



# INTEGRATED MANAGEMENT OF LAGOON ACTIVITIES IMOLA PROJECT II

A REPORT ON

## EVALUATION OF ECONOMIC EFFICIENCY AND ENVIRONMENTAL IMPACTS OF POLYCULTURE OF GRASS CARP TILAPIA, AND CLAM IN CAGES

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Hue, 12/2009



PEOPLE'S COMMITTEE OF THUA THIEN HUE PROVINCE



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POLY CULTURE OF GRASS CARP, TILAPIA, AND CLAM  
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## **PART I BACKGROUND**

Thua Thien Hue has a large lagoon with the area of more than 22,000 ha, which provides a highly favorable condition for the development of aquaculture in the province. Quang Thai is poor among coastal lagoon communes of Thua Thien Hue Province. Aquaculture and capture fisheries have been generating major income for the fishermen in this area.

However, in recent years, diseases occurred to cultured fish, especially in cage culture, and impacted remarkably the income of fish farmers. This is why the research and introduction of an innovative culture models and suitable culture species that suit local conditions play a significant role to tackle the current issues and encourage the cage culture in the locality.

## PART II RESEARCH CONTENTS AND METHODOLOGIES

### 2.1 General information

<i>Pilot name:</i>	Evaluation of economic efficiency and environmental impacts of the polyculture of clam and fresh water fishes in cages
<i>Period:</i>	January-August 2008
<i>Venue:</i>	Quang Thai commune, Quang Dien district, Thua Thien Hue province
<i>Organization:</i>	Fisheries Department, Hue College of Agriculture and Forestry
<i>Prominent:</i>	Nguyen Duy Quynh Tram
<i>Target species:</i>	Grass carp ( <i>Ctenopharyngodon idellus</i> ), unisex tilapia (Genetically Improved Farmed Tilapia), and clam ( <i>Macra quadrangularis</i> )
<i>Involved households:</i>	Mr. Nguyen Vai
<i>Objectives:</i>	Improve the economic efficiency and environmental conditions via the polyculture model suitable to the natural conditions of the locality

### 2.2 Research content

- Experimenting the polyculture of a) grass carp and tilapia and b) grass carp with clam in cages
- Evaluating the growth rate of culture targets and environmental impacts
- Identifying the survival rate, health status and primarily assessing the economic efficiency of the polyculture models

### 2.3 Research methodology

#### 2.3.1 Cage design

Cages are fixed by surrounding bamboo poles and two net layers; there was a net layer on the top with a hole to pour fish feed into cages. The dimensions of cages are 9.2 x 5.1 x 1.1 m (length x width x height).

#### 2.3.2 Experimental models

Cage 1: 100% of grass carp (monoculture - control cage)  
Cage 2: 70% of grass carp and 30% of tilapia (polyculture – treatment cage)  
Cage 3: 70% of grass carp and 30% of clam (polyculture – treatment cage)  
Stocking density: 20units/ m<sup>3</sup>

#### 2.3.3 Monitoring parameters

Water parameters to be monitored include dissolved oxygen (DO), temperature, pH, and NH<sub>3</sub> that are measured both inside and outside cages once per week.

- Temperature (°C) is taken by mercury thermometer with the accuracy of 1<sup>0</sup>C

- DO (mg/l) is monitored by the quick test of Nasalab limited liability company, Thailand
- pH is checked by the quick test of Nasalab limited liability company, Thailand
- NH<sub>3</sub>(mg/l) is checked by the quick test of Nasalab limited liability company, Thailand

Parameters related to fish productivity and health included as follows:

- Fish health status is daily monitored and recording keeping is necessary when the environmental conditions change remarkably like big rains.
- Fish samples are collected randomly (10 fishes/species/cage) once per month to identify the growth rate in length and weight with the scale with the precision of 1g.
- The fish survival rate is monitored by the direct calculation of fish quantity at the model ending time

## 2.4 Preliminary analysis of economic efficiency of models

**Table 1. Comparison of economic efficiency of models**

<i>Total revenue</i>	<i>Total expenditure</i>	<i>Profit</i>
Total production (kg) x unit price	Cage construction fingerlings feed other cost	
Total revenue – total expenditure = profit		

## 2.5 Data treatment methodology

Data is treated by variance analysis (ANOVA) by Minitab 15. Tukey analysis is applied when there is a difference among the models (P=0.05).

