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The status of aquaculture operations and cost analysis in Hondurans tilapia industry

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The main objective of this study was to understand the current production situation and operating costs of tilapia (*Oreochromis spp*) culture in Honduras through survey. Results indicated that, in 2014, the four most important farm levels in tilapia farmed. Furthermore, farm size ranged from 1 to 5 hectares, which employed five or less farm workers throughout the production cycle by earthen ponds and cage in monoculture systems. Fish fry was mostly purchased from others. The use of commercial feed was significantly higher than natural bait or homemade feed. Length of the culture cycle was less than six months. In addition, the produced fish by the farmers were directly contacted by the buyer and to some regular customers. Therefore, most farmers are not considering to change their jobs. The survey found that, the major costs of tilapia aquaculture production are fry, feed and labor. Altogether, the results from this study will benefit to frame an appropriate fishery policy towards the development of fish farming activities and attain sustainable tilapia culture development in Honduras. Further research is required for the development and promotion of more efficient and economically viable strategies for tilapia farming businesses to target key internal markets. Further research is required for the development and promotion of more efficient and economically viable strategies for Hondurans tilapia businesses to target markets.

Key words: Tilapia, aquaculture operation cost, Honduras, survey, aquaculture

INTRODUCTION

Accumulated evidence suggests that due to economic development and environmental factors, tilapia farming have been significantly prosperous in Honduras since the 1970s (Teichert-Coddington and Green, 1993; Hernández-Rodríguez *et al*., 2001; Matamoros, 2010; Wurmann, 2011; Bondie and Wolf, 2013). It is noteworthy that the aquaculture industry in Honduras is still popular because of the demand of export from United States (Figure 1). The main aquaculture production species are tilapia (*Oreochromis spp*) and white shrimp (*Litopenaeus Vannamei*) (Figure 2); Furthermore, Hondurans tilapia industry is largest fresh tilapia fillets producer in United States seafood market (Table 1).

The aquaculture industry is a combination of biological factors (such as fry, bloodstock, and water quality) and economic (such as rent, labor, and infrastructure) factors (Stickney, 2005; Bunting, 2013). The operating costs to farm fish are the most important factors affecting farmers' profits.

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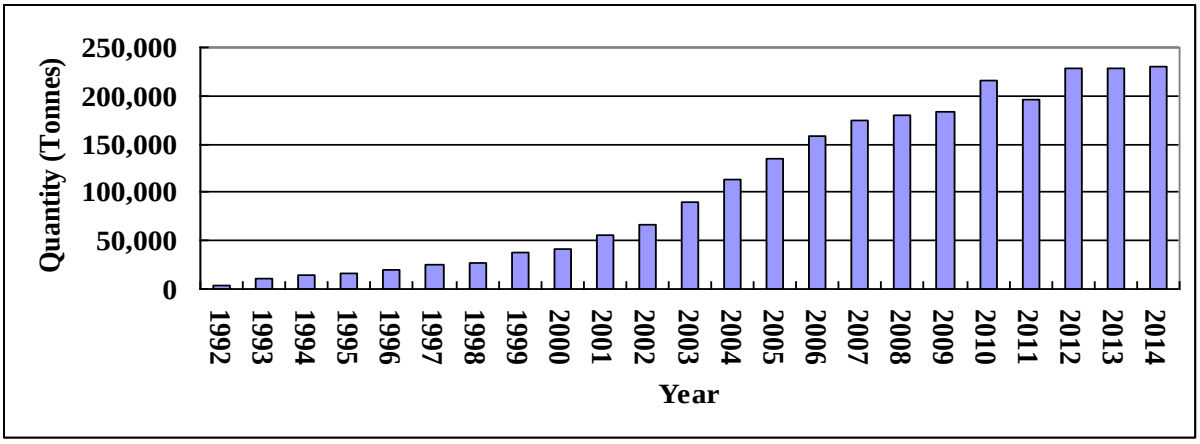

Figure 1. Tilapia imports into the USA, 1992-2014
Source: National Marine Fisheries Service, USA, 2015

