THE INTEGRATED MANGEMENT OF LAGOON ACTIVITIES
THE IMOLA PROJECT

A FINAL REPORT ON

EVALUATION OF ECONOMIC EFFICIENCY AND ENVIRONMENTAL IMPACTS OF POLYCULTURE OF GIANT TIGER PRAWN AND ORANGE-SPOTTED RABBITFISH IN A SHRIMP POND IN LOC DIEN

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1. Summary

1.1 Pilot Model Overview

Name	Evaluation of economic efficiency and environmental impacts of the polyculture of giant tiger prawn (*Penaeus monodon*) and orange-spotted rabbitfish (*Siganus guttatus*) in a shrimp pond
Location	Mieu Nha Village, Loc Dien Commune, Phu Loc District, Thua Thien Hue Province
Duration	1 March – 31 July 2010
Target household	Mr. Mai Cao
Funding agency	The IMOLA Project
Pilot leader	Msc. Tran Quang Khanh Van, Department of Fisheries, Hue College of Agriculture and Forestry
Pilot objectives:	• Diversify the cultured species to minimize the environmental pollution and risks in the shrimp ponds for the sustainable aquaculture
Methodology	• Do the survey for household selection, ponds and facilities for the pilot implementation • Monitor and assess the water quality in the culture process; identify the growth rate and survival rate of shrimp and fish
Model summary	• Pond size: 8,000 m^2 • Stocking densities: shrimp 5-6 units/m^2 + fish 0.1 unit/m^2
Monitoring parameters	• Temperature, salinity, pH, DO, alkalinity, NH_3, water color • Survival rate • Growth rate

1.2 Executive Summary

The pilot for the polyculture of tiger prawn and orange-spotted rabbit fish in the shrimp pond was conducted in Mieu Nha Village, Loc Dien Commune, Thua Thien Hue Province with the purpose of diversifying the culture species, reduce the risk of environmental pollution and risk of shrimp culture venture towards sustainable culture. Two ponds were selected for the culture, including one experimental pond (polyculture of tiger prawn and orange-spotted rabbitfish) and one control pond (shrimp monoculture). The care taking in two ponds was similar. The pilot period was from 1 April 2010 to 30 July 2010. In general, after 2 culture months (from 1 April 2010 to 1 June 2010), the water parameters were stable and suitable for shrimp and fish development with the high growth and survival rate. However, to 6 June 2010, there was a massive shrimp death but the fish was still alive and developed well. Over the pond checking and collection of shrimp samples, the major reasons for shrimp massive death have not been identified. The water environment was polluted; water and waste were directly discharged to the environment without any treatment. Therefore, to the end of May, 2010, all ponds in the culture area were infected with disease and resulted in massive death. Therefore, one of the reasons for shrimp death could be the water pollution due to the

discharge of water and waste and the sudden weather change. So far, orange-spotted rabbit fish in the shrimp pond still develop well and have not been harvested yet. The polyculture of tiger prawn and orange-spotted rabbit fish can help the farmers to minimize the diseases.

- The water parameters are stable and suitable for shrimp and fish growth and development
- However, during the period, the weather always fluctuated and there is a big difference between day and night temperature (sometimes more than 5^oC) and between the days. Towards the end of May, 2010 and early June 2010, the weather changed suddenly from rainy to cold, leading to shrimp massive death on 6 June 2010

Besides, the water of the surrounding environment was polluted due to the disease infection of the nearby ponds. Aquaculturists released the water into the pond without any treatment. Therefore, around the end of May, 2010, all shrimp ponds were infected and shrimps died in mass.

- After two months of implementation (from 1 April 2010 to 31 June 2010) of the polyculture of tiger prawn and orange-spotted rabbitfish in the shrimp pond, the water parameters were stable and suitable for shrimp and fish growth; the growth and survival rate was high.
- However, on 6 June 2010, shrimps in the pond died in mass while the rabbitfish was still alive and developed well. Over the checking and shrimp sample taking, major reasons for shrimp massive death have not been identified. The reasons for the shrimp death may be because of the water and waste from disease infected shrimp ponds were discharged into the lagoon and the sudden change of the weather, causing shock to shrimps.