## **PART III RESULTS AND DISCUSSIONS**

### **3.1 Cage position**

- Cages were set along with the water currents to reduce the pressure of the water flow
- Cages were installed 20-30cm deep in the bottom mud and 0.5m above the water surface to ensure the safety in fish culture management
- Cages were set near the area where natural fish feed was available. Grass carp culture mainly depended on the available natural seagrass (which is a main feed source for this fish) in the locality. Cages were also installed far from the traffic route and rice fields to limit the impacts of agricultural chemical waste

### **3.2 Fish cage design**

#### ***3.2.1 Fish cage material***

Cages were mainly made of bamboo and net with the mesh size of  $2a=1$ cm. Nets were knit together before being set into the water. Each cage composed of 5 sheets of nets with the length of 80m long and 65cm wide. 30 bamboo trees were chopped into bars which were installed horizontally and vertically, holding two net layers solidly and avoiding the impacts of winds and floods.

#### ***3.2.2 Cage structure***

Cages were made in the rectangular shape with two net layers; there was a net layer on the top with a hole for pouring fish feed into the cage. The cage bottom was fixed by small bamboo poles, installed with a net layer to prevent fish escape.

#### ***3.2.3 Cage size***

The cage size was 9.2 x 5.1 x 1.1 m (length x width x height)

### **3.3 Fingerlings and concerns**

Grass carp and tilapia fingerlings were purchased from the Cu Chanh hatchery in Thua Thien Hue province. Clam fingerlings were bought from the locality. Fingerlings were healthy with no signs of disease and swam actively in herds and upstream strongly. The average weight was 70-100 units/kg for grass carp and 200-300 units/kg for tilapia.

Clams were collected from the wild so fingerlings were purchased by booking local fishermen some days in advance to ensure that we had the sufficient number of fingerlings with the similar size and weight (good size is 25-30g/unit).

### **3.4 Fingerling stocking density**

Stocking density plays a significant role in cage management and impacts a lot on the care-taking process and growth of fishes. If the density is too high, fish will be in short of oxygen and easily get disease, which leads to low productivity.

Stocking densities of three experimental models were as follows:

- Cage 1: 100 % of grass carp, 20units/m<sup>3</sup>
- Cage 2: 70% of grass carp and 30% of tilapia, 20units/m<sup>3</sup>
- Cage 3: 70% of grass carp: 17 grass carps and 6 clams

### 3.5 Water parameters before stocking

In general, water parameters before stocking were consistent and in the optimal range for the cultured species.

**Table2. Water parameters before stocking**

Cages	Water parameters			
	Temperature (°C)	pH	DO (mg/l)	NH <sub>3</sub> (mg/l)
Outside cages	28	6.6	5	0.03
Cage 1	28	6.7	5	0.03
Cage 2	28	6.6	5.5	0.02
Cage 3	28	6.6	5.5	0.02

### 3.6 Management and care taking

#### 3.6.1 Feed

- Feed for grass carp included seaweed which is available in Tam Giang lagoon and has high reproduction ability. The utilization of seaweed as a feed source is a good aspect of this model as feed cost accounts for 50-60% of total production cost.
- Feed for grass carp at the time soon after stocking was fish powder and rice bran powder (1:1). Feed was given 20% of the body weight. During this time, tilapia also consumed the similar feed of grass carp so feed for tilapia was given 20% of its weight.
- Feeding frequency was twice per day at 7-8AM and 4-5PM
- From the 20<sup>th</sup> day, seagrass was given to fishes, and dry shrimps were supplemented in 45 days and after 60 days, they consumed mainly seagrass with 25-30% of body weight.
- Once feed was thoroughly consumed, collect waste in the pond and add new seagrass; feed should be supplemented every two days.
- Hang lime bags at 4 cage corners regularly, 10-15cm deep in the water
- Constantly collect feed waste out of the cage before adding new feed into the cages
- Regularly clean cages, once every two weeks and use brushes for cage cleaning
- Install a protection fence around cages to prevent the hitting from boats travelling to and from. The interval from the cages to the fence is 1-1.5m, which created the water exchange for the cages.
- Within the cage area, bamboo poles were set to prevent fish theft, and a watch house was built when fish grew bigger.

