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AN EMPIRICAL STUDY OF FINANCIAL EFFICIENCY AND STABILITY OF CRAB–SHRIMP FARMING MODEL IN MEKONG DELTA, VIETNAM

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ABSTRACT

The study is conducted with the goal of analyzing the financial efficiency of 308 crab - shrimp farming households in the Mekong Delta, finding factors that affect financial efficiency and the extent of their influence on farm household income. Research results show that extensive crab-shrimp farming households are highly effective. With the average cost of investment in production during the crab farming process of 2,051 thousand VND/1,000m2, the average revenue brought from farming Crab farming of 5,099 thousand VND/1,000m2, farmers have an average profit of about 3,020 thousand VND/1,000m2. The average value of the financial ratios shows that the production model in the Mekong Delta is financially effective, the average value of the revenue/cash cost is 8.08, profit/total costs is 2.31, net income/cash costs is 7.08, and profit /revenue is 0.37. Factors affecting the profits of extensive mud crab farmers consist of three influencing factors: Area, crab/total crab ratio, and farmers in Kien Giang Province. Additionally, the number of years of farming experience has an influence, but its impact is not statistically significant

Keywords: Crab-shrimp farming, financial efficiency, mud crabs

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1. INTRODUCTION

Vietnam has the potential to develop the aquaculture industry because of its long coastline of 3,260km and exclusive economic zone of 1 million km2. According to a report from the Directorate of Fisheries, in 2023, outputs were 9,269 million tons, an increase of 2% compared to 2022 (Ha et al., 2023). Among the outputs, fisheries output was 3,861 million tons, equivalent to 2022 and quaculture output was over 5,408 million tons, an increase of 3.5% compared to 2022. The value of exported seafood production was 9.2 billion USD, achieving 92% of the plan (10 billion USD). Along with the development of the economy, the aquaculture industry has also gradually developed, has expanded its scale, and has applied technological and scientific advances to farming models to improve production efficiency. The Mekong Delta is considered a center for mud crab production because it has the largest area of mangrove forests and extensive farming system in the country (Danh et al., 2019). In recent years, the mud crab farming model in the country has mainly been conducted based on improved extensive farming form of combining tiger shrimp - mud crab - fish. The model of raising mud crabs combined with shrimp contributes to development of aquaculture production in the Mekong Delta. Mud crabs have a fast growth rate, high tolerance to changes in the farming environment, and especially resistance to diseases. This makes mud crab become an alternative to shrimp in coastal provinces. The extensive crab-shrimp farming model mainly uses natural food, reduces food costs and is less susceptible to disease. Products of this model, including crabs and shrimp, are considered safe and have lower risk compared to other models (Danh et al., 2021; Huong et al., 2016). Furthermore, due to less use of chemicals and antibiotics, crabs and shrimps have high quality, and the ecological environment is protected. Due to these advantages, the crab-shrimp farming model not only brings high economic value but also helps improve the economic situation for local families. Products from this model are considered safe and minimize risks, creating great benefits for both farmers and consumers.

Although provinces in the Mekong Delta have favorable natural conditions and large farming areas, the crab-shrimp farming model is still facing many challenges (Ha et al., 2023). Farmers lack technical guidance documents, leading to the inability to determine optimal criteria to achieve the highest efficiency. Crab and shrimp production often occurs alone without strict organization. The transition to intensive farming and high stocking density also brings many management difficulties (Danh & Truc, 2021). In addition, the development of crab-shrimp farming still does not have a specific system, still lack information, does not satisfy technical requirements of water management, water supply and drainage, and integrated farming models. The incomplete pond systems, lack of storage ponds and lack of wastewater treatment ponds lead to unsafe water quality, affecting farming. It is important to contribute to development of the strengths and potentials and elimination of limitations in crab-shrimp farming to improve financial efficiency in the crab-shrimp farming model (Nghi et al., 2015). With these reasons, the research is conducted to evaluate financial efficiency and factors affecting financial efficiency. The goal is to propose solutions to improve the financial efficiency of the crab-shrimp farming model, thereby contributing to the sustainable development of this industry in the Mekong Delta

2. LITERATURE REVIEW

2.1. *Productivity*

Productivity is the efficiency level of the production process, measured by the yield harvested per unit of area, time, and effort invested. Agricultural productivity is important because it can ensure adequate food supply for a rapidly growing population and help increase farmers' incomes (Tenpers, 2023). Productivity is an essential indicator that shows the level of operational efficiency within an organization by reflecting the amount of output per unit of input. Productivity and financial efficiency are closely related. Effective output management leads to better financial performance (Robertson, 2021).

2.2. *Financial Efficiency*

Financial efficiency can be understood as the most optimal use of resources to achieve the highest profits. In analysis of financial efficiency, we often only focus on measuring profits by comparing revenues and costs of the model, without taking into account social benefits and losses (Hon & Duyen, 2021). Financial efficiency is only evaluated from an individual perspective, with all costs and benefits assessed based on market value. Financial efficiency in agriculture is calculated as follows (Sujan et al., 2021):

$$\text{Profit} = \text{Revenue} - \text{Cost}$$

In which:
Revenue per unit of area = Product selling price * Output per unit of cultivation area
Financial efficiency reflects the economic viability of the use of materials, labor and capital in the business and production process. It describes the relationship between obtained economic benefits and cash costs in each business cycle. Economic benefits are defined as the surplus of revenue after deducting direct and hidden costs. This implies that the greater the economic benefit, the higher the business performance, and vice versa (Mai et al., 2023). Through analysis of financial efficiency, we can evaluate the ability to generate profits and manage costs in business activities. This helps businesses better understand how to use their resources to achieve the best business results (Ngoc et al., 2023; Shawon et al., 2018; Sujan et al., 2021).