So far, the orange-spotted rabbitfish in the shrimp pond still develops well and the aquaculturists have not harvested it.

2. Background

In recent years, the country has experienced the quick increase of aquaculture, mainly in coastal areas with the tiger prawn. This uncontrolled development has led to the serious consequences such as the water environment deterioration due to the release of a large amount of organic matters beyond the carrying capacity and disease spread. Therefore, the monoculture of tiger prawn is discouraged nowadays. One alternative to monoculture, which is highly recommended in international and national researches, is the adoption of polyculture (i.e. the culture of multiple species), which will bring about more convenience for fishermen and they can make use of the available feed and ensure the aquaculture sustainability. The investment on the fingerlings and feed in the polyculture with the lower stocking density is less than the intensive culture. The feed is fully utilized, and the quality of the products and the profit will be improved.

To date, the polyculture model has been widely applied in the Thua Thien Hue Province. In 2003-2004, the Aquaculture Research Institute II initiated the ecological model of spotted Babylon, *rong sụn*, *gracilaria*, orange-spotted rabbitfish and green mussels in Lang Co Lagoon and restricted diseases in spotted Babylon. The Fisheries Extension Centre of Thua Thien Hue Province carried out the experiment of many polyculture models including the tilapia culture in the earthen pond in Phu An (Phu Vang), the shrimp polyculture in Quang

Thanh (Quang Dien) and Thuan An (Phu Vang) in 2003, the culture of orange-spotted rabbitfish, *gracilaria* and tiger prawn in Huong Phong Commune (Huong Tra) in 2005, and so on.

Mieu Nha in Loc Dien Commune has many shrimp ponds, but a large portion is managed under monoculture system (IMOLA & SDA, 2009) with the belief among local farmers that polyculture produces less profit.

With the support of the IMOLA Project, the polyculture of tiger prawn (*Penaeus monodon*) and orange-spotted rabbitfish (*Siganus guttatus*) in a shrimp pond was conducted from 1 April 2010 to 31 July 2010 in Mieu Nha Village, Loc Dien Commune, Phu Loc District, Thua Thien Hue Province. The objectives were to diversify the culture species, improve the livelihood for fishermen and minimize the pollution and risks in shrimp culture towards the sustainable aquaculture via the polyculture models.

3. The Pilot Model

3.1 Time and venue

Time: 1 April 2010 – 31 July 2010
Venue: Mieu Nha, Loc Dien Commune, Phu Loc District, Thua Thien Hue Province

3.2 Experiment design

- The pilot was conducted in two ponds with the area of 8,000m^2/each.
- Treatment pond: polyculture of tiger prawn and orange-spotted rabbitfish.
- Control pond: monoculture of tiger prawn.
- Fingerlings in the model were purchased in Da Nang and the quality was checked for the white-spot disease and MBV by PCR at the Veterinary Centre (Phu My Commune, Phu Vang, Thua Thien Hue Province).
- Shrimp fingerlings underwent the nursing period of 20 days to the size of 3-4cm to be stocked to the model with the density of 5-6 units/m^2.
- The orange-spotted rabbitfish was purchased from households in Thuan An, Thua Thien Hue with the size of 4-6cm and the stocking density of 0.1 unit/m^2.

3.3 Monitoring parameters

- Temperature, salinity, pH, DO, alkalinity, NH3, water color
- Growth and survival rates of shrimp and fish

3.4 Model preparation

3.4.1 Pond preparation

The pond preparation includes pond drainage after harvest, dredging a layer of mud, distributing lime at the pond bottom at 500-1,000kg/ha, exposing the pond bottom in 10-15 days. After that, take the water through the filtering net and colour the water.

