INTEGRATED MANAGEMENT OF LAGOON ACTIVITIES
IMOLA PROJECT II

A REPORT ON

EVALUATION OF ECONOMIC EFFICIENCY AND ENVIRONMENTAL IMPACTS OF POLYCULTURE OF GIANT TIGER PRAWN AND MULLET IN HIGH-TIDE PONDS

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PEOPLE'S COMMITTEE OF THUA THIEN HUE PROVINCE

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I. Introduction

Fig 1. Study site in Tam Giang lagoon

Thua Thien Hue is one of the coastal provinces in the central strip of Vietnam, with a large and densely distributing river system. Within the system, Tam Giang lagoon is acknowledged as the largest lagoon in Asia in terms of water surface with diverse aquatic species. Its unique form and physical characteristics have created a brackish water ecosystem with a diversity of resources (Phap et al., 2002). This is home to aquatic resources, which provide foodstuff and livelihood for thirty-five percentage of province population (approximately thirty-five thousand inhabitants) living alongside the lagoon (Binh, 2005). However, the pressure of population growth, over-exploitation, and the inharmonious development among economic operations in the same territory are leading to the depletion of Thua Thien Hue's lagoon natural resources; the life conditions of the communities living along the lagoon are being threatened. Aquaculture was introduced in Tam Giang lagoon in 1990s by government officials and has been regarded as an alternative livelihood for capture with the aim of improving local nutritional levels and variety, by both the direct food production and via household income improvement. Furthermore, aquaculture also brings about high productivity and reduces the pressure on the lagoon resources by captures; and finally, it may generate employment opportunities in communities in the lagoon in particular and Thua Thien Hue province in general.

In Loc Binh commune, in the southern part of the lagoon, shrimp pond culture has been among the major livelihoods in recent years. Shrimp disease is the most severe problem that the farmers have been facing and a measure is to practice the polyculture. The main principle of polyculture is utilizing species that feed at different levels of the food web to produce a harmonizing ecosystem. The concepts of improving a hydrographical system, balancing the ecology between the primary and secondary producers and consumers and the nutrient circulation are crucial factors for the aquaculture sustainable development. Aquatic plants and high economic value species such as rabbit fish, mullet, grass carp and clam are good candidates for the polyculture. Mullet (Mugil cephalus) is a filtering feeder that is commonly seen swim and feed near the water surface, accommodate itself well in both brackish and fresh water environment. In 2006, a model of shrimp and crab polyculture was conducted in this area (Mr. Huynh Dau) and succeeded. It is suggested by many farmers that this model should be duplicated to the whole area. However, crab is an intermediary pathogen host to shrimps (eg. white spot disease), so should be avoided introducing into shrimp pond. One model that was also suggested by local farmers was the polyculture of giant tiger prawn (tôm sú) and mullet (cá đối) with the density of 5 units/m^2 and 0.1 unit/m^2, respectively. This model was applied in this commune in 2007 by IMOLA project fund. Better environmental parameters and shrimp growth rate were recognized after two culture months. However, because of the flood incidence last year, farmers had to harvest shrimp and fish after 60 culture days and the economic efficiency was only calculated at that time. This year, this model has been replicated with the purpose of understanding its environment impacts and economic efficiency before being applied to other farmers.

II. Objective

To evaluate the economic efficiency and environmental impacts of a polyculture model (giant tiger prawn and mullet)

III. Experimental design

The experiments were conducted in two ponds to investigate the impact of the polyculture (with a species of a different feeding habit) on production and quality of the culture environment. Each experiment was carried out in one season and in an earthen pond selected in close consultation with farmers and provincial authorities. Data that was monitored included growth rate, water parameters, survival rate, yield and economic evaluation.