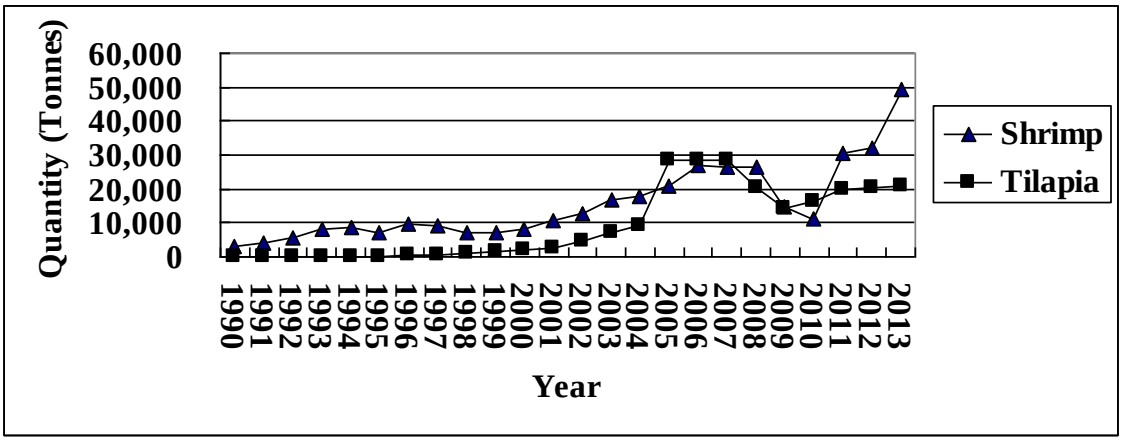

Figure 2. The trend of Hondurans shrimp and tilapia aquaculture production in recent decades (1990–2013).
Source: FAO (The Food and Agriculture Organization of the United Nations), 2015

Table 1: Sources of USA fresh tilapia fillets imports in 2014

Product	Country	Value (1,000 U.S. dollars)
Fresh Fillets	Honduras	78,245
	Costa Rica	40,364
	Colombia	33,186
	Mexico	23,801
	Ecuador	14,342
	Taiwan	1,546
	El Salvador	598
	Other countries	4,466

Source: USDA (The United States Department of Agriculture), 2015

The fish farming industry is also affected by many other factors such as stocking density, price, fishery production, survival rate, labor cost, farming technique, and feed costs (Lee *et al*., 2003; Melià and Gatto, 2005; Asche and Khatun, 2006; Hartley, 2007; Miao *et al*., 2009; Tisdell, 2012).

The production cost in the aquaculture farming industry can be divided into fixed costs and variable costs (Shang, 1990; Miao and Tang, 2002). The fixed cost covers the expenses of renting land, labor, insurance, interest, and depreciation costs. The variable cost covers the cost of fry, feed, drugs, utilities, maintenance, equipment, pond preparation, transportation and part-time labor wages (Liao, 2008; Huang *et al*., 2011).

Although Honduras is one of the main tilapia producers in the global aquaculture industry, according to the recent

Table 2: Basic Information of the Respondents

Question	Options	Sample no.	%
Position	Farmer	57	91.9
	Marketing operators	5	8.1
Monoculture	Yes	48	77.4
	No	14	22.6
Culture species in polyculture	Freshwater fish	5	35.7
	Seawater shrimp	9	64.3

literature on tilapia aquaculture there is a lack of operations cost analysis study in different farm levels and interrelated sectors in Honduras. Against this background, we conducted a farm survey throughout Honduras with the following objectives to focus on the types of tilapia aquaculture practices Honduras to gain insights and to better understand the current business situation and operating costs of the tilapia culture.

MATERIALS AND METHODS

Questionnaire Design

A questionnaire was designed based on the research method and related academic literature, and a field study was conducted in Honduras to understand the operating status in the tilapia aquaculture industry.

A purposive sampling technique was used to select which subjects took the questionnaire surveys that were conducted from January 2014 until December 2014. Before distributing the formal questionnaire, it was first proofread by related scholars in order to confirm accurate wordings or prevention of possible errors.

Field study was conducted in Honduras to understand the aquaculture industry's operating status through Taiwan ICDF (International Cooperation and Development Fund) assistance. The fieldwork was carried out mainly in the Comayagua Department, Yoro Department, Olancho Department, Lempira Department, and Cortes Department. These Departments were chosen because they are the major producer of tilapia within the country, with a well developed aquaculture industry (Taiwan ICDF, 2013).

In this study a total of 62 questionnaires were distributed. 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 all 62 questionnaires were valid, the effective return ratio was 100 %.