3.4.2. Sterilizing the intake water

In the pond, there are many types of virus, bacteria, fungus, algae and protozoa causing diseases like yellow head, white spot, MBV, Vibrio parahaemolyticus (*phát sáng*), algal gathering, red gill, supplementary organ necrosis and so on. Therefore, it is required to sterilize the intake water before stocking shrimp fingerlings. The common chemical for water sterilization is Chlorine. Chlorine with the dosage of 30-38% will be easily evaporated so the evaporation of chlorine will be checked before stocking fingerlings. The usual concentration of 2 ppm has good bacteria eradication. For the pond of 1 m depth, use 195 kg of Chlorine concentration to mix with water and distribute it over the pond. If this concentration is sprayed in cool days, the bacteria eradication impact can last for 4-5 days. Operate the aerator, which was managed by local farmers, before stocking shrimp fingerlings to dissipate Chlorine in the water. This operation was managed by local famer. .

3.4.3 Distributing fertilizers for water coloring

Factors that contribute the water colour includes metal ion, organic humus dissolved in the water, bottom mud, suspended matters, colloid, especially aquatic organisms like uni-cell algae.

The water colour represents the density of algae in the pond as well. The amount of uni-cell algae and algae composition depends on the concentration and percentage of fertilizers. During the water colouring, we use Nitrogen and Phosphorus for distribution into the pond with the ratio of 10/1 (Nitrogen/Phosphorus), and the water is always remained as light green.

The water colour plays a significant role in shrimp pond culture in enhancing the dissolved oxygen in the water, stabilize the water quality, and reduce the poisonous matters in the water and create more feed for shrimps. Reducing the transparency of the water help shrimps avoid the predators, enhance and stabilize the temperature in the pond, limit the development of *Phaeocystis globosa* (*tảo sợi*) and phytoplankton (*tảo đáy*), and ensure the ecological balance in the water area.

Once the pond bottom has been well prepared, take water and distribute fertilizers for water colouring and stock shrimps and fish timely. Aquatic organisms will develop impacting the physical, chemical, and biological parameters if fingerlings are not stocked long after water colouring.

3.5 Some optimal physical and chemical parameters

In tiger prawn culture, water parameters have a quite big influence on the health of the cultured species. The optimal range of some water parameters is as follows:

Table 1. Some environmental parameters in the pond

Parameters	Optimal range	Suggestion
Water temperature	20 – 30^{0}C	Fluctuating during day and night not more than 5^{0}C.
Salinity	5-30‰	The best optimal range of 10 - 25‰.
pH	7.5 – 8.5	Do not fluctuate more than 0.5 during the day
Dissolved oxygen	More than 4 mg/l	
Transparency	35 – 45 cm	
Water color	Green, dark green or light green	

4. Research Methodology

4.1 Identification of water parameters in the culture ponds

Water parameters were checked every 15 days. The test, branded Serra by the German Federation, was used to check all parameters including temperature, salinity, dissolved oxygen, pH, NH_3, and alkalinity.

4.2 Identification of growth and survival rate of shrimp and fish

4.2.1 Survival rate

Shrimp:

The survival rate was checked every 15 days. In the first 15 days, the net was used to estimate the survival rate of shrimps. In the next 15 days, the survival rate was estimated based on the shrimp consumption feed amount and the number of shrimps in the feeding tray. After one culture month, the survival rate was calculated by using the net to collect shrimps from different positions in the pond and the survival rate was assumed from the average number of shrimps in an area unit.

Fish:

The cast net was used to check the number of fish in the pond, and survival rate will be forecasted by multiplying the number of collected fish per cast net with the square rate between pond and net. The number of fish collected from one harvest was checked, and the survival rate was estimated by the average fish in an area unit, similar to shrimp checking.

4.2.2 Growth rate

The samples were randomly taken by using the net, feeding tray or small cast net (*chài*). 30 units of shrimps and fish were checked in one checking time. Shrimp samples after the harvest were weighed by an electrical balance and measured by a ruler.

4.2.3 Data aggregation and treatment

The data was aggregated and treated on the software of SPSS (version 16.0).

5. Pilot Results

5.1 Implementation time

The time for the pilot implementation is shown in Table 1.

