

## The Current Status of Grouper Culture Operations and Cost Analysis of the Industry in Taiwan

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### Abstract

The main objective of this study is to evaluate the different operations sector and cost information in Taiwan grouper culture industry through survey. Results showed that, the most important cultivable species in Taiwan was orange-spotted grouper (*Epinephelus coioides*). Further, the farm size for grouper culture ranged between 1 to 5 hectares. The farmer had employed three or less farm staffs throughout the culture period. Moreover, the harvested grouper were mainly sold to wholesaler and to some regular customers. Our survey emphasized that, the major cost of Taiwan's grouper culture industry are on fry (25-46%), feed (25-35%), and labor (15-31%). Additionally, farmers opined that, the development of associated measures of farming cost subsidies and disease control measures are required to increase their profit margin which can promote grouper culture industry to sustainable development.

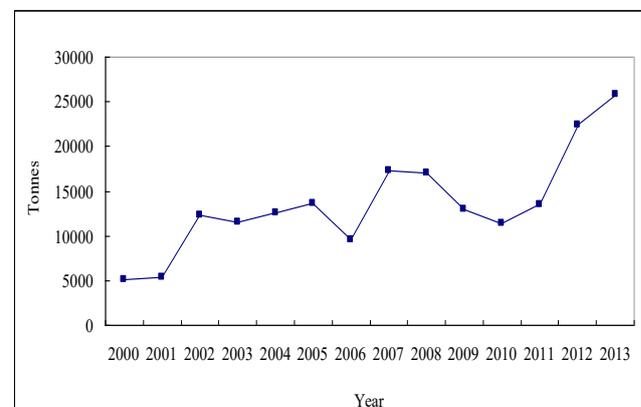
**Keywords:** Aquaculture operation; Cost; Survey; Grouper; Taiwan

### Introduction

Among the various marine finfish species, the grouper (*Epinephelus* spp.) is one of the popular and high economic value species in global aquaculture industry. In Taiwan, since 1970's the progressive achievement has been made in grouper farming with the support on the economic development, finfish culture technology support, government policy, market demand [1-4]. Among the different species of grouper, the main cultivable grouper species are orange-spotted grouper (*Epinephelus coioides*), giant grouper (*Epinephelus lanceolatus*), greasy grouper (*Epinephelus malabaricus*), coral grouper (*Plectropomus leopardus*), tiger grouper (*Epinephelus fuscoguttatus*) and other hybrid grouper [5-6].

The possible reason for high demand in grouper is mainly achieved due to the market from China and successful artificial propagation. During the last decade Taiwan grouper production has progressed and reached high production (Figure

1). The annual total production of Taiwan grouper aquaculture is 25,749 metric tons in 2013[7].



**Figure 1.** Production trends of grouper culture in the past 13 years (2001-2013).

Source: [7]

The success in aquaculture industry depends on a thorough combination of biological (fry, bloodstock, water quality, and other) and economic (rent, labor, infrastructure, and other) factors. Further, the operating costs during farming are the most important factors which affect profit to the farmers. In addition, various factors such as stocking density, price, competition of fishery production, survival rate, labor cost, farming technique and feed cost may affect the industry [6, 8- 13].

Currently, grouper is one of the main aquaculture marine fish species in Taiwan. However, there is a lack of study on operating cost analysis in different grouper species and interrelated sectors according to the recent literature published on grouper aquaculture. Against this background, we conducted farm survey throughout Taiwan with the following objectives to focus on the types of grouper aquaculture practices and the main grouper species farmed in Taiwan to gain insights and to better understand the current business situation and operating costs of the grouper culture industry.

## Materials and Methods

### Questionnaire design

Questionnaire was designed based on the research method and related academic literatures. Field study was conducted in Taiwan Island area to understand the grouper industry's operating status.

A purposive sampling technique was used to collect the data by questionnaire which was conducted during January 2014 to December 2014 in southwestern Taiwan. The fieldwork was carried out using the questionnaire in the county namely Pingtung, Kaohsiung, and Tainan (Figure 2). The main reason to select these counties are due to their maximum aquaculture production in grouper within Taiwan [7]. According to Fisheries Agency [7] surveys, these counties have a total of around 2,000 farms which are involved in producing different species of grouper. Further, the overall production from these counties accounted for 90 % of the total grouper production within Taiwan. Before distributing the formal questionnaire, it was first proofread by related scholars in order to confirm accurate wordings or preventing possible errors. In this study a total of 75 questionnaires were distributed. Accordingly, if there was any doubt over an incomplete questionnaire survey, the respondents were contacted directly for clarification to avoid deviation from the standard results. Since 75 questionnaires were valid, the effective return ratio was 100%.

