

1 **Economic Analysis of White-Leg Shrimp (*Penaeus vannamei*) Production.**

2 **Case Study: Rudong County of Nantong city, Jiangsu Province, China**

3

4

5 **Abstract**

6 This paper examines the economic performance of White-leg shrimp (*Penaeus vannamei*)  
7 production in Rudong county of Nantong city, Jiangsu province, China. White-leg shrimp  
8 (*Penaeus vannamei*) production is an important economic activity in the overall farming  
9 system in China. Despite the current achievements witnessed by white-leg shrimp production,  
10 there are many challenges (high cost of production, disease, over feeding, effluent discharge,  
11 lack of technical knowledge, low educational level, inexperienced managers, among others)  
12 continuing to set back the growth of this sector in China. Three seasonal crops data in 2016  
13 were collected from 52 white leg shrimp farmers. Descriptive statistics, profitability and  
14 regression analysis were employed in the data analysis. The study revealed that all white-leg  
15 shrimp farmers sampled were males. Most farmers (78.9%) belonged to an age group of 41-  
16 60 years with 6-10 years farming experience. Operational costs of White-leg shrimp farming  
17 accounted for 89.2% out of the total cost with feed, fingerlings and fuel representing 34.3%,  
18 13.1% and 12.7% respectively. Farmers obtained an average revenue of CNY 924,359.74/ha  
19 from shrimp sold at an average price of CNY 43/kg and secured a net profit of CNY  
20 378,144.55/ha. The gross margin ratio (0.47), benefit cost ratio (0.69) and return on  
21 investment (0.69) revealed that white-leg shrimp is economically viable. Feed cost, cost of  
22 fingerling and experience showed negative significant effect on revenue at 5%, 10% and 1%  
23 respectively while farm size and average price showed positive effect on revenue at 1% level  
24 of significance.

25

26 **Key Words:** Economic Analysis, White-Leg Shrimp (*Penaeus vannamei*), Jiangsu, China

## 27 **Introduction**

28 Chinese shrimp farms are located along the coastline nearly 18,000km from Hainan province  
29 (South) in the tropics to Liaoning province (North) in the temperate region. The main shrimp  
30 producing provinces in China are Guangdong, Guangxi, Zhejiang, Jiangsu, Shandong, Fujian,  
31 and Hainan [27]. There are about 14,000 shrimp farms in China, [2]. According to [3], in  
32 northern province of China, extensive system of shrimp farming is usually practice by  
33 farmers, especially for those who have to farm shrimp with seawater. While in the southern  
34 province, intensive farming system is common especially for white-leg shrimp (*P. vannamei*)  
35 species, which is featured by pond built in supralitoral zone with a central drain and aerating  
36 equipment. Presently, green-house pond is used in the south for over-wintering and harvest is  
37 done during the early spring. It has been reported that in the southern province, farms  
38 generally have 2-3 production cycles per year, while in the northern province, farms normally  
39 have one cycles per year due to the winter season [3]. China is the world largest producer of  
40 shrimp, follow by Thailand, Vietnam and Indonesia [7].

41

42 Shrimp is the most valuable fisheries commodity in the world representing 15% of the total  
43 value of international traded fisheries products [7]. China is the second largest exporter in  
44 volume of farmed shrimp after Thailand [13] and third largest exporter by value globally.  
45 Shrimp stands out as the highest economic value seafood products export from China. As one  
46 of the major producers, China is determined to meet the needs of both international and  
47 domestic demand for shrimp especially its delicious taste with high protein. It contributes to  
48 animal protein intake, employment generation, household incomes, foreign exchange  
49 earnings and livelihood of farmers. Many investors and aquaculturists are hopeful about the  
50 potential of shrimp farming industry in China because of the vast domestic shrimp markets  
51 indicating the confidence and enthusiasm to the future of the industry. The study attempted to  
52 investigate the economic analysis of white-leg shrimp production using enterprise budget  
53 approach including, revenue, net income, gross margin, gross margin ratio, benefit cost ratio  
54 and return on investment among others.