2.3. Financial Efficiency Measurement Indicators

Total costs: The costs are the total costs invested in production activities to create the product. It can be said that total costs are the total amount of money that farmers spend on production activities from the stocking stage to the stage of creating the final product (Kalirajan & Shand, 1988).

$$\text{Total costs} = \text{cash cost} + \text{Non-cash cost}$$

In which:
Cash costs include water pumping costs, impurity removal costs, lime application cost, probiotic and water discoloration costs, food costs, allocation cost, crab seed cost, shrimp seed cost.
Non-cash costs include family labor costs.

Total costs = Material costs + Labor costs

Revenue: The revenue is the monetary value from the total quantity of products with the unit price of the product sold. It can be said that revenue is the amount of money received after farmers sell products (Gorga et al., 1979).

Revenue = Output * price per unit Trong đó: Output = Productivity * Area

Profit: The profit is the remainder of total revenue after total production costs are subtracted. Profit in agricultural production is the amount of money that a farming household earns after deducting investment costs (family workday costs) and can be used for personal spending purposes.

Profit = Total revenue – Total costs (including family workdays and depreciation)

2.4. Factors Affecting Financial Efficiency

Human resources are one of the important input factors in agricultural production (Gorga et al., 1979). Farming experience has a very high influence on the productivity of the farming model. Farmers with the more years of farming experience have higher farming productivity and they are easier to implement and manage their farming ponds (Gorga et al., 1979; Loc & Thuy, 2015; Long, 2017).

Cultivation area is the land area that is an important concept in the field of agriculture and land management because it measures the ability to produce agricultural products and livestock products on a specific area. Land area significantly affects profit (Em, 2017; Hon & Duyen, 2021; Vay et al., 2001). In addition, crab output in ponds also affects the revenue of the farming model because crabs have a higher selling price than shrimp (Nascimento et al., 2017; Oersted et al., 2014).

The study uses the Cobb-Douglas production function to analyze and identify input factors that affect the profits of extensive crab-shrimp farmers in the two research provinces.

General model: $\mathbf{Y = A\sum Xi^{\alpha i}\, e^{Dj}}$

The Cobb Douglas equation can be converted to linear form by taking the logarithm of both sides of the equation as follows:

$$Ln(Y)=LnA + \alpha_1 Ln(X_1) + \alpha_2 Ln(X_2) + ... + \alpha_n Ln(X_n) + b_1 D_1 + b_2 D_2 + ... + b_n D_n$$

In which:
Y = Profit
A = Constant

Dj: Dummy variables (D1= Breeding development; D2= Kien Giang province; D3= Ca Mau province)
αi: Elasticity coefficients of the production function are estimated by regression method. Coefficient (represents the influence of the independent variables (Xi) on the dependent variable (Y).
αn: It represents % change in Y for 1% change in X.
Xi: These are factors that affect household profits, specifically: (X1=Ln (Area); X2 Ln (Experience); X3 = Ln (Ratio of crab quantity/total quantity of crab and shrimp).

Table 1: Variables Affecting Financial Efficiency

Variable name	Coding	Description	Expected
Profit	Y	Shrimp farming profit (1000VND/1000m^2)	
Ln (Area)	X1	Crab and shrimp farming area (m^2)	+
Ln (Farming experience)	X2	Crab and shrimp farming experience of households (Year)	+
Ln (Ratio of crabs/total quantity of crabs and shrimps)	X3	Ratio of crabs to the total quantity of crabs and shrimps raised by farmers (%)	+/-
Breeding development	D1	Percentage of households with breeding development (%)	+
Kien Giang province	D2	Households in Kien Giang province	+
Ca Mau province	D3	Households in Ca Mau province	+