Apart from basic content in the questionnaire survey, the operating status of fish farms, marketing methods, and operating costs were also analyzed.



**Figure 2.** Location of main Taiwan grouper farming areas.

### Statistical analyses

After retrieved, the questionnaire data was subjected to encoding and archiving. The software package used in this study was PASW (Predictive Analytics SoftWare, IBM, USA) 18.0 for questionnaire reliability analysis, and subsequent statistical analysis.

#### Percentile method (Frequency distribution)

In this study, frequency distribution statistics were used to describe the percentage distribution of the sample structure mainly for the purpose of understanding the consistency of the questionnaire responded.

#### Reliability test

Using the Cronbach  $\alpha$  coefficient as a benchmark, a total table  $\alpha$  value greater than 0.80 shows high reliability; if between 0.70 and 0.80 the reliability is acceptable; and if the value is less than 0.70 this shows a low reliability. On a subscale, the  $\alpha$  value should be greater than 0.70; and if greater than 0.80 this indicates a high degree of reliability. If the  $\alpha$  value is from 0.60 to 0.70, it is still within the acceptable range [14].

After PASW 18.0 questionnaire reliability analysis, the questionnaire survey's  $\alpha$  value was 0.84. The questionnaires demonstrate high reliability. The fish farms operational status reliability  $\alpha$  value was 0.84, and the  $\alpha$  value of the questionnaire's reliability for marketing was 0.82.

## Validity evaluation

The validity of questionnaires is assessed to verify that the contents of the questionnaire can reflect the research theme [15]. The questionnaire contents were amended by the opinions of academics in this field after the pre-test, so the results can clearly expressed the current operations in the aquaculture industry.

## Nonparametric method

The nonparametric Wilcoxon signed rank test [16] was used to determine whether there were significant differences among items in the questionnaire. The objective is to analyze respondents under different variables standards and to see whether there are any significant differences between the variables of each question.

## Net private profitability

The net private profitability (NPP) was used to investigate the main grouper aquaculture species in Taiwan. This measures the returns from aquaculture activities, which is defined as total revenue minus total operating cost [17]. It indicates the profitability of farm when devoted to production.

The net private profitability was calculated using the formula [17]:

$$NPP_i = \text{Domestic market price-Tradable factors at market Price-non-tradable factors at market price}$$

Accordingly, when  $NPP_i > 0$ , the producers make profits from the production;  $NPP_i = 0$ , the production is at breakeven point; and  $NPP_i < 0$ , the producers face a deficit in the production.

Since the expenses on inputs are required in calculating the NPP, the categories of inputs used in production and their costs are discussed first.

## Results

### Basic information of respondents

The distribution of the respondents' basic data was listed in Table 1 which included sectors and amount of cultured species. Most respondents were growout farm owner and all the farms were located in Taiwan (including coastal and inland areas). Subsequently, within the various grouper species, more farmers raised orange-spotted grouper, which accounted for 77.3 %. After orange-spotted grouper, the less farmed species were giant grouper and hybrid grouper (hybridization from giant grouper and tiger grouper), accounted for 13.3 % and 9.3 %, respectively.

Question	Options	Sample no.	%
Sectors	Fry propagation	25	33.3
	Growout farms	50	66.7
Cultured species	Orange-spotted grouper	58	77.3
	Giant grouper	10	13.3
	Hybrid grouper	7	9.3

**Table 1.** Basic information of the responders.

### Operational Status

The overview of the operational status was listed in Table 2 including farm acreage, number of staffs (including operators), and water sources.

Results from the Table 2 shows that most farmers had farming areas range under 5 hectares. Majority of the fish farms had hired three or less farm staff and accounted for 78.6 % of the total surveyed. For their inland grouper farming, most of the farm owners extracted groundwater or used seawater with only 13.3 % of the farm owners bought seawater as water supply.