The pilot model was designed in the following table

Table 1. Experimental design in Loc Binh

Models	**Species**	**Density**	**Size of fingerling**	**Feed**
Polyculture (Treatment pond)	*P.monodon*	7 shrimps/m^2	3 – 5 cm	Industrial feed
	Mullet	0,1 fish / m^2	8 - 10 cm	
Monoculture (Control pond)	*P.monodon*	7 shrimps /m^2	2 – 3 cm	Industrial feed

Fig.2. a. Experimental pond; b. Shrimp fingerling; c. Water parametters measuring and technical support

Pond preparation

- Pond area: 5000m^2
- Number of ponds for each model: 2 ponds

Pond improvement:

- Wash the pond and remove waste
- Dry the pond in 3-5 days
- Stock lime with 500-600kg/ha after 3 days; supply water through filtering net until 0.6m height
- Distribute fertilizers including 15 kg of NPK, 5 kg of Urea and 2kg of Phosphate
- After 3 days, supply water to the level of 1.0m height
- Check the water quality parameters before stocking

Variables will be measured:

- Water quality (Dissolved oxygen (DO), pH, temperature, water color, Ammonia) by using test kit except for water color by observation.
- Fish growth rate: fish sampling was monthly checked in order to determine the growth rate of the fish by recording the length and weight of a sample
- Shell growth rate (body weight)
- Fish health status: monitor fish activity, and unusual symptom and disease diagnosis
- Survival rate
- Economic efficiency analysis

Socio- Economical variables

- **Inputs**:

Costs include cage and pond making and material purchase, fingerling cost, labor payment, lime, medicine and feed

- **Outputs:**

Growth performance (g/month) of each species; survival rates; income (aquaculture income, husbandry income, crop income, and off-farm income); education levels and others

- **Feed, feeding and management**
  i. During the first culture month, fish and shrimp were fed with macrophyte and industrial feed
  ii. Feeding rate: 20% of body weight for macrophyte and 10% for industrial feed. Amount of feed was adjusted according to the fish and shrimp growth as well as the number of fish and shrimps in pond
  iii. Feeding was given twice per day
  iv. Water/ environment was bimonthly replaced
  v. Data was treated by ANOVA formula based on the SPSS software

IV. Results

1. Water quality in the experimental and control ponds

Water environment parameters were daily measured; the fluctuation of all parameters was presented in table 2.

Table 2. Water environmental parameters

Parameters	**Models**			
	Polyculture		**Monoculture**	
	Mean	SD	Mean	SD
DO (mg O_2/L)	4.76	0.31	4.13	0.65
Temp. (^{0}C)	28.2	1.64	28.0	1.41
Salinity (‰)	19.0	1.00	19.5	1.20
pH	8.50	0.20	8.30	0.28
NH3 (mg/l)	<0.02	0.00	0.20	0.01
Alkanity(KH+)	95	0.10	92	0.13

All water parameters were quite suitable for shrimp and mullet growth. pH, DO, salinity and alkalinity were in the optimal range of shrimp and mullet. The significant difference that was observed in two ponds was NH_3 amount. The NH_3 in polyculture pond (0.01 mg/L) was lower than in the control pond (0.2mg/L) ($p<0.05$). Others were not considerably dissimilar in two ponds. This implies that the organic matter could have been controlled by mullet, which resulted in the reduction of total N and P in the environment; therefore, the amount of NH_3 was diminished in the polyculture pond.

2. Growth rate of mullet fish and shrimp in different ponds

The growth rate of shrimp and fish in the treatment and control ponds was regularly checked every 10 days. Growth rate of shrimp in polyculture model significant was higher compared with that in monoculture ($p<0.05$) (Fig. 3). After 90 culture days, the weight of shrimp reached to 18.73g in the polyculture pond, which was significantly higher than that in the monoculture pond (14.54g).