55

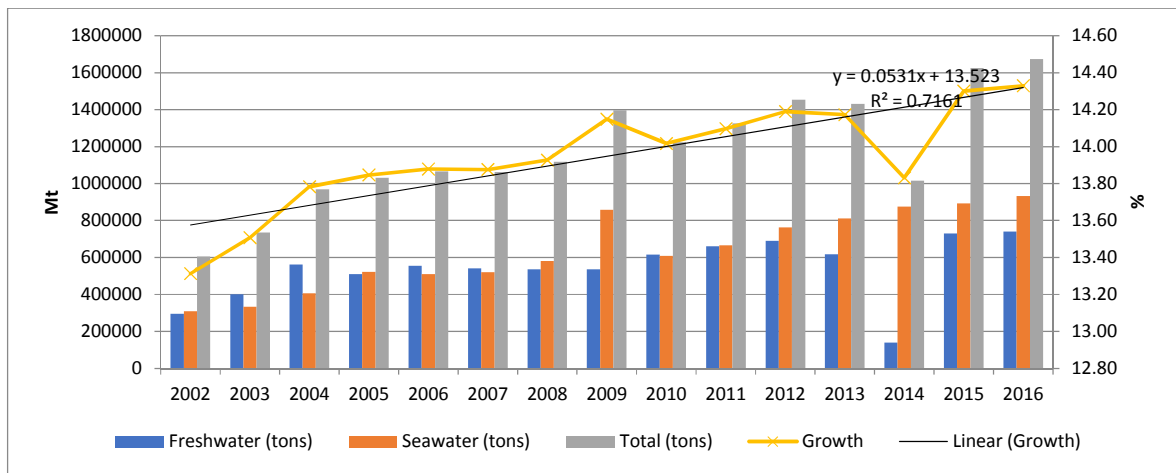
56

57

## 58 **Overview of White-leg Shrimp Production in China**

59 Shrimp production in China has been increasing over the past years especially the white-leg

60 shrimp (*Penaeus vannamei*) which has followed a general trend of increasing output [8].  
 61 Total white-leg shrimp production increased from 60,5259mt (2002) to 1,672246mt (2016  
 62 with a growth rate of 0.053% (Fig. 1). The year 2014 saw a sharp decline of freshwater  
 63 white-leg shrimp production of 140,606mt (2014) 81,2545mt (2013) [4]. [20] and [3] have  
 64 also reported that this increase in white-leg shrimp production has been achieved with  
 65 intensification of farming systems by large commercial companies. White-leg shrimp (*P*  
 66 *vannamei*) output surpassed 1.37mt and accounted for 40% of farmed shellfish production  
 67 nationwide [12]. In spite of the growing trend in white-leg shrimp (*P. vannamei*) output,  
 68 increase in the number of farm sites have occurred only in more recent years from provinces  
 69 such as; Guangdong, Jiangsu, Zhejiang, Hainan, Guanxi and also to lesser extend in  
 70 Shandong, Fujian and other provinces [11]. In 2016, annual production of white-leg shrimp in  
 71 China has recorded of about 1.67 million mt (Fig. 1) [4].



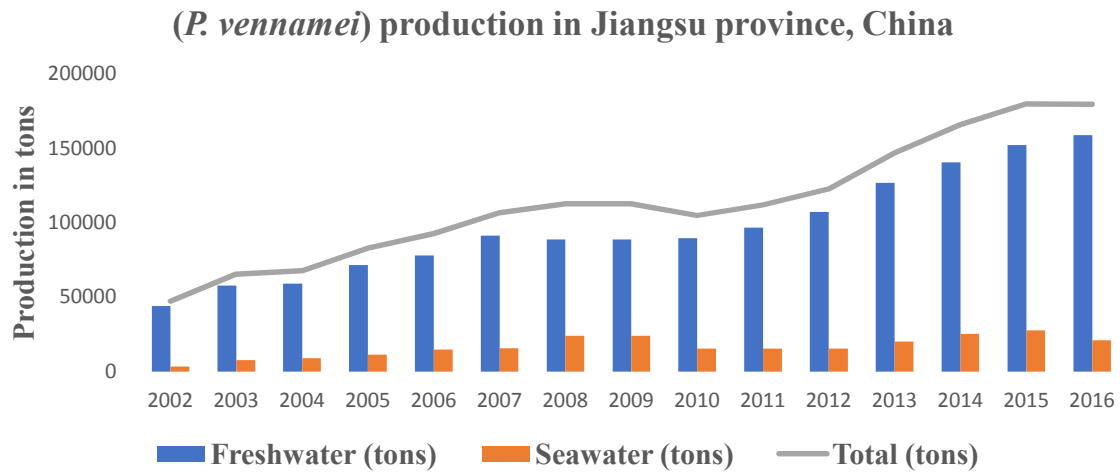
72 **Fig.1:** Production of white leg shrimp (*P. vannamei*) in China, 2002-2016.

73 [Data source: 5].

74  
 75  
 76 **White-Leg Shrimp Production in Jiangsu Province, China**

77 The production of shrimp has been increasing primarily in Guangdong, Jiangsu, Hubei,  
 78 Zhejiang and Guangxi provinces. Jiangsu province has been regarded as one of the leading  
 79 producers of aquatic products. In 2012, total aquatic production in Jiangsu province for  
 80 seawater and freshwater were estimated at, 1,421 tons and 3,339 tons respectively totaling to  
 81 4,760 tons. Hubei, Guangdong, and Jiangsu provinces are the largest producers of freshwater  
 82 cultured shrimp [12]. Annual white-leg shrimp (*P. vannamei*) production in Jiangsu province  
 83 reached a record of 179,750mt in 2015 of which freshwater and seawater accounted for  
 84 152,111 tons (84.62%) and 27,639mt (15.38%) respectively and a total decline in 2016

85 (179,587mt) as a result of a decline in seawater white-leg shrimp production (20,904mt) (Fig.  
86 2).



87

88 **Fig.2:** White leg shrimp (*Penaeus vannamei*) production in Jiangsu province, China

89 [Data source: 4].