Question	Options	Sample no.	%	Wilcoxon signed ranks test
Farm size	Under 1 hectare	35	47.7	
	1 to 5 hectares	30	40.0	
	5 to 10 hectares	10	13.3	
Number of labors	1 person	7	9.3	
	2 people	36	48.0	
	3 people	16	21.3	
	4 people	11	14.7	
	5 people or over	5	6.7	
Water source (Multiple choice)	Groundwater	55	73.3	0.02*
	Seawater	65	86.7	0.02*
	River or lake	5	6.7	
	Buying seawater	10	13.3	

\* $P < 0.05$  \*\*  $P < 0.01$  \*\*\*  $P < 0.001$

**Table 2.** Operational status sample distribution.

### Marketing methods

The status of marketing was listed in Table 3 which included sales targets and opinions on the future direction of operations.

The main customer were through the wholesalers (including broker), which accounted for 92 % of all respondents' feed-

back, with only 4 % of the respondents' having direct contact with the buyer. Furthermore, the sale to regular customers accounted for 73 %.

In the perception of future business, 69.3 % of the farmer opined that it is hard to find new customers. With regard to 81 % of the respondents' said that it was increasingly difficult to operate; however, 92 % of the respondent did not considered to change jobs. The reasons of difficulties for farmers to manage farm are mainly due to the increase of costs in production and disease control which accounted for 68.0 % and 70.7 % of the respondents, respectively.

Question	Options	Sample no.	%	Wilcoxon signed ranks test
<b>The main customer</b>	Processor	1	1.3	0.001***
	Wholesaler	69	92.0	
	Restaurant	1	1.3	
	Exporter	1	1.3	
	Buyer	3	4.0	
<b>Regular customers or new customers?</b>	Regular	55	73.0	
	New	20	27.0	
<b>Are new customers hard to find?</b>	Yes	57	69.3	
	No	18	30.7	
<b>Are operations increasingly difficult?</b>	Yes	61	81.0	0.02*
	No	14	19.0	
<b>Have you considered changing jobs?</b>	Yes	6	8.0	0.001***
	No	69	92.0	
<b>Reasons for difficulties (multiple choice)</b>	Lack of specific industrial policy	17	28.0	
	Operating costs are too high	51	68.0	
	Disease problems	53	70.7	
	Competitiveness of imported products	23	30.1	
	Price instability	19	25.3	

\* $P < 0.05$  \*\*  $P < 0.01$  \*\*\*  $P < 0.001$

**Table 3.** Marketing methods sample distribution.

The Wilcoxon signed ranks test results are presented in Table 2 and Table 3. The significant differences were water source, main customer, and future operations.

### Operating cost analysis

The general operating cost analysis was shown in Table 4. As the respondents were breeding different grouper species, the breeding scale and operating systems varied, so the two most important farmed species on their average proportional costs were listed as orange-spotted grouper and giant grouper, furthermore, contained fry farm. This includes fixed costs and variable costs, which includes: fry, feed, utilities, administrative costs (including rent), labor costs and depreciation.

Items	Fry propagation	Growout farm	
		Orange-spotted grouper	Giant grouper
Fry/fingerling	25%	46%	42%
Feed and fertilizer	32%	25%	35%
Utilities	3%	1%	2%
Administrative costs, <sup>a</sup>	4%	1%	3%
Labor	31%	22%	15%
Depreciation	5%	5%	3%

<sup>a</sup> Administrative costs include equipment, medicine, and rent.

**Table 4.** Annual average cost analysis.

The main costs identified in grouper farming were on fry, feed and labor. The grouper hatchery had the high costs with respect to feed and labor and both constituted more than 30 % of the cost. In general, expenditure of grow-out farmers was found high when buying fry with over 40 % of the total costs.

### Net private profitability of grouper culture

The NPP analysis was shown in Table 5. NPP is a major concern for the farm owners to make decisions on production scale and management. Therefore, the NPP of culturing orange-spotted grouper was compared with that of giant grouper to investigate their difference in profitability. Furthermore, because of the prevailing warm weather conditions in southwestern Taiwan, grouper hatcheries could produce fry throughout the year. However, private firms opined that, sale of fry was limited due to the unstable in the market chain amongst grouper industry. Hence, profitability in grouper hatcheries was unstable. Also, grouper fry which were marketed with the assistance of wholesaler, the market prices were uncertain. Therefore, it was not applicable to include it in Table 5.