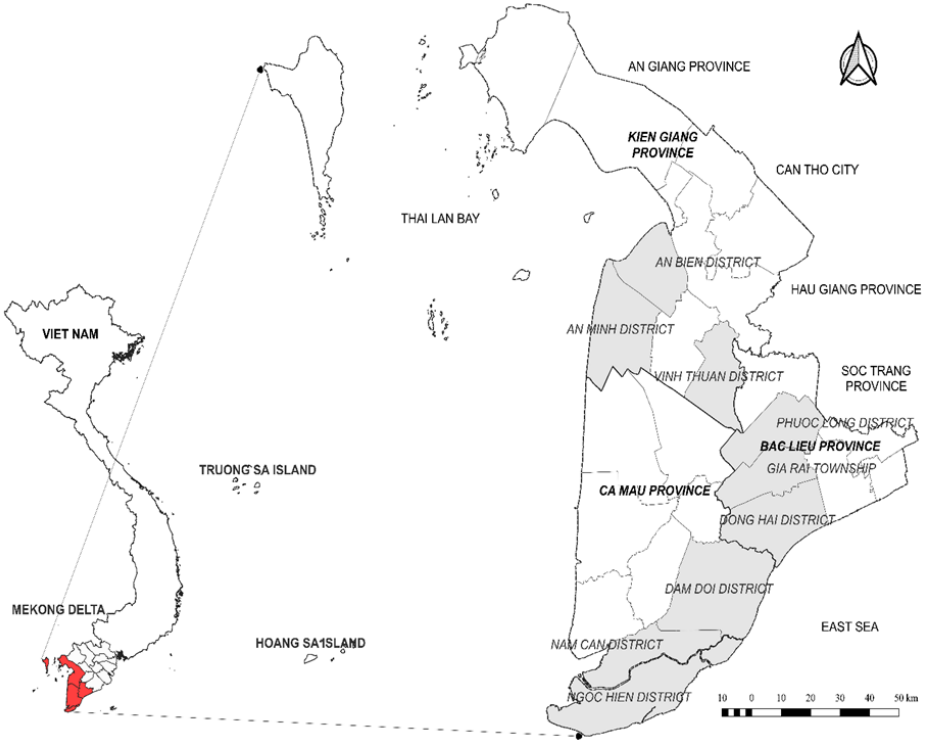
Source: *Results from literature review*

3. METHODOLOGY

3.1. Location

With multi-stage probability sampling based on the criteria of mud crab output of provinces in the Mekong Delta in 2020 after the covid 19 pandemic, the study selected three provinces with the largest mud crab output, mainly Kien Giang, Ca Mau and Bac Lieu. From the distribution structure of mud crab production of districts in three provinces, the study selected three districts from each province. Three communes were selected from each district, and three hamlets were selected from each commune according to the criteria of greatest output to be the research areas. In Kien Giang province, there were 03 districts (An Minh, An Bien, Vinh Thuan) with the highest mud crab production (accounting for 90% of the entire province). In Ca Mau province, there were 3 districts (Nam Can, Dam Doi, Ngoc Hien) with the output accounting for 60% of the entire province and Bac Lieu province had 3 districts (Gia Rai, Phuoc Long and Dong Hai) with output accounting for 70% of the entire province. At hamlets based on the list of mud crab farmers, probability sampling was conducted using a systematic sampling method.

Figure 1: Map of Survey Locations



Note: *Red is the survey area of mud crab farmers (Kien Giang, Ca Mau and Bac Lieu).*
Source: *compiled by the authors*

Table 2: Statistics on Investigation Samples of Kien Giang, Ca Mau and Bac Lieu Provinces

Investigation regions		**Samples**	
Province	**District**	**Household**	**Percent**
Kien Giang	An Bien	49	15.91
	An Minh	17	5.52
	Vinh Thuan	36	11.69
Ca Mau	Dam Doi	38	12.34
	Nam Can	39	12.66
	Ngoc Hien	26	8.44
Bac Lieu	Dong Hai	23	7.47
	Gia Rai	54	17.53
	Phuoc Long	26	8.44
Total		**308**	**100**

Source: Survey *data, 2020*

3.2. Sampling Respondents

Secondary data: Secondary data were collected from statistical reports of the Departments of Agriculture and Rural Development in the Mekong Delta region; annual reports, annual statistics and future planning directions related to crab and shrimp production in the Mekong Delta provinces. In addition, secondary data were also collected from agricultural departments, economic and cadastral officials in communes, districts and towns in the Mekong Delta provinces.

Primary data: The study had 308 observations, of which Bac Lieu province had 103 observations, Kien Giang province had 102 observations and Ca Mau province had 103 observations. To ensure the number of observations for the research and because of limitations in human resources, time and funding, the authors selected 308 shrimp and crab farming households in the 3 provinces with the largest area and output in the Mekong Delta.

The sample size of the production stage of mud crab farmers is determined to satisfy the minimum sample size in the sample size calculation formula based on (Yamane, 1967) as follows:

$$n = \frac{N}{(1 + N * \varepsilon^2)}, \quad (1)$$

In which: n is the minimum number of households that need to be surveyed and N is the number of households raising crabs in the research areas. According to Directorate of Fisheries (2020) of the three provinces of Kien Giang, Bac Lieu and Ca Mau, the total number of households raising mud crabs (N) is 225,167 households. ε is the sampling error, and according to (Subong & Beldia, 2005), ε is 6% (Nam, 2008).

Therefore, according to the formula, the minimum sample number of the research:

$$n = \frac{225{,}167}{(1 + 225{,}167 * 0.06^2)} = 277$$ household.

However, to ensure high representativeness, the research chose to interview 304 mud crab farmers in three provinces of Kien Giang, Bac Lieu and Ca Mau. Face-to-face interviews with 304 mud crab farmers using structured questionnaires. 100% of the farmers agreed to answer.

3.3. Instruments

Stratified systematic sampling method was used to determine research areas and select convenient samples for crab and shrimp farming households. Data were obtained from interviews with 308 farming households.

The data were collected through direct interviews with crab-shrimp farming households using structured questionnaires. The data were coded and analyzed using Stata 12 software.

3.4. Data Analysis

Descriptive statistics method: Analysis of the mean value, standard deviation, maximum value and minimum value is used to describe the characteristics of crab farming households and the current production status of crab farming households in Mekong Delta region.