90

### 91 **Problem Statements**

92 Production of white-leg shrimp (*Penaeus vannamei*) is a very important economic activity in  
93 the farming system in China. The practice of white-leg shrimp farming is gaining popularity  
94 in most areas in China. In spite of the present successes witnessed by white-leg shrimp  
95 farming, there are many challenges continuing to set back the growth of this sector in Jiangsu  
96 province, China. The risk of disease outbreak has a significant negative effect on farm  
97 economy and this is a major concern in the shrimp industry. The outbreak of disease can  
98 cause massive crop failure, which can largely challenge sustaining production and affect  
99 profitability of the sector [3]. Moreover, over feeding and effluent discharges have created  
100 challenges for policy makers and threaten the sustainable development of shrimp aquaculture.  
101 In addition, lack of technical knowledge, low educational level, inexperienced managers,  
102 high cost of production, inefficiencies, differences in socio-economic characteristic and  
103 management practice are some of the problems that are hampering the success of shrimp  
104 farming in the study areas.

### 105 **Objectives of the study**

106 The aim of this study is to assess the economic performance of White-Leg Shrimp (*P.*  
107 *vannamei*) production in Jiangsu Province and examine the factors affecting revenue  
108 generation.

109

110 **Hypotheses**

- 111 1. **H<sub>0</sub>**: High costs of feed and fingerling does not lead to less revenue;
- 112 2. **H<sub>0</sub>**: There is no significant relationship between the farm size, average price of the white-
- 113 leg shrimp products and the revenue.

114

115 **Materials and Methods**116 **Study Location**

117 The study was conducted in Rudong county in the Nantong city of Jiangsu province, east

118 coast of China. Rudong is a municipal government area with 14 towns and 5 districts with an

119 area of 1,872 Km<sup>2</sup> and a total population of 1.08 million people.

120



121

122 **Map.1: Study Area**123 **(Source: 25)**

124

125

126 It is located on the bank of the Yellow Sea [26]. Nantong city is located in Jiangsu province

127 on the northern bank of the Yangtze River, near the river mouth. It has an area of 8,544 Km<sup>2</sup>

128 with a population of about 7.3million people of 2010 census. Nantong is a vital river port

129 bordering Yancheng to the north, Taizhou to the west, Suzhou and Shanghai to the south

130 across the river and the East China Sea to the east [25]. The author chose Jiangsu for the

131 study because is among the three largest producers of White-leg shrimp (*Penaeus vannamei*)

132 in China. Nantong city is the largest shrimp producer in Jiangsu province of which Rudong  
133 county stands out as the largest contributor [26].

134

### 135 **Data collection and sampling method**

136 The primary data used for carrying out this study was a cross-sectional data for three crop  
137 seasons in 2016. Each of the crop seasons is made up of three months hence the three cop  
138 seasons total 9 months. Data collection commenced in October 2017, and with the final field  
139 work completed in November 2017. Information and data were collected from 52 white-leg  
140 shrimp farmers in the study areas using structured questionnaires. The questionnaires were  
141 first tested among 10 white-leg shrimp farmers in Rudong County, before it was finally  
142 administered.

143

### 144 **Data analysis**

145 All the data collected were coded and entered into a statistical package for social sciences  
146 (SPSS). SPSS version 20 and Microsoft Excel 2007 spreadsheets were used in the analysis.  
147 Descriptive statistics, enterprise budget and regression (ordinary least square) analysis were  
148 used in analysis. All the calculations in this study were based on ( $1 \mu=667 \text{ m}^2$ ) for average  
149 shrimp production area.

150

### 151 **Analysis of profitability**

152 [23] described profitability analysis model as deterministic assumption, where random  
153 variables reflected by uncertain factors of production can be easily added. The budgetary  
154 analysis of profitability was obtained using Equation 1 to Equation 6:

155 Net Farm Income (NFI) = TR – TC

156 Eqn.1

157 Benefit Cost Ratio (BCR) =TR/TC

158 Eqn.2

159 Gross Margins Ratios (GMR) = (TR – TVC)/TR

160 Eqn.3

161 Return on Investment (ROI) = NFI/TC

162 Eqn.4

163 Percentage Profitability (PP) = NFI/TCx100

164 Eqn.5

165 Where:

166 TR = Total revenues, TC = Total cos, TVC = Total Variable cost, NFI = Net farm income,

167 TC = Total cost.

168

169 **The break-even point rules**

170 To conduct breakeven analysis, the fixed costs was divided by the price minus the variable  
 171 costs as shown in Equation 6:

172 **Breakeven Point** = Fixed Costs/ (Unit Selling Price - Variable Costs)

173 Eqn.6

174

175 **Regression Analysis**

176 This was used in this research to examine the factors that affect shrimp production. All the  
 177 functional forms were tested before selecting the double log which was best fit for Cobb-  
 178 Douglas production function model [22]. To estimate the factors affecting revenue (output),  
 179 ten inputs variables were included in the analysis. The output is the revenue of the white-leg  
 180 shrimp production while the inputs used were cost of feed [9], cost of fingerlings, fuel cost,  
 181 labor cost, cost of chemicals, and fixed cost [19]. In addition, household size, experience,  
 182 average price [24] and farm size [1] were included in the model. This model shows the  
 183 relationship between dependent variable (Y) and independent variables. ( $X_1, X_2, X_3, X_4, X_5,$   
 184  $X_6, \dots, X_{10}$ ). The production function used is specified as follows (Equation 7).