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

Statistical Analyses

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

a. 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 responses.

b. Reliability Test

Using the Cronbach α coefficient as a benchmark, a total table α value greater than 0.80 shows high reliability; if the value is between 0.70 and 0.80 the reliability is acceptable; and a value of less than 0.70 shows a low reliability. On a subscale, the α value should be greater than 0.70; and if the value is greater than 0.80 then this indicates a high degree of reliability. If the α value is between 0.60 to 0.70, this is still within the acceptable range (Devellis, 1991).

After PASW 18.0 questionnaire reliability analysis, the questionnaire survey's α value was 0.82; the questionnaires demonstrated high reliability. The fish farms operational status reliability α value was 0.82, and the α value of the questionnaire's reliability for marketing was 0.80.

c. Validity Evaluation

The validity of the questionnaire was assessed to verify whether the contents of the questionnaire can reflect the research theme (Lynn, 1986). The questionnaire contents were amended in accordance with the opinions of academics in this field after the pre-test, so the results could clearly express the current operations in the aquaculture industry.

d. Nonparametric Method

The nonparametric Wilcoxon signed rank test (Conover and Iman, 1981) 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.

e. Net Private Profitability

The net private profitability (NPP) was used to investigate the Hondurans tilapia industry. This measures the returns from aquaculture activities, which is defined as total revenue minus total operating cost (Lee *et al*., 2003);

Table 3. Operational Status Sample Distribution

Question	Options	Sample no.	%	Wilcoxon signed ranks test
Farm size	Under 5 hectares	34	54.8	
	5 to 10 hectares	15	24.2	
	11 to 15 hectares	5	8.1	
	16 to 20 hectares	5	8.1	
	21 to 25 hectares	3	4.8	
Number of labors	1 person	2	3.2	
	1 to 5 persons	46	74.2	0.039*
	6 to 10 persons	6	9.7	
	11 to 15 persons	5	8.1	
	16 to 20 persons	3	4.8	
Infrastructure (multiple choice)	Earth pond	60	96.8	0.001*
	Tank	7	11.3	
	Cage	20	32.3	
Fry source	Having	29	46.8	
	Buying	33	53.2	
Culture length	Under 6 months	54	87.1	0.01*
	6 months to 1 year	7	11.3	
	1 to 1.5 years	1	1.6	
Type of feed	Commercial feed	58	93.5	0.001 ***
	Home made	1	1.6	
	Natural feed	3	4.8	
Total annual production	10 to 20 tonnes	34	54.8	
	21 to 30 tonnes	15	24.2	
	31 to 40 tonnes	2	3.2	
	41 to 50 tonnes	2	3.2	
	50 to 60 tonnes	2	3.2	
	Over 200 tonnes	7	11.3	

*P<0.05 ** P<0.01 *** P<0.001

it indicates the profitability of production farms.

Since the expenses for inputs are required in calculating the NPP, the categories of inputs used in production and their costs are discussed first. In general, inputs applied to production activities can be divided into two factors: tradable and non-tradable. Tradable factors are those that are either exported to earn foreign exchange, or used domestically to save foreign exchange. Non-tradable factors represent those inputs that cannot be traded and can only be used domestically.

RESULTS

Basic Information of Respondents

The distribution of the respondents' basic data is listed in Table 2.

Most respondents were farmer and all the farms were located in Honduras. Subsequently with regard to farming products, 22.6 % of the respondents produced more than two kinds of species by using either rotational or polyculture methods. The majority of polyculture species were freshwater fish and marine shrimp, mainly farming white shrimp and jaguar cichlid (*Parachromis managuensis*) with accounted for 64.3% and 35.7% respectively.

Operational Status

Results from the Table 3 shows that most farmers had farming areas ranging from less than 5 hectares, and 79.0 % of total number of farmers had a farming area of less than 10 hectares (Table 3). The majority of the fish farms hired one to five laborers, which accounted for 74.2 % of the total surveyed. The main facilities used in aquaculture system were earthen ponds, and cage. Fish fry was mostly purchased from other hatcheries. Also, most respondent's culture length was under 6 months, accounted for 87.1%. The use of commercial feed was significantly higher than the natural bait or homemade feed. Most respondent were produced 10 to 20 metric tons of fish products, accounted for 54.8%.