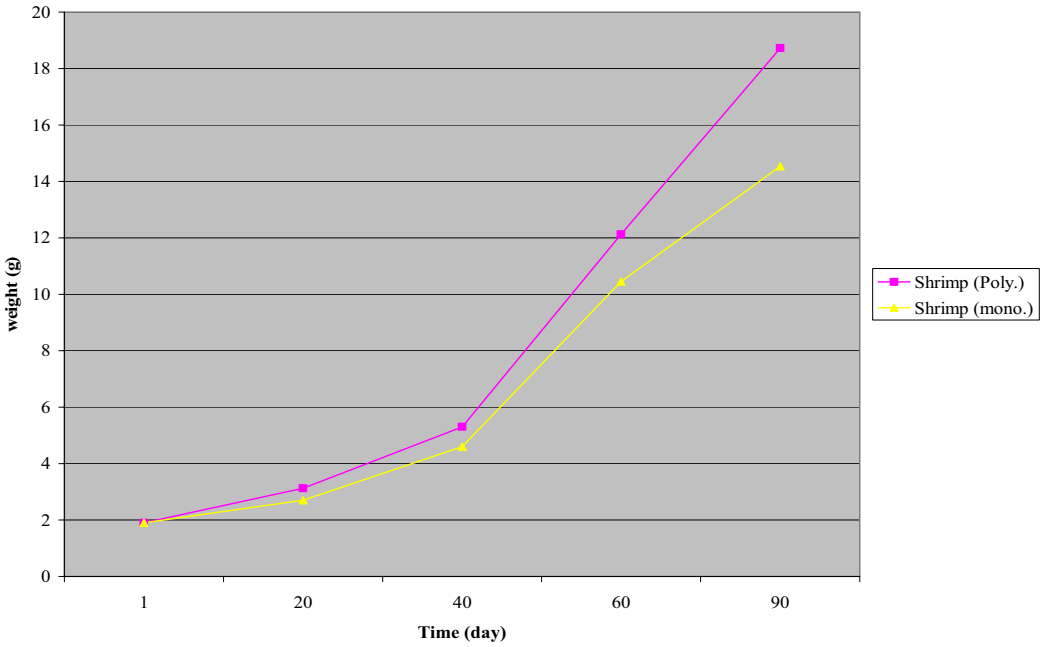

Figure 3. Growth rate of shrimp in polyculture and monoculture pond

Although the quality of shrimp and the nutrition were vital factors that have the impact on the shrimp growth rate; however, the quality of water parameters was also regarded as influential factors for shrimp growth. Better water parameters quality in polyculture leads to enhance the shrimp growth rate.

Mullet fish reached to 1.6 g/day after 30 culture days (Fig.4). Grouper got the highest growth rate after 40 culture days. The accumulation of uneaten feed and shrimp waste led to the increase of the organic matters in the pond, and stimulated the plankton growth. When the live feed was available in the pond, mullet got better growth rate.

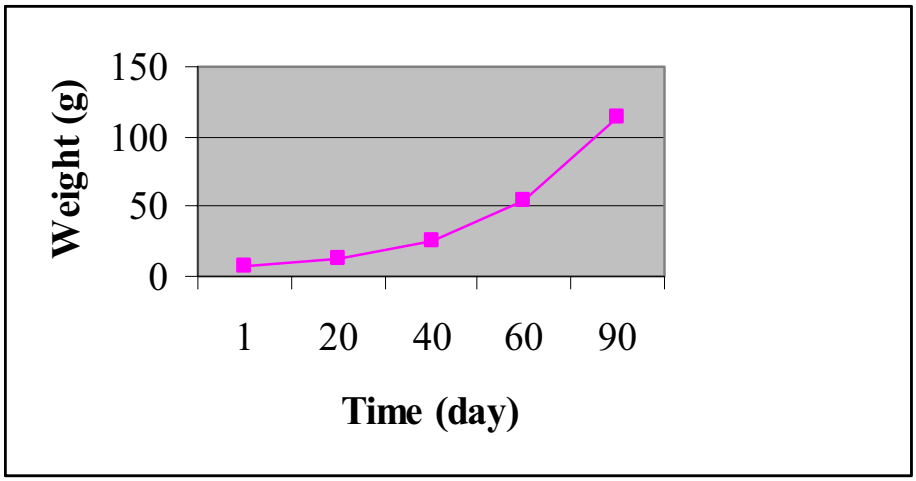

Figure 4. Grow rate of mullets in polyculture pond

3. Economic efficiency

After 3 culture months, shrimp and fish was partly harvested. Harvesting was conducted in one month. Harvested data was computerized. The economic efficiency was calculated after all fish and shrimp were entirely harvested. The primary economic competence of the pilot and control pond was presented in table 2 and table 3.

The results of pilot were quite triumphant and the farmer got some profit from the pilot. At that time, farmer earned VND 9,148,000 after four culture months. On average, the farmer could obtain more than VND 2,000,000 per month, drastically higher than other section's income. In the meanwhile, in the monoculture pond, the net profit was only VND 2,430,000 in four months.

It is clear to say that polyculture of shrimp and mullet is significantly better than shrimp monoculture in both economic efficiency and environment impacts.