185  $\ln Y = b_0 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + b_8 \ln X_8 + b_9 \ln X_9$   
 186  $+ b_{10} \ln X_{10} + E$

187 Eqn.7

188 Where:

- |   |                                       |   |
|---|---------------------------------------|---|
| 189 <b>Y</b> = Dependent variable (Revenue)         | <b>X<sub>1</sub></b> , = Cost of feed | <b>X<sub>2</sub></b> = Cost of fingerling |
| 190 <b>X<sub>3</sub></b> = Cost of fuel/electricity | <b>X<sub>4</sub></b> = Cost of labor  | <b>X<sub>5</sub></b> = Cost of chemical   |
| 191 <b>X<sub>6</sub></b> = Household size           | <b>X<sub>7</sub></b> = Farm Size      | <b>X<sub>8</sub></b> = Average price      |
| 192 <b>X<sub>9</sub></b> = Fixed cost               | <b>X<sub>10</sub></b> = Experience    |   |

193  $b_0$  = Constant term     $b_1 - b_2$  = Parameters that were estimated     $E$  = Error term

194

## 195 **Results**

### 196 **Socio-economic features of the white-leg shrimp farmers**

197 The result of the socio-economic features of the respondents are summarized in Table 1.

198 **Table 1:** Socio-economic characteristics of the white-leg shrimp farm owners

Variables	Classification/Range	Frequency	Percentage
<b>Gender</b>	Female	5	9.6
	Male (farm owners)	47	90.4
	<b>Total</b>	52	100.0
<b>Age of farmers/ respondents</b>	21-30	1	1.9
	31-40	7	13.5
	41-50	24	46.2
	51-60	17	32.7
	>60	3	5.8
	<b>Total</b>	52	100.0
<b>Educational level</b>	Primary school	4	7.7
	Junior high school	13	25.0
	Senior high school	27	51.9
	College/university	8	15.4
	<b>Total</b>	52	100.0
<b>Shrimp farming experience</b>	<= 5	14	26.9
	6-10	31	59.6
	11-15	5	9.6
	> 20	2	3.8
	<b>Total</b>	52	100.0
<b>Household size (person)</b>	< 3	2	3.8
	3-5	41	78.8
	> 5	9	17.3
	<b>Total</b>	52	100.0
<b>Farming as a Primary occupation</b>	Yes	48	94.2
	No	3	5.8
	<b>Total</b>	52	100.0
<b>Secondary occupation</b>	Driver	1	1.9
	Factory worker	1	1.9
	Shop seller	2	3.8
	Shrimp farming	48	92.3
	<b>Total</b>	52	100.0
<b>Having technical training</b>	Yes	49	94.2
	No	3	5.8
	<b>Total</b>	52	100.0
<b>Buy fishery insurance</b>	Yes	23	44.2
	No	29	55.8
	<b>Total</b>	52	100.0

199

**Source:** Field survey

200 Majority (90.4%) of the white-leg shrimp farm owners sampled were male while female

201 (mostly family members) represent 9.6%. Most (46.2%) of the respondents fall within the age



202 group of 41-50 years, 32.7% fall within the age bracket of 51-60. The minimum and  
 203 maximum age of farmers ranges from 22 to 75 years (48.9±8.25). Regarding the educational  
 204 level, the result showed that 32.7% of the respondents had one form of educational (Primary  
 205 and junior high school) exposure while 51.9% and 15.4% had senior high school and college  
 206 education respectively. The Table 1 also shows that 59.6% of the farmers have 6-10 years of  
 207 experience in white-leg shrimp farming. Experience ranges from 2 to 24 years with average  
 208 experience of 8.2 years and standard deviation of 4.2 years. Based on household size, the  
 209 result indicated that most of respondents have 3-5 persons per family, representing 78.8%.  
 210 Household size is between 2 to 8 people (4.6±1.3). Finally, 94.2% of the respondents had  
 211 secured technical training.

212

### 213 Sources of Input Employed

214 Table 2 shows different types of sources of inputs employed by the white-leg shrimp farmers  
 215 in the study area.

216 **Table 2:** Percentage distribution of Inputs employed in white-leg shrimp production

Variables	Classification/Range	Frequency	Percentage (%)
<b>Sources of seed/feed</b>	Self-breeding/self-made feed	8	15.4
	Buy from local enterprise	40	76.9
	Buy from non-local enterprise	4	7.7
	<b>Total</b>	<b>52</b>	<b>100.0</b>
<b>Weight of seed</b>	(5-8g)	6	11.5
	(10-12g)	46	88.5
	<b>Total</b>	<b>52</b>	<b>100.0</b>
<b>Type of feed used</b>	Sinking pellet	49	94.2
	Floating pellet	3	5.8
	<b>Total</b>	<b>52</b>	<b>100.0</b>
<b>Financial sources</b>	Individual savings	47	90.38
	Loan from relative	21	40.38
	Loan from bank	17	32.69
	Loan from relatives	3	5.77
	<b>Total</b>		<b>171.15*</b>

217 \*Total percentage greater than 100 as a result of multiple responses

218

**Source:** Field survey, 2017

219 Most (76.9%) of the respondents sourced shrimp seed, feed and medicine from local  
 220 enterprise, 15.4% of the farmers make their own feed and breed their own fingerlings while  
 221 7.7% sourced feed and seed from non-local enterprise. Majority (94.2%) of the farmers used  
 222 sinking pellet while 5.8% used floating pellet. The results further showed that most (90.38%

223 showing multiple responses) of the respondents sourced their working capital from personal  
 224 savings. 40.38% of the farmers used loan from relative, 32.69% accessed loans from the bank  
 225 while 5.77% sourced funding from cooperatives.