Non-parametric test (Wilconxon-Mann-Whitney): It is also known as 2-sample mean test is a form of non-parametric test and it is used to compare the difference between two independent groups when the dependent variable can be an ordinal or continuous variable, but does not require a normal distribution.

Anova test: It is used to determine the influence of independent variables on the dependent variable in regression research.

Multivariate regression: The research uses the Cobb-Douglas production function to analyze and identify input factors affecting the profits of extensive crab-shrimp farmers in the research provinces

4. RESULTS AND DISCUSSION

4.1. Descriptive Analysis

In terms of descriptive statistics results, with observation of 308 shrimp and crab farming households in Kien Giang, Bac Lieu, and Ca Mau provinces in the Mekong Delta, male respondents accounted for 81.8%, the remaining were female respondents and that the majority of households participated in shrimp and crab farming. The majority of the respondents are Kinh ethnic people, accounting for 98.7% of the total 308 observations. The average age of the head of a crab farming household was 47.8 years old, with the youngest household head aged 25 years old and the oldest household head aged 82 years old. In general, the majority of farming households were 45 years old or older, accounting for 94.8% of the total number of surveyed households.

Table 3: Demographic Information of Crab and Shrimp Farming Households in The Mekong Delta

Đặc điểm đáp viên	**Mean**	**Standard deviation**	**Min**	**Max**
1. Male (%)	81.8			
2. Household head (%)	85.4			
3. Ethnic (%)				
Kinh	98.7			
Khmer	1.3			
4. Age (years)	47.8	19.4	25.0	82.0
Under 35 years old (%)	5.2			
35-45 years old (%)	33.7			
45-55 years old (%)	32.8			
Over 55 years old (%)	28.3			

5. Educational levels (%)	8.0	2.9	1.0	12.0
Level II (Grade 1 – 5)	24.3			
Level II (Grade 6 – 9)	45.4			
Level III (Grade 10 – 12)	30.2			
6. Years of experience (year)	12.7	7.1	1.0	32.0
7. Training participation (%)	30.8			

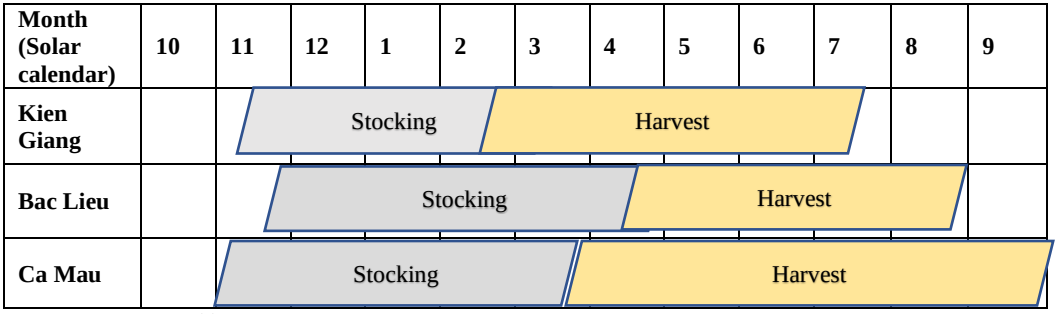
Source: *Survey data of farm households, 2020*

The education level of the heads of crab and shrimp farming households in the research area was low, with the heads of households with educational level of Level I accounting for 24.4%, level II accounting for 45.4%, level III accounting for 30.2%. There were not heads of households with intermediate and college levels. The average number of years of production experience of household heads was 12.7 years. The lowest number of years of experience was 1 year and the highest was 32 years, with the standard deviation representing the number of years of experience among household heads in crab farming was 7.1 years. The reason behind the low education level of the household heads was because difficult previous family conditions and education was not guaranteed. This caused many difficulties in the process of the state of Vietnam implementing scientific and technical training as well as applying new processes to the crab-shrimp farming model. The survey results also indicated that 95 households participated in the training in a total of 308 surveyed farming households, accounting for 30.8%. This result was consistent with the research of Brennan et al. (2002). This described that the majority of crab farming households here mainly relied on existing experience in shrimp farming many years ago to apply to the mud crab farming model. Local agricultural extension activities aimed to help crab farming households in the research area improve financial efficiency. However, in reality, this activity still faced some limitations such as lack of rightly meeting the needs and expectations of crab farming households.

4.2. Features of Extensive Crab-Shrimp Production

According to information provided by farm households, crab-shrimp farming only takes about 3.5-4 months. When the crabs have appropriate weight, they can be gradually harvested. Thus, there may be three crab-shrimp farming crops in a year. In Kien Giang, farm households implement seed stocking from November to March of the following year, and harvest from March to July. Farm households in Bac Lieu province start seed stocking from the end of December until April of the following year, and begin harvest from April to August.

Figure 2: Crab Season Calendar



Source: *Survey data of farm households, 2020*

4.3. Production Status of The Crab-Shrimp Model in The Mekong Delta

4.3.1 Total Production Costs

According to the results of survey of crab-shrimp farming households about production costs, the average total production costs of the crab-shrimp farming households in the Mekong Delta was 2,057 thousand VND/1,000 m2. There were differences in investment costs of the farming households because the households had differences in the amount of fertilizer, medicine, lime, probiotics, supplementary feed, and investment in machinery and equipment with different capacity and brands.