Table 2 Implementation time

No.	Implementation time	Content
1	1/3/2010-15/3/2010	Survey for household and venue selection
2	16/3/2010-30/3/2010	Initial instruction on the culture techniques, pond preparation and improvement, dissemination of the culture process of tiger prawn and orange-spotted rabbitfish
3	2/4/2010	Orange-spotted rabbitfish stocking
4	3/4/2010	Tiger prawn stocking
5	8/4/2010-31/7/2010	Monitoring, care taking and management of water parameters in the culture pond; calculation of the survival and growth rate of tiger prawn, orange-spotted rabbitfish and harvest

5.2 Result of care taking and monitoring

5.2.1 Fingerling stocking

Table 3 The quantity and size of stocked shrimps and fish

Culture type	Stocked species	Pond area	Number of fingerlings (unit)	Size
Polyculture	Tiger prawn	8,000m^2	150,000 [1]	P15
	Orange-spotted rabbitfish		850 [2]	4-6 cm
Monoculture	Tiger prawn	8,000m^2	150,000	P15

5.2.2 Water parameters

During the time of the pilot implementation, the weather changed suddenly. In the initial stage, due to the long-lasting hot weather, the temperature in the pond increased to 32^{0}C. After two culture months, the weather shifted from hot to rainy days (3-5 days) so the temperature in the pond was unstable. However, the majority of water parameters in the pond were maintained at the suitable level for shrimp and fish growth. The pond water colour was

[1] 5 - 6 units/m^2 of stocking density (= 40,000-48,000 units/pond) was expected for shrimps that are large-sized from 4 to 6 cm/unit. However the pilot farmer only used shrimps with P15 size. Therefore 150,000 units of P15 were used instead of fewer numbers of large shrimps.

[2] 0.1 unit/m2 of stocking density (= 800 units/pond) was expected for rabbitfish. However, after the discussion with the farmer, it was increased to 850 units/pond.

light or dark green or yellow green. The transparency ranges between 30 and 40cm. Among the parameters of the water quality, pH is the most important factor influencing shrimps and other factors, especially the alkalinity. Too high pH will cause difficulty for shrimps to shell off and they will grow poorly but too low pH injures the shrimp organs and gills. Besides, pH decides the presence of NH_3 and H_2S in the pond. In the culture process, pH normally ranged between 7.5 and 8.5 and was suitable for shrimp growth.

Table 4 Some environmental parameters in the pond

No.	Parameters	Polyculture pond	Monoculture pond
1	Temperature (t^0C)	29.50 ± 2.07	29.13 ± 2.03
2	Salinity ($S‰_0$)	11.25 ± 1.13	11.38 ± 1.06
3	pH (min - max)	7.5 – 8.5	7.5 – 8.5
4	DO (mg/l)	4.19± 0.37	4.13 ± 0.35
5	Alkalinity	91.19 ± 11.69	82.21 ± 8.84
6	NH_3	0.06 ± 0.06	0.06 ± 0.06

5.2.3 Care taking and pond management

The care taking and management in the polyculture and monoculture ponds were the same.

5.2.4 Feeding

Shrimps were fed with Sinh Long Industrial feed. The utilized feed amount was 10% of the shrimp weight. Feed was given 4 times per day, 10% of fish body weight with 6am, 10am, 2pm and 5 pm, respectively.

5.2.5 Disease prevention measures

The comprehensive disease prevention measures were applied during the culture process with the focus on the pond preparation, pond bottom dredging to get rid of the old mud layer, and pond bottom exposure to the sun. The water was taken through the filtering net. Besides, in the culture process, dolomite lime was periodically applied to stabilize the pH after the water renewal and in heavy rainy days.