226

### 227 **White leg shrimp farm size (ha) and stocking density**

228 The areas of shrimp farm (ha) owned by the farmers is shown below. Most (57.7%) of the  
 229 farm size operated by the farmers is less than 7ha. Majority (69.2%) of the farmers stocked  
 230 between 1,000,000-40,000,000ha fingerlings while 30.8% of the respondents stocked  
 231 between 41,000,000-200,000,000ha fingerlings. The mean stocking density of fingerlings  
 232 was 31,618,245.5.

233 **Table 3:** Area of Shrimp farming (size/ha) and stocking density (ha)

Variables	Range	Frequenc y	Percent age	Min	Max	Mean	Std.
<b>Area-2016</b>	< 7.0	30	57.7				
	7-27ha	22	42.3	26.7	2000.4	240.75	311.08
	<b>Total</b>	52	100.0				
<b>Stocking density</b>	1,000,000-40,000,000	36	69.2	1,017,2	150,030	31,618	29,837,4
	41,000,000-200,000,000	16	30.8	97.4	,000.0	,245.5	94.9
	<b>Total</b>	52	100.0				

234 **Source:** Field survey.

235

### 236 **Profitability and Breakeven Analysis of white-leg shrimp production**

237 Table 4a and b show the costs as well as returns and profitability ratios of White-Leg shrimp  
 238 farming with variable costs (89.2%) representing the largest cost out of total cost of white-leg  
 239 shrimp production. Feeds alone accounted for the largest proportion (34.3%) of the total cost.  
 240 This is followed by fingerlings, fuels and labors costs, accounting for 13.1%, 12.7% and 10.4%  
 241 respectively, of the total costs.

242

243

**Table 4a:** Costs analysis of White-Leg Shrimp Farms.

Cost Items	Amounts (CNY)/ha	Percentage (%) Total Cost
<b>Variable Costs</b>		
Fingerlings	71,407.61	13.1
Shrimp feed	187,173.58	34.3
Chemical	24,798.18	4.5
Labor wage	57,038.40	10.4
Electricity/fuel	69,098.43	12.7
Manger salary	45,673.08	8.4
Others	32,147.39	5.9
<b>Total Variable Cost (TVC)</b>	<b>487,336.67</b>	<b>89.2</b>
<b>Fixed Costs</b>		
House construction	10,150.64	1.9
Pond construction	24,988.46	4.6
Hatchery construction	3,130.77	0.6
Aerators	4,254.81	0.8
Feeders	2,458.33	0.5
Pump	4,047.12	0.7
Vehicle/Tricycle	7,685.90	1.4
Boats	200.00	0.0
Nets	481.73	0.1
Others	1,480.77	0.3
<b>Total Fixed Cost (TFC)</b>	<b>58,878.53</b>	<b>10.8</b>
<b>Total Cost</b>	<b>546,215.20</b>	<b>100.0</b>

244

**Source:** Field survey

245

246 The fixed cost accounted for 10.8% of the total production cost. Also, the result revealed that  
 247 the farmers spent a total cost of CNY546,215.20/ha (Table 4a) and secured a total revenue of  
 248 CNY924,359.74/ha with a net farm profit of CNY378,144.55 from shrimp sold at an average  
 249 price of CNY43/kg (Table 4b).

250

**Table 4b:** Returns and profitability ratios of White-Leg Shrimp Farms

Yield (kg)	21,283
Price of shrimp (kg)	43
Revenue	924,359.74
Net Farm Income (NFI)/Profit	378,144.55
Benefit Cost Ratio (BCR)	1.69
Gross margin	437,023.07
Gross Margin Ratio (GMR)	0.47
Return on Investment (ROI)	0.69
Percentage Profitability (PP)	69.23
Breakeven Price	25.6
Breakeven Yield	2,867

251

252 The results of the profitability ratio analysis showed that the white-leg shrimp farmers in the  
 253 study area had a positive Gross Margin Ratio (GMR) of 0.47, a Benefit Cost Ratio (BCR) of

254 1.69, Return on Investment (ROI) of 0.69 and Percentage Profitability (PP) of 69.23. From  
 255 Table 4b, it can be seen that the breakeven yield and the breakeven price were recorded as  
 256 2,867 Kg and CNY25.7/kg, respectively.

257

### 258 **Regression Results; Factors influencing white-leg shrimp production**

259 Table 5 shows the results of the regression analysis of factors affecting revenue. The  
 260 independent variables such as input variable (feed, fingerling, labor), socio-economic  
 261 variables like, farming experience, household size showed negative relationship with  
 262 revenue. Other independent variables included were farm size and average price both  
 263 exhibiting positive relationship with revenue.

264 **Table 5:** Multiple regression analysis result of the determinant of shrimp revenue.