Seed is an important factor that has a decisive influence on productivity and production costs. Because crabs and shrimps are aquatic species that are easy to grow, require little care, and are increasingly popular in the market. The average cost of crab seeds for each 1,000m2 of production land is about 365.78 thousand VND, while the average cost of shrimp seeds for each 1000m2 of production land is about 189.33 thousand VND, being lower than the cost of crab seeds. The reason why the average seed cost is different is because the number of seeds per 1,000 m2 is different, the seed price is also different for each different source.

The costs of lime, probiotics, fuel of water pumping, elimination of impurities and supplementary foods are not too high, use of the amount of fertilizer is also carefully considered by households and their abuse of the fertilizers is very limited.

The average cost of lime for crab-shrimp farming households is about 1,579 thousand VND/1,000 m2. There is a high difference between the households because the amount of lime and the prices of lime that households use are not similar. Like the cost of lime, the cost of probiotics used by the households is also very low. The average cost of probiotics for crab-shrimp households per 1000m2 is about 2,712 thousand VND.

Although costs such as electricity, water, gasoline, and oil only account for a small portion of the total costs, they also account for a lot of expenses for farm households. The average fuel cost of pumping water to improve ponds and manage and care for the ponds over 1000m2 is 945,194

thousand VND. The cost of eliminating impurities for the crab-shrimp farming households only accounts for a small amount of the total cost. The average cost of eliminating impurities for the households per 1000m2 is 32.41 thousand VND.

Only 60 farm households use supplementary feed for ponds, the average feed cost per 1000m2 is 3,381 thousand VND. There is a huge cost difference between the farm households who use supplementary feed.

The cost of hired labor and family labor when raising crabs and shrimps is mainly in the work tasks in pond renovation stage, pond management and care stage, and harvesting stage. Land preparation and crab-shrimp farming are hired by farming households and paid daily wages or using family labor. According to survey data, the average labor cost for crab-shrimp farming households was 92 thousand VND/1,000m2. The majority of crab-shrimp farming households in the Mekong Delta tend to use family labor. According to survey data, the average family labor cost of crab-shrimp farming households is 1,003 thousand VND/1,000m2.

Table 4: Costs in The Crab-Shrimp Farming Model in The Mekong Delta

(Unit:1000VND/1000m^2/year)

Item	Kien Giang (n=102)		Bac Lieu (n=103)		Ca Mau (n=103)		Total (n=308)	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
1. Material cost	**1,043**	**789.4**	**1,116**	**885.0**	**1,458**	**1,555**	**1,211**	**1,144**
Crab seed	265.6[a]	185.1	367.5[a]	359.3	763.01[b]	940.0	365.78	360.16
Shrimp seed	368.5[a]	357.2	473.3[a]	500.7	630.35[b]	885.65	189.33	266.68
Lime	109.9[a]	173.7	86.98[a]	194.1	24.86[b]	22.76	1,579	2,425
Probiotics and fertilizers	188.1[a]	250.9	185.3[a]	473.2	69.52[b]	130.47	2,712	6,061
Water pump	56.96[a]	62.3	78.8[a]	206.2	32.5[b]	9.03	945.194	771.776
Elimination of impurities	52.7[a]	39.8	46.2[a]	48.4	123.8[a]	32.66	32.41	770.022
Feed	228.1[a]	311.2	135.1[a]	94.2	60.06[a]	50.6	3,381	4,539
2. Labor cost	**653,65[a]**	**725.2**	**655.1[a]**	**828.4**	**334.6[b]**	**375.2**	**1,014**	**1,115**
Hiring cost	121.8[a]	296.2	16.3[a]	9.8	115.3[a]	92.21	92	219
Family labor	629.8[a]	716.8	651.2[a]	827.8	342.3[b]	376.13	1,003	1,114
Total costs	**1,697[a]**	**1,268**	**1,771[a]**	**1,377**	**1,803[a]**	**1,649**	**2,057**	**1,529**
Cash cost	1,067[a]	801.3	1,119[a]	886.5	1,461[b]	1,554	1,049	785
Non-cash cost	629.8[a]	716.8	651.2[a]	827.8	342.3[b]	376.13	1,003	1,114

Source: Survey data of farm households, 2020

4.3.2 Crab and Shrimp Farming Productivity in the Mekong Delta provinces

The average productivity of crab in the Mekong Delta per 1,000m2 is 10.71 kg/1000m2. For crab of type Y1, the average yield is about 4.61 kg/1,000m2. Crab of type Y4 has the average yield of

6.26 kg/1000m2, gravid crab 1 has the average yield of 1.73 kg/1000m2 and gravid crab 2 has the average yield of 2.65 kg/1000m2. Mixed crab has the average yield of 2.16 kg/1000m2.