Species	Domestic market prices, <sup>a</sup> (US\$/kg)	Tradable factors at market Price, <sup>b</sup> (US\$/kg)	Non-tradable factors at market price, <sup>c</sup> (US\$/kg)	NPP, <sup>d</sup> (US\$/kg)
Orange-spotted grouper	12.78	7.77	1.57	3.44
Giant grouper	10.17	6.92	1.43	1.82

$$NPP_i = a - b - c$$

When  $NPP_i > 0$ , the producers make profits from the production;  $NPP_i = 0$ , the production is at breakeven point; and  $NPP_i < 0$ , the producers face a deficit in the production.

**Table 5.** Net private profitability analysis.

## Discussion

From previous studies [18-19], the national average number of staff on aquaculture farms was 2.2 people with the farm size of all type of fish farming systems mainly concentrating on the range of 0.5 to 3 hectares in Taiwan. In our present study, 87.7 % of total farmers surveyed held a farm size less than 5 hectares. In addition, 78.6 % of total farmers surveyed hired less than three staffs. Our results revealed that there was no significant change in grouper culture industry comparing to other previous studies on average farm size and numbers of staff hired in Taiwan [18-19].

Our survey showed that the main costs in grouper farming were on fry, feed and labor in Taiwan. Similarly, Bombeo-Tuburan *et al.* [20] demonstrated that the cost of grouper fry and feeds represents 88–89 % of the total cost in Philippine grouper farming. Later a study of Indonesian and Philippine grouper industry by Pomeroy *et al.* [21] concluded that fry, feed and labor accounted for 61 and 74 % of the total production cost in tiger grouper and humpback grouper (*Cromileptes altivelis*), respectively. Also, Hu [5] showed that cost of fry, feed and labor accounted for over 65 % in Taiwanese greasy grouper culture. A survey in Indonesia grouper farming by Afero *et al.* [22] showed that major variable costs for grouper culture industry were mainly on fry, feed and labor accounting for more than 65 % of the total production cost. Furthermore, Petersen *et al.*, [23] presented that feed, fry and labor were main cost in Vietnam grouper culture industry.

The grouper culture industry in Taiwan consisted of two interrelated sectors: grouper hatchery (fry propagation) and grow-out productions. For the expenditure of grouper hatcheries, the highest cost was on feed and labor, and both of them accounted for more than 30 % of the total costs. However, the highest cost of grow-out farming was on grouper fry accounting for 42-46 % of the total costs in our present study. Thus, the grow-out production relies heavily on the supply and price of grouper fry regarding to possible profit in Taiwan.

Additionally, we observed that orange-spotted grouper farm used intensive systems compared to other species of grouper farming. Therefore, orange spotted grouper farming demands many labor to carry out the culture units which had contributed maximum towards labor costs. The feed cost during culture was found to be less from orange spotted grouper compared to other species due to the preferable market size hence, the farmer could reduce their feed cost during culture period. Further, considering market demand, giant grouper fry farms significantly increased during last 3 years, therefore the price of giant grouper fry got decreased.

The lowest cost of grouper culture industry in Taiwan was on the utility, the possible reason may be due to the availability of abundant groundwater and seawater resource around

most grouper farm areas together with a cheaper supply of electricity.

Based on the results of NPP analysis, the culturing of orange-spotted grouper and giant grouper could be considered as high profitable businesses. From the viewpoint of farmer, the profitability of raising orange-spotted grouper was higher than that of raising other grouper species since a short culture period was needed together with stable fry supply for the former. Notably, problems due to disease outbreaks were found to be a major influencing factor for profit in Taiwan grouper industry; therefore, it was severely impacted the production of the grouper. Moreover, in order to maximize the profit, the farmer has to consider stocking the disease resistance species namely, hybrid grouper.

## Conclusion

Currently, Taiwanese grouper farmers focused mainly on the raising of orange-spotted grouper. The majority of the farm owner held small-scale farm ranging from 1 to 5 hectares and hired three or less staffs. The harvested grouper were mainly sold to wholesaler and regular customers. The main operating costs in farm production are on fry, feed and labor. Based on the present results, the future policies on grouper culture should be framed and could be emphasized on the associated measures of farming cost subsidies and to mitigate the disease problems in the system which altogether can benefit the farmers leading to a formidable sustainable development of grouper culture industry in Taiwan.

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