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error			
(Constant)	-1.924	4.703		-2.842	.007***
Feed	-1.468	5.235	-.083	-2.191	.034**
Seed/fingerlings	-8.546	6.218	-.061	-1.760	.086*
Fuel	6.585	5.389	.015	.428	.671
Labor	-3.940	9.484	-.014	-.415	.680
Chemical	9.874	5.335	.014	.390	.699
Fixed cost	11.371	0.445	.020	.556	.581
Experience	-6.538	0.393	-.081	-2.351	.024***
Household size	-5.025	0.712	-.033	-.974	.336
Farm size	3.375	9.910	.974	25.268	.000***
Average price	1.961	0.814	.235	6.611	.000***
F -Statistics	97.95				.000***
R <sup>2</sup> Adjusted	0.950				
R <sup>2</sup>	0.960				

265 Dependent Variable: Revenue, \*\*\*Variables significant @1%, \*Variables significant @10%

266

**Data source:** Field survey.

267

### 268 **Test for Hypothesis 1: H<sub>0</sub>: High cost of feed and fingerling does not lead to less revenue**

269 Based on the result in Table 5, it was revealed that the costs of feed and fingerlings showed  
 270 negative relationship with revenue. This negative sign indicated that feed and fingerlings  
 271 moved in opposite direction to revenue. In addition, feed and fingerlings were statistically  
 272 significant at 5% and 10% respectively. Which means, high cost of these input variables  
 273 affect revenue negatively. This explanation does not agree with the null hypothesis that states  
 274 that high cost of feed and fingerlings does not lead less revenue but rather in favour with the  
 275 alternative.

276

277 **Test for Hypothesis 2:  $H_0$ : There is no significant relationship between the farm size,**  
 278 **average price of the white-leg shrimp products and the revenue**

279 With regards to the results, farm size and average price of white-leg shrimp product exhibited  
 280 positive relationship at 1% level of significant to revenue. It means that 1% increase in the  
 281 average price of shrimp products would result to 23.5% increase in revenue. The larger the  
 282 farm size the more revenue generation ceteris paribus. Based on this strong statistically  
 283 significant level of 1% for farm size and average price with revenue, the null hypothesis  
 284 which states that there is no significant relationship between farm size, average price and  
 285 revenue is rejected and the alternative is accepted. That is, there is significant relationship  
 286 between farm size, average price and revenue.

287

### 288 **Constraints encountered by shrimp farmers**

289 Table 6 summarized the constraints encountered by farmers in White-leg shrimp production.  
 290 Total percentage is greater than 100% indicating multiple responses. The major constraints  
 291 highlighted by the farmers are; Quality of shrimp seed (80.8%), Water quality (63.5%) and  
 292 shrimp disease (32.7%) while minor constraints were low shrimp price (13.5%). frequent  
 293 natural disaster (5.8%) and technology request (3.8%).

294 **Table 6:** Percentage distribution of constraints encountered by shrimp farmers

Variables	Frequency	%*
Quality of shrimp seed	42	80.8
Shrimp disease	17	32.7
Water quality	33	63.5
Low shrimp price	7	13.5
Frequent natural disaster	3	5.8
Technology request is high	2	3.8
<b>Total</b>		200.0*

295 (\*) Total percentage greater than 100% due to multiple responses

296 **Data Source:** Field survey.

## 297 **Discussion**

### 298 **Farmer's socio-economic characteristics**

299 Gender is an important socio-economic factor that plays significant role in aquaculture, in  
 300 terms of assets acquisition, for example, land and machines. Majority (90.4%) of the White-  
 301 leg shrimp farmer sampled for this study were males. With regards to age, it has been

302 revealed that most White-leg shrimp farmers' fall within the ages of 41 to 60 years  
303 representing 78.9%. These are within the productive and economically active ages which  
304 indicate better future for shrimp production. This assertion is in agreement with [17] that  
305 these age brackets are considered as economically active ages. In term of the household size,  
306 it was discovered that 78 percent of the respondents have family size ranging from 3-5  
307 persons per household. It means that increase in household size can lead to an increase in  
308 white-leg shrimp production. This result is in line with [10] that large family size supports  
309 productivity in fish farming. The research further discovered that the respondents usually get  
310 technical training from fellow farmers and organizations. Majority (90.38%) of the  
311 respondents depended on their own personal savings source of funding. This result is in  
312 agreement with the findings of [5] which stated that most fish farmers in Cross River and  
313 Ogun States, Nigeria sourced working capital from personal savings. The study also revealed  
314 that very few shrimp farmers access loans from bank (32.69%). This could be as a result of  
315 high interest rate. This assertion is in line with the suggestion given by [19] who said that the  
316 inability of fish farmers to assess bank might be connected to its high rate of interest.

317

#### 318 **White-Leg Shrimp production costs and profitability**

319 Based on the cost and return analysis, it was revealed that the four most important cost items  
320 among the production cost are shrimp feed (34.3%), fingerlings (13.1%), fuel/electricity cost  
321 (12.7%) and labour (10.4%). [9] conducted a study on White-leg shrimp farming in Song Cau  
322 District, Phu Yen Province Vietnam and concluded that the highest variable cost item is feed  
323 which accounted for 45.19% of the total cost of production. [15] had also reported that  
324 farmers had to spend large sum of money on feeds during production process. The high cost  
325 of electricity shows that significant amount of money was spent by white-leg shrimp farmers  
326 on electricity to run aerators, pumps and feeders for efficient shrimp production. This may be  
327 as a result of the fact that China has expanded electricity even to the most remote rural areas  
328 hence contributing to an increase productivity and profitability from aquaculture production.

