).

Some economic value finfish can be selected such as tilapia, milkfish, rabbit fish or barramundi. In our trial, non-shrimp pond produced different species of fish (Table 3) make an income. Occurence of finfish in buffer pond has also very important as it could act as biofilter to eliminate escaping mysid into buffer pond. Efforts is still need to explore the potential of fish species that can be cultivated as an alternative to shrimp into buffer ponds. By cultivating economically profitable finfish, farmers who 'sacrifice' their ponds as buffer still get income wich are not differe than that of farmers cultivate shrimp. This study also an effort to convert the International Principles for Responsible Shrimp Farming into practice like those already considered by Corsin *et al.* (2007).

Conclusion

This study has shown that arrangement of shrimp ponds in cluster and surrounding by non-shrimp ponds proven effectively to prevent White Spot Syndrome Virus transmission from traditional shrimp ponds in surrounding area This result also suggest that the arrangement can be implemented as part of Better Management Practices in aquaculture.

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