Marketing Methods

Afterwards the harvested yield was sold live directly, which accounted for 80.6 %. The main targeted customers were buyer, which accounted for 77.4 % of all respondents' feedback, with only 9.7 % of the respondents having direct contact with the exporter. Among all of the results, the sales to regular customers

Table 4. Marketing Methods Sample Distribution

Question	Options	Sample no.	%	Wilcoxon signed ranks test
Processing after harvest	Sold live	50	80.6	0.031*
	Self-processed	12	19.4	
The main customer	Processor	4	6.5	
	Wholesaler	2	3.2	
	Restaurant	2	3.2	
	Exporter	6	9.7	
	Buyer	48	77.4	0.036*
Regular customers or new customers?	Regular	57	91.9	0.001***
	New	5	8.1	
Are new customers hard to find?	Yes	6	9.7	
	No	56	90.3	0.01*
Are operations increasingly difficult?	Yes	6	9.7	
	No	56	90.3	0.01*
Have you considered changing jobs?	Yes	8	12.9	
	No	54	87.1	0.01*
Reasons for difficulties (multiple choice)	Lack of guidance	25	40.3	
	Operating costs are too high	39	62.9	0.039*
	Lack of specific industrial policy	34	54.8	0.039*
	Lack of development planning	23	37.1	
	Poor farm location	5	8.1	
	Disease problems	8	12.9	
	Competitiveness of imported products	1	1.6	

*P<0.05 ** P<0.01 *** P<0.001

accounted for 91.9 %.

In the perception of future operations, only 9.7 % of the farms surveyed were of the opinion that it is hard to find new customers. Also 9.7 % of the respondents said that it was increasingly difficult to operate; therefore, 87.1 % of respondents did not consider changing jobs. The main difficulties in managing a farm are rise of operating costs and lack of specific industrial policy, which accounted for 62.9 % and 54.8 %, respectively.

The Wilcoxon signed ranks test results are presented in Table 3 and Table 4. The significant difference items included were infrastructure, feed type, number of labors, culture length, processing after harvest, main customer, and future operations.

Operating Cost Analysis

The general operating cost analysis is shown in Table 5. As the respondents were managed different scale, the farm scale and operating systems varied, so the four farm scale and their average proportional costs were listed as small, medium, Industrial scale and polyculture farm. This includes fixed costs and variable costs, which includes: fry, feed, utilities, administrative costs, labor costs, harvesting and marketing cost, and depreciation.

The main costs identified in general tilapia farming systems were fry (5.29 to 8.81%), feed (63.76 to 78.33%), and labor (4.51 to 10.98%).

Net Private Profitability of tilapia aquaculture in Honduras

The net private profitability (NPP) analysis is shown in Table 6. NPP is a major concern for farmers' production and in making further decisions.

Therefore, the NPPs of each tilapia farming systems were compared to investigate their producers' profitability. Based on the NPP analysis results, the industrial scale farms are considered as highly profitable since industrial scale farmers sold that fresh fillet is the high price product.

Table 5. Annual Average Cost Analysis

Items	Small scale (Less than 5 hectare)	Medium scale (Over than 5 hectare)	Industrial scale (For export market)	Polyculture
Fry/fingerling	6.24%	8.81%	5.29%	7.24%
Feed	78.33%	64.36%	63.76%	59.88%
Fertilizer	0.80%	0.65%	0.36%	0.50%
Labor	4.51%	8.66%	10.98%	0.83%
Harvesting and marketing cost	1.23%	4.14%	5.11%	2.48%
Utilities	0.50%	3.95%	4.06%	15.64%
Administrative costs, [a]	2.29%	3.91%	3.81%	0.99%
Loans and interest	0.18%	2.07%	0.76%	0.21%
Depreciation	5.92%	6.44%	5.87%	12.24%

[a] Administrative costs include equipment, medicine, and rent.

Table 6. Net Private Profitability Analysis

Farm scale	Domestic market prices, [a] (US$/kg)	Domestic market prices of tradable, [b] (US$/kg)	Domestic market prices of non-tradable, [c] (US$/kg)	NPP, (US$/kg)
Small scale	2.20	0.87	0.23	1.10
Medium scale	2.86	0.84	0.46	1.56
Industrial scale	5.54	0.76	1.77	3.01
Polyculture	2.18	0.68	0.45	1.05

Net private profitability (NPP) = a-b-c; NPP>0, the producers make profits from the production; NPP= 0, the production is at breakeven point; NPP < 0, the producers face a deficit in the production.