329 Revealed from the profitability analysis showed that white-leg shrimp farmers obtained a  
330 profit of CNY378,144.55 (\$58,176) per hectare. [9] examined the profitability of White-leg  
331 shrimp farms and revealed an average profit of 78,883,209 VND (\$3,944.16), per hectare for  
332 the shrimp farmers. Benefit Cost Ratio (BCR) was found to be 1.69. It means that the white-  
333 leg shrimp farming is profitable because the BCR is greater than 1 and farmers can pay for  
334 both fixed and operational costs. [14] indicated that as a rule of thumb, project with cost ratio

335 greater than one, equal to one or less than one, shows profit, break-even or less profit,  
336 respectively. White-leg shrimp farming is profitable with positive Gross Margin of  
337 437,023.07. This is in agreement with the finding of [6] that fish farming enterprise were  
338 profitable in the short run with gross margin greater than total variable cost. [16] also  
339 reported that positive gross margin shows that a fish farming enterprise would make  
340 reasonable profit as long as these farms kept overhead costs in control. The research  
341 discovered that the Percentage Profitability (PP), Return on Investment (ROI) and Gross  
342 profit margin ratio were found to be 69.23%, 0.69 and 0.47 respectively. For every 1.00CYN  
343 invested, the farmers were able to gain CYN0.69 at a percentage rate of 69.23%. [18] in their  
344 study on fish farming showed that the return on investment was 0.92 which implies that for  
345 every one naira invested, 92 kobo was gained. The higher gross profit margin shows the  
346 farms are profitable. According to [16], a ratio of 0.35 or higher is more desirable.

347

#### 348 **Regression analysis of explanatory variables**

349 Multiple regression results revealed that white-leg shrimp revenue is significantly influenced  
350 by the cost of inputs. Out of the 10 independent variables, 5 significantly influence revenue at  
351 various level of significance. Cost of feed, seed, experience, farm size and average price  
352 significantly influence revenue at 5%, 10%, 1%, 1% and 1% level of significance respectively.  
353 Farm size and average price met their expected signs of positive while the other three were  
354 negative. It shows that an increase in farm size and average price would increase the overall  
355 revenue of the farmers and vice versa for the others. According to [19], input costs affect  
356 revenue. For the farm size, the study agreed with the finding that large farm sized produced  
357 the highest yield [1]. The result further revealed that one unit increase in the average price of  
358 white-leg shrimp products resulted to 23.5% increase in revenue. This finding is in agreement  
359 with the ideas of [24] which states that an increase in average price of shrimp will lead to an  
360 increase in white-leg shrimp production. [21] also stated that selling price was the most  
361 significant variable for white-leg shrimp production.

362

#### 363 **Conclusions**

364 Based on the analysis and the results obtained, it can be concluded that most White-leg  
365 shrimp farmers in the study area depend on their own source of savings for farming. A high  
366 percentage of farmers bought seeds and feed from local enterprise and operate less than 7ha  
367 of pond size. The three major highest production costs are: feed, fingerlings and

368 electricity/fuel cost. The results further showed that White-leg shrimp farms are profitable  
 369 based on the percentage profitability, return on investment and gross margin ration obtained.  
 370 The factors affecting revenue are: cost of feed, cost of seed, experience. Farm size and  
 371 average price of White-leg shrimp production. The three important challenges faced by the  
 372 farmers are low quality of seed, water quality and disease.

373

## 374 **References**

- 375 1. Begum, M.E.A., Hossain, M.I., Tsiouni, M. and Papanagiotou, E. Technical  
 376 Efficiency of Shrimp and Prawn Farming: Evidence from Coastal Region of  
 377 Bangladesh. Proceeding of the 7<sup>th</sup> International Conference on Information and  
 378 Communication Technologies in Agriculture, Food and Environment, Kavala, Greece.  
 379 2015, 842-857 pp.
- 380 2. Biao, X., Kaijin, Y. Shrimp farming in China: Operating characteristics,  
 381 environmental impact and perspectives. *Ocean and Coastal Management*. 2007, 50,  
 382 538-550 pp.
- 383 3. Cao and Ling. Farming Shrimp for the Future: A Sustainability Analysis of Shrimp  
 384 farming in China. PhD thesis, University of Michigan. 2012, 1-6 pp.
- 385 4. China Fisheries Yearbook. Yearbook Publishing House. 2016, 7-15 pp.
- 386 5. Ekanem E., Damian A., and Etim, G. Socioeconomic Analysis of Fish Farming in  
 387 Cross River State, Nigeria: Implication for Food Security Tropentag, Göttingen  
 388 Resilience of agricultural systems against crisis. 2012, 1-56 pp.
- 389 6. Emokaro, C. O., Ekunwe, P.A, and Achille, A. Profitability and Viability of Catfish  
 390 Farming in Kogi State, Nigeria. *Research J. of Agriculture and Biological Science*.  
 391 2010, 215-219 pp.
- 392 7. FAO, Food and Agriculture Organization. World review of fisheries and  
 393 aquaculture.2012, 77 pp.
- 394 8. FIGIS, Fisheries Global Information System. (2015), 3-15pp.  
 395 <http://www.fao.org/fishery/statistics/global>
- 396 9. Hoai T. N. Profitability and technical efficiency of black tiger shrimp (*Penaeus*  
 397 *monodon*) culture and white leg shrimp (*Penaeus vannamei*) culture in song Cau  
 398 district, Phu yen province, Vietnam. The Norwegian College of Fishery Science  
 399 University of Tromso, Norway & Nha Trang University, Vietnam. 2012, 1-56 pp.
- 400 10. Kumolu-Johson. C.A and Ndimele, P.E. Length-Weight relationships and condition