Table 5: Productivity of Crabs in the Mekong Delta

Unit: Kg/1000m²/year

Item	Kien Giang (n=102)		Bac Lieu (n=103)		Ca Mau (n=203)		Total (n=308)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Crab Y1	5.7[a]	4.59	5.4[a]	10.7	3.81[a]	6.33	4.61	7.07
Crab Y4	8.4[a]	14.1	6.5[a]	10.6	4.87[a]	7.29	6.26	10.71
Gravid crab 1	1.8[a]	1.4	2.3[a]	4.1	1.35[a]	1.38	1.73	2.55
Gravid crab 2	3.9[a]	4.7	3.3[a]	4.6	1.27[a]	1.19	2.65	3.87
Mixed crab	2.7[a]	2.8	1.99[a]	1.92	2.45[a]	4.68	2.16	2.32
Total	**12.8[a]**	**15.18**	**12.8[a]**	**17.9**	**8.64[a]**	**13.52**	**10.71**	**14.16**

Source: Survey data, 2020

The average yield of shrimp in the Mekong Delta per 1,000m2 is 16.14 kg/1000m2. Shrimp of type of 50 shrimps/kg has the average yield of about 8.69 kg/1,000m2. Shrimp type of 40 shrimps/kg has the average yield of about 7.93 kg/1000m2. Shrimp type of 30 shrimps/kg has the average yield of 10.15 kg/1000m2. The average yield of shrimp type of 20 shrimps/kg is 6.15 kg/1000m2.

Table 6: Productivity of Shrimps in the Mekong Delta

Unit: Kg/1000m²/year

Item	Kien Giang (n=102)		Bac Lieu (n=103)		Ca Mau (n=203)		Total (n=308)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
50 shrimps/kg	9.2[a]	6.5	9.1[a]	9.4	3.38[a]	1.93	8.69	8.23
40 shrimps/kg	9.78[a]	9.83	7.7[a]	7.96	4.11[b]	3.02	7.93	8.39
30 shrimps/kg	11.01[a]	10.62	12.0[a]	19.1	8.43[a]	10.02	10.15	13.62
20 shrimps/kg	5.3[a]	3.09	4.1[a]	5.2	8.23[b]	11.47	6.15	8.74
Total	**17.02[a]**	**12.1**	**18.7[a]**	**19.8**	**13.7[a]**	**16.93**	**16.14**	**16.24**

Source: Survey data, 2020

In general, the average yield per 1,000m2 of crabs and shrimps in the farming model is not much different. There are a few of households also implementing this farming model. However, because of lack of farming techniques, the high stocking density, the inappropriate amount of used fertilizer (too much compared to the safe level), they do not have high productivity.

4.3.3 Shrimp and Mud Crab Selling Prices of Crab and Shrimp Farming Households in The Mekong Delta

Different types of crab have different selling prices. The average selling price of crab Y1 is about 227 thousand VND. The average price of crab Y4 is about 163 thousand VND. The average selling price of gravid crab 1 is 363 thousand VND and gravid crab 2 is 349 thousand VND. The average selling price of mixed crab is about 98.7 thousand VND.

The average selling price of shrimp type of 50 shrimps/kg is about 124 thousand VND. The average price of shrimp type of 40 shrimps/kg is about 151 thousand VND. The average selling price of shrimp type of 30 shrimps/kg is 200 thousand VND. The average price of shrimp type of 20 shrimps/kg is about 278 thousand VND.

Table 7: Shrimp Selling Price of Crab-Shrimp Farming Households in The Mekong Delta

Unit: Thousand VND

Item	Kien Giang (n=102)		Bac Lieu (n=103)		Ca Mau (n=203)		Total (n=308)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Crab Y1	208.0[a]	42.6	202.5[a]	36.0	268.1[b]	60.7	226.58	56.01
Crab Y4	157.2[a]	40.02	145.0[a]	26.3	194.5[b]	47.9	163.15	43.01
Gravid crab 1	339.9[a]	74.8	305.5[a]	49.4	434.0[b]	105.3	363.33	97.67
Gravid crab 2	308.0[a]	55.1	291.1[a]	59.3	428.3[b]	120.5	349.35	107.67
Mixed crab	101.9[a]	22.4	89.1[a]	8.96	96.3[a]	17.7	98.7	17.43
Price of 50 shrimps/kg	124.5[a]	41.3	117.5[a]	18.6	132.0[a]	37.0	123.89	23.3
Price of 40 shrimps/kg	154.4[a]	25.7	143.01[a]	23.06	164.2[b]	50.2	151.45	31.87
Price of 30 shrimps/kg	193.1[a]	27.9	187.9[a]	28.8	219.7[b]	59.5	200.51	44.17
Price of 50 shrimps/kg	267.4[a]	24.99	273.2[a]	41.96	285.7[a]	48.2	277.88	43.07

Source: Survey data of farm households, 2020

4.3.4 Revenue of Crab-Shrimp Farming Households in the Mekong Delta

Revenue is a comprehensive criterion, determined by two main factors: selling price and productivity(yield). The results show that there is a significant difference in revenue between different types of crab. Table 8 describes that the revenue of crab Y1 and crab Y4 is much higher than that of gravid crab. This is also consistent with local reality because biological characteristics of crabs Y (male crabs) are to grow faster than gravid crabs (female crabs). Thus, the types of crabs Y are harvested with larger sizes. When female crabs do not appear on crab eggs, traders still classify them as crabs Y, leading to increase meaty crab yield in the farming model. For mixed crabs, traders buy them at very low prices but the output of the mixed crabs in the farming model is always high for many different reasons. For example, crabs have habits of biting each other and the process of raising and harvesting crabs causes damage of body parts of crabs. In addition, due to the farming crop features, households have to harvest all the crabs during the last harvest crop and thus mixed crab output also increases.