Feed was a major source of tradable factors because Hondurans aquaculture industry depends on import feed.

DISCUSSION

Green *et al.*, (1994) and Molnar *et al.*, (1996) concluded that Honduran small tilapia farms use semi-intensive systems and industrial tilapia farm are using intensive systems. Fish ponds are rarely integrated with animal husbandry activities. Ponds are uncommon in the countryside and fish culture is not widely practiced. Fish farmers are not skilled in the art of fish culture. Pellet feeds are available. However feeds are expensive and the quality is suspect. The cage is imported, expensive and not widely available. Length of the culture cycle was five months.

Also, Morales (2001) and Meyer *et al*., (2007) demonstrated that the Hondurans tilapia fry source were mainly decided by the government and fry farmer assistance.

Matamoros (2010) showed that the most aquaculture systems were semi-intensive farms, monoculture by earthen ponds and cage in Hondurans tilapia farming, and all types of farming areas are mainly concentrated in the range of 1 to 5 ha. The farmer most used commercial feed. However, the Hondurans tilapia industry was the lack of fry and fingerlings source. An investigation by the Taiwan ICDF in recent years did not show any significant change (Taiwan ICDF, 2013).

In our study, we showed that there were 79.0 % of total farmer with farming area of 1 to 10 ha by earthen ponds and cage in monoculture systems. The fish farms had a number of hired labors less than five which accounted for 77.4 % of the total surveyed. Fish fry was mostly purchased from others. The use of commercial feed was significantly higher than natural bait or homemade feed. Length of the culture cycle was less than six months, which accounted for 87.1 % of the total surveyed.

Molnar *et al*., (1996) and Morales (2001) demonstrated that the issue of business and the natural environment which included lack of aquaculture facilities, poor quality of feed, lack of personnel, difficulties with air transportation and natural disaster in Honduras tilapia farming.

Later a study by Fúnez *et al*., (2003) concluded that Honduran tilapia farmers face several problems regarding product size and export-quota requirements. Also, Wurmann (2010) and Bondie and Wolf (2013) showed that the issue of tilapia production structure and development management of government policy and foreign capital, which included farm scale, export and future investment in Honduras rural communities.

In this study, we showed that the difficulty in farming management is mainly from high production costs and lack of government policy assistance. The industry's current operating conditions were merely to maintain profit, so 87.1 % of the respondents would not consider changing

jobs. This may be probably due to high profitability in fish culture and difficulty to find highly paid jobs in the same region.

Our research showed that in Honduras, the main costs tilapia farming were fry, feed and labor costs. Green *et al*., (1994) showed that because of Hondurans government provides an agricultural loan for fish farming, therefore feed, labor and loan accounts for over 83 % of semi-intensive tilapia aquaculture production costs. Similarly, a survey in Philippines tilapia farming by Pillay and Kutty (2005) showed that major cash costs for tilapia industry were mainly fry, labor and interest on capital accounted for more than 90% of the total cost. Furthermore, Chen and Huang (2011) presented that feed, fry and labor were main cost in Taiwan tilapia industry. Parker (2012) showed that variable cost was higher in proportional rather than fixed costs in aquaculture; therefore feed and fry were major expenditures in fish farming.

In our research we found that the polyculture system had the higher expenses in both utilities (15.64 %) and depreciation (12.24 %). Due to polyculture farm cultured white shrimp, need for more water, electricity and equipment costs.

CONCLUSION

In Hondurans tilapia industry, the majority of aquaculture systems focused on monoculture systems. Farming size mostly ranged from between 1 to 5 ha, which had five or less farm workers. Farmers' fish products were mainly sold onto buyer and to some regular customers. The major Operating costs in tilapia production are fry, feed, and labor. Future aquaculture policies should be based on these study results, with an emphasis on the associated measures of farming cost subsidies for the farmers and to formulate specific industrial policy which would benefit Hondurans tilapia industry in attaining sustainable development. Although this study described and analyzed the most operational status and cost to understand the tilapia aquaculture industry in Honduras. Further research would also be needed to explore the marketing strategies most suitable and feasible for particular conditions in the Hondurans tilapia industry.

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Conflicts of Interest

The authors declare no conflict of interest.

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