Table 3. Estimate of the pilot economic efficiency

Items		**Units**	**Quantity**	**Price**	**Amount**
Sales	*Mullet*	Kg	29	68,000	1,972,000
	P. monodon	Kg	397	58,000	23,026,000
Total					**24,998,000**
		Fingerling	Feed	Other costs	
Purchases		4,850,000	9,000,000	2,000,000	**15,850,000**
Net Profit					**9,148,000**

Table 4. Estimate the economic efficiency of monoculture model

Items	Units	Quantity	Price	Amount
Sale (*P. monodon)*	Kg	320 kg	54,000	17,280,000
Purchases	Fingerling	Feed	Other costs	
	3,850,000	9,000,000	2,000,000	**14,850,000**
Net Profit				**2,430,000**

V. Conclusions

- Growth rate of shrimp in polyculture model significant is higher compared to growth rate of shrimp in monoculture ($p<0.05$).
- Mullet fish can reach to 1,6 g/day after 30 culture days.
- NH_3 is notably different between two models ($p<0,05$)
- Other parameters are no appreciably between two models

VI. Recommendation

- Polyculture (Tiger shrimp and mullet fish) is quite suitable for this area
- Quality of shrimp fingerling should be considered when carrying out the pilot
- Supporting culture techniques to the farmers

VII. Appendix

1. Growth rate of shrimp in polyculture pond

Culture day	1	20	40	60	90
shrimp 1	1.99	3.44	5.46	12.12	18.18
shrimp 2	1.95	2.97	4.98	12.54	21.02
shrimp 3	1.37	3.56	5.78	12.21	17.56
shrimp 4	1.85	2.69	5.34	11.86	17.75
shrimp 5	2.1	3.10	5.47	11.94	18.34
shrimp 6	1.73	3.22	5.30	12.30	19.32
shrimp 7	1.86	3.30	5.66	12.41	17.96
shrimp 8	1.98	2.89	4.87	12.37	18.45
shrimp 9	1.99	2.75	5.63	12.08	18.60
shrimp 10	2.18	3.28	4.51	11.47	20.10
Mean	1.90	3.12	5.30	12.13	18.73

2. Growth rate of shrimp in monoculture pond

Culture day	1	20	40	60	90
shrimp 1	1.83	2.71	4.62	9.80	15.20
shrimp 2	1.96	2.85	4.76	10.54	14.85
shrimp 3	2.00	2.68	4.56	10.69	13.76
shrimp 4	1.91	2.91	4.40	10.72	16.73
shrimp 5	2.01	2.57	4.21	10.88	13.87
shrimp 6	1.67	2.77	4.78	10.55	13.20
shrimp 7	1.97	2.43	4.90	10.47	14.30
shrimp 8	1.78	2.64	4.55	10.34	14.76
shrimp 9	1.82	2.49	4.67	10.12	13.68
shrimp 10	2.05	2.95	4.55	10.39	15.05
Mean	1.90	2.70	4.60	10.45	14.54

3. Growth rate of mullet fish

Culture day	1	20	40	60	90
Mullet 1	6.81	12.50	27.50	55.12	120
Mullet 2	5.98	12.58	23.41	50.71	105
Mullet 3	6.72	12.00	22.13	49.37	117
Mullet 4	6.86	13.12	21.68	56.35	132
Mullet 5	7.13	12.75	24.56	58.90	111
Mullet 6	7.23	12.68	25.25	59.00	98
Mullet 7	6.97	12.82	28.12	51.15	105
Mullet 8	6.58	12.59	22.89	53.32	107
Mullet 9	6.62	13.10	24.67	54.49	120
Mullet 10	7.10	12.66	26.99	57.19	115
Mean	6.80	12.68	24.72	54.56	113

4. Water parametters in mono and polyculture

Parametters	Oxy	Temp.	S‰o	pH	NH3	KH
Polyculture pond						
1	4.7	28	17	8.2	0.01	90
2	4.8	30	19	8.5	0.01	95
3	4.5	28	19	8.7	0.15	97
4	4.9	29	20	8.5	0.15	97
5	4.7	28	19	8.5	0.01	95
6	4.8	26	18	8.7	0.01	98
7	4.9	28	20	8.7	0.15	95
8	4.76	28	20	8.5	0.1	95
Monoculture pond						
1	4.5	28	18	8	0.1	90
2	4.2	30	19	8.6	0.15	90
3	4.2	28	19	8.3	0.2	94
4	4	29	20	8	0.2	94
5	3.9	28	19	8.6	0.25	93
6	4	26	21	8.4	0.3	89
7	4	28	21	8.3	0.3	92
8	4.11	28	19	8.3	0	92