Table 8: Revenue of Mud Crabs of Crab-Shrimp Farming Households in the Mekong Delta

Unit: Thousand VND/1000m^2/crop

Item	Kien Giang (n=102)		Bac Lieu (n=103)		Ca Mau (n=203)		Total (n=308)	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Crab Y1	1,172[a]	935.5	1,122[a]	2,308	955.4[a]	1,577	1,011	1,524
Crab Y4	1,342[a]	2m219	922.1[a]	1,541	893.8[a]	1,592	986.5	1,638
Gravid crab 1	579.7[a]	442.2	733.4[a]	1,442	568.3[a]	675.4	585.1	884.9
Gravid crab 2	1,160[a]	1m516	1,030[a]	1,582	482.3[a]	393.3	863.1	1,264
Mixed crab	271.2[a]	275.8	196.5[a]	199.4	245.7[a]	582.7	210.3	223.1
50 shrimps/kg	1,191[a]	820.3	1,040[a]	497.9	404.4[a]	117.3	1,049	909.3
40 shrimps/kg	1,498[a]	1,469	1,125[a]	1,267	671.4[b]	503.9	1,197	1,284
30 shrimps/kg	2,133[a]	2,257	2,115[a]	3,381	1,953[a]	3,058	1,932	2,499
20 shrimps/kg	1,424[a]	835.8	1,099[a]	1,337	2,233[b]	2,700	1,631	1,978

Source: Survey data of farm households, 2020

Shrimp revenue in the extensive crab-shrimp farming model also helps households increase their income. The results show that there is a significant difference in revenue between different types of shrimps. Specifically, for shrimp type of 50 shrimps/kg, the average revenue is 1,049 thousand VND/1000m2/year. For shrimp type of 40 shrimps/kg, the average revenue reaches 655 thousand VND/1000m2/year. For shrimp type of 30 shrimps/kg, the average revenue is 1,197 million VND/1000m2/year and and shrimp type of 20 shrimps/kg has the average revenue of 1,631 thousand VND/1000m2/year. Thus, shrimp revenue in the extensive crab-shrimp farming model in the Mekong Delta is high because the households have a lot of experience in shrimp farming models as well as use large-mesh traps to harvest large-sized shrimps to have higher selling price. However, shrimp is raised all year round and thus prices of shrimps are significantly different between months of the year.

4.4. Financial Efficiency of Crab-Shrimp Farming Model in the Mekong Delta

Table 9: Financial Efficiency of Crab-Shrimp Farming Model in the Mekong Delta

Unit: 1000 VND/1000m²

Item	Kien Giang (n=102)		Bac Lieu (n=103)		Ca Mau (n=203)		Total (n=308)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1.Total costs	**1,697[a]**	**1,268**	**1,771[a]**	**1,377**	**1,803a**	**1,649**	**2,051.47**	**1,529.14**
1.1 Cash cost	1,067.2[a]	801.3	1,119[a]	886.5	1,461[b]	1,554	1,049	785
1.2 Non-cash cost	629.8[a]	716.8	651.2[a]	827.8	342.3[b]	376.13	1,003	1,114
2. Revenue	**5,354[a]**	**3,905**	**5,548[a]**	**6,332**	**5,207[a]**	**6,747**	**5,099**	**4,736**
3. Profit	**3,657[a]**	**3,930**	**3,777[a]**	**6,086**	**3,404[a]**	**6,837**	**3,020**	**4,745**
4. Net income								
Net income = Revenue – cash cost	4,287[a]	3,850	4,428[a]	6,099	3,746[a]	7,021	4,050	4,634
5. Revenue/cost								
5.1. Revenue/total costs	4.38[a]	3.41	3.89[a]	3.75	5.5[a]	7.8	3.38	3.23
5.2. Revenue/cash cost	7.09[a]	5.93	7.32[a]	10.9	10.4[a]	18.1	8.08	13.16
6.Profit/total costs	**3.38[a]**	**3.41**	**2.89[a]**	**3.75**	**4.5[a]**	**7.8**	**2.31**	**3.05**
7.Net income/cost								
Net income/cash cost	6.09[a]	5.93	6.32[a]	10.9	9.4a	18.1	7.08	13.16
8.Profit/revenue	**0.46[a]**	**0.77**	**0.39[a]**	**1.35**	**0.27[a]**	**1.19**	**0.37**	**1.44**

Source: Survey data of farm households, 2020

Total cost: The average total cost of 308 observations is 2,051.47 thousand VND/1,000m2. The total cost of crab production of households is generally lower than the total cost of shrimp production, about 1,197.61 thousand VND/1,000m2.

Revenue: The average revenue of crab and shrimp farming households is about 5,099 thousand VND/1,000m2. In general, there is a large difference in revenue between crab and shrimp. The average total revenue of mud crab is 2,057 thousand VND/1,000m2, while the average total revenue of shrimp is about 3,042 thousand VND/1,000m2.

Profit: The average profit of 308 observations is about 3,020 thousand VND/1,000m2. Farming of crab is still profitable but not much and the average shrimp farming profit of households is higher than the profit of crab farming. In general, the profits between the two species of crab and shrimp have a significant difference. The average profit of crab farming is about 722 thousand VND/1,000m2 while the average profit of shrimp farming is about 2,298 thousand VND/1,000m2.