### 3.7 Results of water parameter monitoring

**Table 3. Results of water parameter monitoring**

Cages	Cage 1	Cage 2	Cage 3
	$\frac{\text{Min} \div \text{Max}}{\bar{X}}$	$\frac{\text{Min} \div \text{Max}}{\bar{X}}$	$\frac{\text{Min} \div \text{Max}}{\bar{X}}$
Temperature ( $^{\circ}\text{C}$ )	$\frac{23 \div 32}{28.69}$	$\frac{24 \div 32}{28.81}$	$\frac{23 \div 32}{28.69}$
Temperature in the afternoon ( $^{\circ}\text{C}$ )	$\frac{24 \div 33}{29.94}$	$\frac{25 \div 33}{30}$	$\frac{24 \div 33}{29.94}$
Temperature difference ( $^{\circ}\text{C}$ )	1.3	1.2	1.3
pH in the morning	$\frac{6.5 \div 6.8}{6.62}$	$\frac{6.5 \div 6.9}{6.69}$	$\frac{6.6 \div 7}{6.71}$
pH in the afternoon	$\frac{6.6 \div 7.3}{6.83}$	$\frac{6.7 \div 7.3}{6.88}$	$\frac{6.7 \div 7.2}{6.88}$
pH difference	0.2	0.2	0.2
DO in the morning (mg/l)	$\frac{3.5 \div 6}{4.75}$	$\frac{3.5 \div 5.5}{4.53}$	$\frac{4 \div 5.5}{4.91}$
DO in the afternoon (mg/l)	$\frac{5 \div 7}{5.54}$	$\frac{4 \div 6.5}{5.34}$	$\frac{5 \div 6.5}{5.72}$
NH <sub>3</sub> in the morning (mg/l)	$\frac{0.15 \div 0.4}{0.28}$	$\frac{0.2 \div 0.4}{0.3}$	$\frac{0.1 \div 0.3}{0.25}$
NH <sub>3</sub> in afternoon (mg/l)	$\frac{0.15 \div 0.4}{0.29}$	$\frac{0.25 \div 0.4}{0.33}$	$\frac{0.15 \div 0.35}{0.26}$

#### 3.7.1 Temperature

The temperature in each experimental model was not much different. The average temperature of models ranged from 29.31 $^{\circ}\text{C}$  (models 1 and 3) to 29.41 $^{\circ}\text{C}$  (model 2). The difference in temperature in the morning and afternoon was also unremarkable – 1.3 in the models 1 and 3 and 1.2 in model 2. These differences did not impact the growth and development of culture targets.

During the experiment period, the temperature was high up to 29 $^{\circ}\text{C}$  on average. However, in the lagoon, thanks to the depth of the lagoon (around 1-1.5m), fish can move to lower levels (with lower temperature) when the temperature is high.

#### 3.7.2 pH

pH of experimental models was similar. In the morning, the average pH levels were 6.62, 6.69, and 6.71 for model 1, 2, and 3, respectively. Although lime bags were hung in four corners of the cages, the pH was not high. However, for freshwater fish species, such pH was suitable enough for their growth and development.

### 3.7.3 DO

DO of experimental models showed unremarkable difference with the cage 3 with slightly higher DO level.