- 401 factors of twenty-one fish species in Ologe lagoon, Lagos, Nigeria. *Asian Journal of*  
402 *Agricultural Science*. 2010, 2(4):174-179 pp.
- 403 11. Ma, S. and Bao, W. Shrimp Farming in China Ocean University of China. 2011, 1-55  
404 pp.
- 405 12. Meador, M. and Xinping Wu. People's Republic of China Fishery Products Annual.  
406 USDA Foreign Agricultural Service. Global Agriculture Information Network (GAIN)  
407 Report Number. 2012, Pp. 1-56 pp.
- 408 13. Mungkung, R.T. Shrimp Aquaculture in Thailand: Application of life cycle  
409 assessment of support sustainable development PhD Thesis. Centre for Environment  
410 Strategy, School of Engineering, University of Surrey, United Kingdom. 2005, 1-5 pp.
- 411 14. Olagunju F. I., Adesinyan I. O, Ezekiel A. A. Economic Viability of Cat Production in  
412 Oyo State. *Journal of Human Ecology*. 2007, 21(2): 121-124 pp.
- 413 15. Olaoye O J. Dynamics of the Adoption Process of Improved Fisheries Technologies in  
414 Lagos and Ogun States Nigeria. Ph. D thesis, Federal University of Agriculture,  
415 Abeokuta, Ogun State, Nigeria. 2015, 337 pp.
- 416 16. Olasunkanmi, J. B. Economic Analysis of Fish Farming in Osun state, South-Western  
417 Nigeria. IIFET, Tanzania Proceedings, Tanzania. 2012, 2-45 pp.
- 418 17. Olowosegun, T., Sanni, A. O., Sule, A. M and Bwala, R. L Contribution of women to  
419 fisheries development in Kainji Lake Basin in 2004 FISON Conference proceedings.  
420 2004, 91-97 pp.
- 421 18. Okpeke et al. Analysis of The Profitability of Fish Farming in Warri South Local  
422 Government Area of Delta State, Nigeria. *IOSR Journal of Agriculture and Veterinary*  
423 *Science (IOSR-JAVS)* e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 8, Issue 12  
424 Ver. I. 2015, 45-51 pp.
- 425 19. Omobepade B. P. et. al. Profitability Analysis of Aquaculture in Ekiti State, Nigeria.  
426 *Nigerian Journal of Agriculture, Food and Environment*. 2015, 11(1): 114-119 pp.
- 427 20. Prein, M. Comparative analysis of material flows in low input carp and poultry  
428 farming an overview of concept and methodology, In D.M. Bartley, C. Brugere, D.  
429 Soto, P. Gerber, B. Harvey (eds). Comparative Assessment of the environment costs  
430 of aquaculture and other food production sectors: methods for meaningful  
431 comparisons. FAO fisheries proceeding. 2007, No. 10. Rome, 183-199 pp.
- 432 21. Quagraine, K. Profitability of Indoor production of Pacific White Shrimp  
433 (*Litopenaeus vannamei*): A case Study of the Indiana Industry. Agriculture Economic  
434 & Marketing Specialist, Purdue University. 2015, 1-7 pp.

- 435 22. Rahaman, M.M., Mallick, N., Shamsuzzaman MD. M, Rahaman, M.Z. Sarker, S. On  
436 the Way of Success: Aquaculture Economics of Noakhali, Bangladesh. 2012, 556 pp.
- 437 23. Salim. Role of fish as food to human nutrition. International conference on” solving  
438 problems of Freshwater Fish Farming in Pakistan”. UVAS, Lahore. 2006, 23-45 pp.
- 439 24. Tammaroopa, K., Suwanmaneepong, S. and Mankeb, P. Socio-Economic Factors  
440 Influencing White Shrimp Production in Chachoengsao Province, Thailand.  
441 *International Journal of Agricultural Technology*. 2016, Vol. 12(7.2):1809-1820 pp.
- 442 25. Wikipedia. Nantong. Access in 15 May 2018. <https://en.wikipedia.org/wiki/Nantong>  
443 Accessed May. 22, 2018.
- 444 26. Wikipedia. Rudong. 27 April 2018. [https://en.wikipedia.org/wiki/Rudong\\_County](https://en.wikipedia.org/wiki/Rudong_County). 22  
445 May, 2018.
- 446 27. Yuan, Y., Cai, J., Leung, P. An overview of China’s Cultured Shrimp Industry.  
447 Shrimp culture; Economic market and Trade. Edited by PingSun Ling and Carole  
448 Engle, World Aquaculture Society and Blackwell Publication. 2006, 1-65 pp.