5.2.6 Average weight and survival rate

Samples were periodically taken for checking shrimp and fish weight and survival rate during the culture process. The results are shown in tables 4 and 5

Table 5 Shrimp average weight and survival rate

Culture time	polyculture model		monoculture model	
	Average weight (g/con)	Survival rate (%)	Average weight (g/con)	Survival rate (%)
After 30 culture days	1.4 ± 0.5	70	1.4 ± 0.5	70
After 60 culture days	3.3 ± 0.6	60	3.2 ± 0.6	60

Table 6 Orange-spotted rabbitfish average weight and survival rate

Culture period	Orange-spotted rabbitfish in the shrimp pond	
	Average weight (g/unit)	Survival rate (%)
After 30 culture days	35.7 ± 8.6	90
After 60 culture days	62.1 ± 8.9	85
After 90 culture days	108.8 ± 12.4	82
After 120 culture days	205.9 ± 26.4	82

Table 4 illustrates that the shrimp average weight and survival rate in the polyculture and monoculture ponds are nearly the same. The average shrimp weight reached 1.4g/unit after 30 culture days and 3.3g/unit after 60 culture days. The shrimp survival rates in both polyculture and monoculture ponds were relatively high. For orange-spotted rabbitfish, the survival rate was high after 90 culture days (82%) and the average weight reached 108.8g/unit (Table 5).

5.2.7 Cost for the pilot

Table 7 Cost calculation for the experimental model

Item	Polyculture pond (VND)	Monoculture pond (VND)
Pond preparation	2,700,000	2,700,000
Shrimp fingerlings	2,000,000	2,000,000
Fish fingerlings	2,550,000	0
Environmental test	1,300,000	0
Industrial feed (900 kg x 23VND/kg)	20,700,000	20,700,000
Total	29,250,000	25,400,000

5.2.8 Harvest

Products at harvest time:

Tiger prawn after two culture months (early June) died due to shrimp disease. No harvest of this species was therefore recorded. Estimated harvest of orange-spotted rabbitfish is 144 kg x VND 120,000/kg=VND 17,280,000.[3]

Economic accounting:

Total income - Total expenditure = VND 17,280,000 - VND 29,250,000 = VND - 11,970,000
Due to the failure to harvest shrimps, the farmer got a loss of around VND 11,970,000.

- **Monoculture pond**: There was a massive shrimp death, so it was impossible to harvest shrimps. The farmer faced a complete failure. Total income - Total expenditure = VND 0 - VND 25,400,000 = **VND - 25,400,000**
- **Polyculture pond**: Only fish has survived: Total income - Total expenditure = VND 17,280,000 - VND 29,250,000 = **VND - 11,970,000**.

For the monoculture pond, the disease outbreak caused massive death of shrimps and a loss of VND 25,400,000. For the polyculture pond, the farmer's loss was mitigated by the fish in

[3] At the time of this calculation, the farmer is still keeping the fish in the pond.

the same pond to VND - 11,970,000. Although polyculture could not prevent the occurrence of the shrimp disease in the pond, the polyculture could mitigate the economic/financial impacts of shrimp death on the farmer.

5.2.9 Some lessons learnt from this pilot

- Weather changes should be well noticed in order to take prompt actions
- It is necessary to have the treatment pond to limit the disease germs to the pond

6. Conclusions and proposals

6.1 Conclusion

- The polyculture model of tiger prawn and orange-spotted rabbitfish was targeted to diversify the culture species and risks from shrimp culture
- Water parameters in the pond are favourable for shrimp and fish growth
- Orange-spotted rabbitfish are growing well with high survival rate
- Conclusion on this model is difficult as the model has to be stopped due to the disease occurrence, but one thing we can say is that polyculture, existence of fish in the pond, could mitigate the negative livelihoods impacts due to shrimp disease, which is very common and widespread in the area. The polyculture provides a good insurance system for the local farmers in the area disease risk is significantly high.

6.2 Proposals

- The causes for the massive death of shrimps after two culture months should be investigated and some measures for shrimp disease prevention are necessary.
- Currently the shrimp farming area was polluted and the waste from the culture pond was directly discharged to the environment without any treatment. Therefore, it is necessary to check the water quality before culture
- In the culture process, it is advisory to supplement bio-products to improve the environment and some vitamins to the feed to increase the shrimp resistance capacity

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