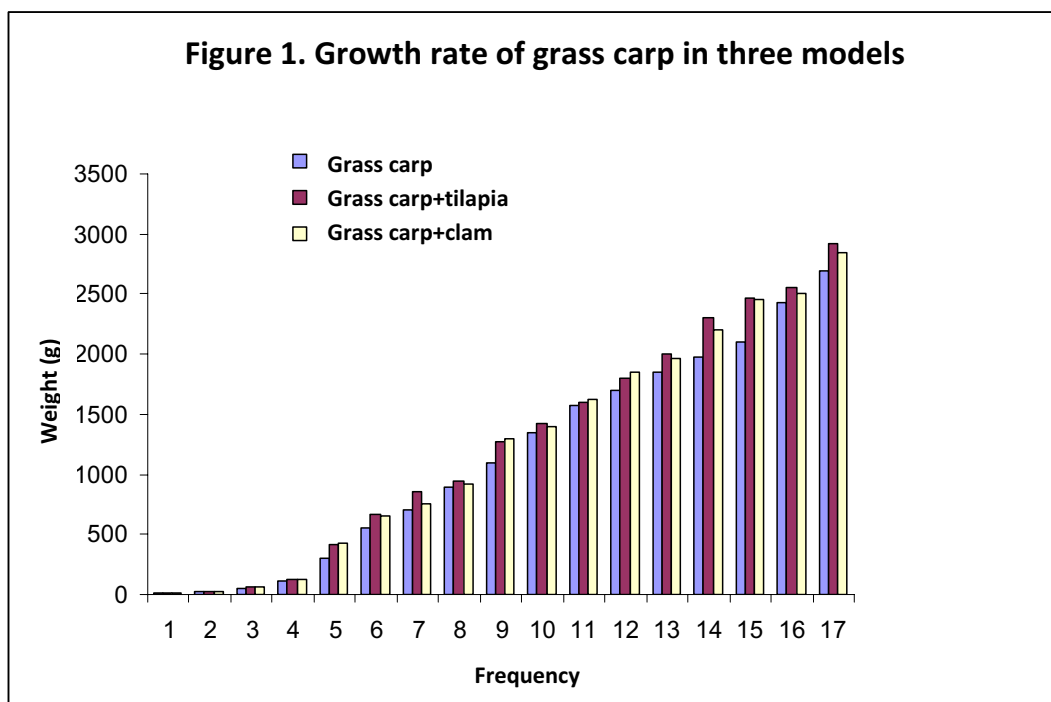
### 3.7.4 NH<sub>3</sub>

NH<sub>3</sub> of experimental models showed unremarkable difference with the cage 3 with slightly lower NH<sub>3</sub> level.

## 3.8 Monitoring fish growth rate

### 3.8.1 Growth rate of grass carp

After 16 months of culture, the average weight of grass carp reached 2,700; 2,840 and 2,920g for the monoculture of grass carp, polyculture of grass carp and clam and polyculture of grass carp and tilapia, respectively (Figure 1). The grass carp and tilapia polyculture model generated the highest fish growth rate; ranking the second was the grass carp and clam polyculture model, and the last was grass carp monoculture.



### 3.8.2 Growth rate of tilapia and clam

After 15 culture months, tilapia reached 240 g/unit on average, so the growth rate of tilapia was slow. This is because tilapia was not provided with sufficient supplementary feed, and the major objective of the model was to use tilapia for consuming discharge from the grass carp and help reduce the cage bottom organic pollution. Similarly, clam also had the slow growth rate at 77 g/unit on average.

**Table 4. Growth rates of clam and tilapia**

<i>Measurement times</i>	<i>Weight of tilapia (g)</i>	<i>Weight of clam (g)</i>
1	1.5	40
2	8	42
3	12	45
4	20	45
5	34	47
6	46	50
7	60	50
8	76	52
9	90	55
10	115	57
11	136	58
12	150	60
13	170	64
14	185	67
15	210	71
16	225	73
17	240	77

### 3.9 Survival rate of some cultured species

During the culture process, fishes were gradually harvested in three times. The holding time was shortened as much as possible to avoid fish damage so it was impossible to count exactly the number of fishes. Therefore, the reported survival rate is only relative.

**Table 5. Survival rate of cultured species**

Species		Survival rate (%)
Grass carp	Cage 1	18
	Cage 2	24
	Cage 3	20
Tilapia	Cage 2	70
Clam	Cage 3	12

### 3.10 Primarily economic accounting

Fingerling cost:

*Grass carp:* VND28,000  
*Tilapia:* VND20,000  
*Clam:* VND3,000

*Total revenue:*  
*Model 1:* VND13,608,000  
*Model 2:* VND14,743,680  
*Model 3:* VND11,141,116

**Table 6. Cost of three models (million VND)**

<i>Item</i>	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>
Cage construction material	1	1	1
Fingerlings	1	0.85	0.73
Feed	0.6	0.8	0.6
Others	0.5	0.5	0.5
<b>Total expenditure</b>	3.1	3.15	2.83
<b>Total revenue</b>	13.6	14.7	11.1
<b>Profit</b>	10.5	11.6	8.2

Notes: in the preliminary accounting, the labor cost has been excluded. And feed cost only concerns the first two months when fish fingerlings were still small.

## **PART IV. CONCLUSIONS AND PROPOSALS**

### **4.1 Conclusion**

All three models showed good results. Although the water environmental parameters were not significantly different from other models, the polyculture of grass carp and tilapia experienced thinner mud bottom layer, and grass carp did not float their heads in the morning. In the monoculture model, the mud bottom layer was thicker, and grass carps usually floated the heads in the early morning. The growth rate of grass carp stocked with tilapia was the highest, and that of the monoculture model was the lowest.

### **4.2 Proposals**

The beneficiary continues to conduct the model. If the model is duplicated with large cages under the support of the project, fish will enjoy more comfortable living conditions.

## ANNEX

### SOME PICTURES ILLUSTRATING THE IMPLEMENTATION PROCESS



Fig 1. Cage material preparation



Fig 2. Cage installation in the lagoon



Fig 3. Completed cage



Fig 4. Checking water parameters