4.5. Factors Affecting Financial Efficiency of Extensive Crab-Shrimp Farming Households

The profits of Mekong Delta households depend on the area, ratio of crab/total amount of crab and shrimp. Kien Giang province has influential variables with significance levels of 1%, 5%, 10% respectively. The remaining variables of experience and breeding in Ca Mau province do not affect the crab farming profits of households.

Table 10: Factors Affecting the Profits of Crab and Shrimp Farming Households in the Mekong Delta

Variables		**Total (n=308)**			
		β		**SE**	**VIF**
Y	**Profit (1.000VND/1.000m^2)**				
Ln (X_1)	***Area (1.000m^2)***	***-0.25***	*****	***0.095***	***1.06***
Ln (X_2)	Experience (year)	0.11	ns	0.093	1.09
Ln (X_3)	***Crabs /Total crabs and shrimps (%)***	***-0.25***	*	***0.13***	***1.01***
D_1	Breeding (%) (D_1=1: Yes)	-0.06	ns	0.18	1.04
D_2	***Kien Giang (%) (D_2=2: Yes)***	***0.25***	*	***0.14***	***1.32***
D_3	Ca Mau (%) (D2=3: Yes)	-0.08	ns	0.15	1.48
N		308			
Prob > F		0.0056			
R-squared		0.0677			
Adj R-squared		0.0461			
Prob > chi2		0.8949			

Source: Survey data of farm households, 2020

*Note: *, **, ***: The corresponding differences are at the significance level of 10%, 5%, 1%; ns: Not significant at the 10% level.*

A survey of 308 observations shows that area has a negative impact on the profits of crab and shrimp farming households with the correlation coefficient of -0.25. This means that the households with large areas will bring low profits when farming crabs and shrimps and other factors remain unchanged. If the area increases by 1%, the farmer's profit will decrease by 0.25%. With a statistically significant estimated coefficient at the 1% level, it shows that area has a great impact on the profits of crab and shrimp farming households. This can be explained that when the area is too large, it will cause difficulties in the management process, thereby reducing the income of the farming households. This result is also consistent with the research of Ngoc *et al.* (2023).

The ratio of crabs/total crabs and shrimps has a correlation coefficient of -0.25, showing that the higher the ratio of crabs, the lower the profit is. If the ratio of crabs/total crabs and shrimps increases by 1%, profits will decrease by 0.25%. Crabs have a habit of biting each other and this can easily cause damage of parts of their bodies. At the same time, in the controlled farming model, households are forced to harvest all of them to avoid a case that crabs eat shrimps when releasing shrimp seeds in ponds. As a result, the quantity of mixed crabs (defective crabs) is increased in total output of harvested crabs due to the harvest process nature and their habit of biting each other. Thus, the households' income is reduced. This is also consistent with the research of Ha *et al.* (2023).

Kien Giang is a province with the highest crab-shrimp yield among the three provinces representing the Mekong Delta. This can explain the fact that Kien Giang province has a positive impact on profits. This means that profits of crab-shrimp farming households will increase if the farming area is in Kien Giang province. This result is also consistent with the research of Minh (2017).

4.6. Solutions Improving Financial Efficiency for Extensive Crab-Shrimp Farmers

Through the actual survey process, it was found that crab-shrimp farming households used inputs effectively. Therefore, the authors of this study would like to offer some solutions that contribute to improving financial efficiency for crab-shrimp farming households to achieve better results.

- Regarding production, households can discuss how to re-process the seasonal calendar more appropriately to avoid mass production congestion and minimize the situation of too high supply and little demand, causing a decrease in prices, leading to a decrease in revenue and profit.

- Households should update market information through newspapers, radio and surrounding areas about prices, price fluctuations over time and crab consumption in domestic and foreign markets to avoid a case that crabs or shrimps are bought by traders at low prices.

- Regarding chemical fertilizers, households should consider use of chemical fertilizers because they affect the quality of crabs. The technical process needs to be researched and the households should apply the right measures, use the right amount of medicine, avoid using too much to cause waste and polluting the surrounding environment.

- In terms of area, the survey shows that households have not optimally used the crab farming area. The number of crabs raised is still quite small. The larger the area, the higher the renovation and medicine costs is, negatively affecting the profits of households. Therefore, they need to optimize and use the right area to achieve higher profits.

- Use of seeds: Households should use new seeds with high productivity and good quality into the farming structure, gradually replacing seeds that have been raised for a long time. For the new seeds, the households should only use disease-free seeds that meet standards.

Material costs of households in Kien Giang province have lower average costs than households in other provinces, and households in Ca Mau province have the highest cost. Households need to reduce material costs such as lime costs, fertilizer costs, etc., and use them appropriately and at the right time to match quality and safety while still achieving high productivity and quality products. Therefore, the households' profits can be increased.

5. CONCLUSION

From the analysis of the current production situation of the crab-shrimp farming model in the Mekong Delta, it is evident that the production costs of the model are very high and not utilized efficiently. The average productivity of the model is very low, particularly in Ca Mau province. The average values of the financial ratios indicate that the production model in the Mekong Delta is financially efficient. The average revenue-to-cash cost ratio is 8.08 times, and the profit-to-total cost ratio is 2.31 times. There are three dependent variables (area, ratio of crabs to total crab-shrimp; and the production region of Kien Giang) that affect the financial efficiency of the crab-shrimp farming model in the Mekong Delta

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