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Giant freshwater prawn (*Macrobrachium rosenbergii* de Man, 1879) farming in brackish water areas of the Mekong Delta, Vietnam

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ABSTRACT

Giant freshwater prawn (Macrobrachium rosenbergii de Man, 1879) is one of important aquaculture species in Vietnam, especially the Mekong Delta. Farming of giant freshwater prawn has been so far very well-known in the freshwater area with some important systems, typically the alternative rice-prawn farming system. However, this activity has recently expanded rapidly and largely to the brackish water area. Currently, there are 15,270 ha of prawn culture in the Mekong Delta with total production of 5,306 tons, of which coastal provinces cover for 90.1% of total culture area, and 64.8% of total production. Two important systems for prawn culture in the brackish water area are (1) prawn and rice farming alternatively with tiger shrimp culture on the rice field; and (2) prawn culture in pond alternatively with tiger shrimp culture. The survey on 108 households in Bac Lieu and Tra Vinh provinces found that the system (1) is in extensive management with the average yields of 110 kg/ha/crop and net income of 11.5 million VND/ha/crop, the system (2) is considered the semi-intensive farming system with the average yield and net income of 886 kg/ha/crop and 68 million VND/ha/crop, respectively. A trial on prawn culture in 9 brackish water ponds with salinity of 0-10‰ carried out in Tra Vinh province showed improved yield as of 988-1342 kg/ha/crop. Prawn culture contributed significantly to the total income of the farming systems. The success of these new farming systems together with a large area of brackish water surface in the Mekong Delta gives prawn farming a great potential for further development.

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1 INTRODUCTION

World production of cultured giant freshwater prawn in 2014 attained 216,856 tons (FAO, 2016). Prawn culture in the world is diverse and classified with different systems, from extensive farming systems to intensive farming systems with specific advantages and disadvantages (Valenti and New, 2000). With abilities of high tolerance and adaptation to salinity, the giant freshwater prawn can grow well in brackish water up to 5-10 ‰ (Huong *et al.*, 2010; Huong *et al.*, 2015). This enables the culture of giant freshwater prawn in brackish water area where are recently practiced around (Chand *et al.*, 2015).

In Vietnam, the Mekong Delta is the main aquaculture area. The traditional systems such as prawn culture in garden ditch, prawn-rice integration have been practiced in freshwater areas. Since early 2000, prawn culture developed rapidly in the rice field during flooding season in An Giang and Dong Thap provinces. Intensive pond culture of prawn was also practiced. Prawn yield greatly varied with different systems (Phuong *et al.*, 2008, 2009; Long *et al.*, 2011). In recent years, prawn culture has been extended to the coastal provinces. According to the master plan of Directorate of Fisheries (2012), prawn culture target will attain 32,060 ha and 60,000 tons by the year 2020. Owing to the issues of climate change and saline water intrusion in the region (Ministry of Natural Resources and Environment, 2009) and penaeid shrimp diseases problems, the need for diversification of culture species and farming systems in the brackish water area of over 600,000 ha, the introduction and extension of the giant freshwater prawn in the brackish water can be one of the appropriate solutions for this circumstance. Therefore, the aim of this study was to evaluate the current status as well as to conduct the trial on freshwater prawn culture in the coastal region to provide scientific basis for further planning and development of this species in the Mekong delta.

2 STUDY METHODOLOGY

2.1 Survey and evaluation of the status of freshwater prawn in brackish water in the Mekong Delta

The survey was carried out in Bac Lieu and Tra Vinh provinces in the year of 2013. Secondary data were collected in 2013-2015 from annual reports of Fisheries Division, Department of Agriculture and Rural Development in the provinces for information of the period of 2010-2014. Primary data were collected through the interview of 60 prawn farmers in Bac Lieu province applying the popular system (1) of prawn and rice farming alternatively with tiger shrimp culture on the rice field; and 48 prawn farmers in Tra Vinh province applying the popular system (2) of prawn culture in pond alternatively with tiger shrimp culture. Sample sizes of 60 and 48 were large enough for statistical analysis and comparison, and also reflected that the system (1) is more popular than the system (2). The interview was based on the prepared questionnaires which content mainly (i) general information of farms, (ii) technical aspects, (iii) economical aspects, (iv) advantages and disadvantages of farming, and (v) plan and suggestion. Major technical and socio-economical aspects of the systems were analyzed in detail.

2.2 Experiment on prawn culture in pond alternatively with tiger shrimp culture in Tra Vinh province

A total of 9 brackish water ponds (salinity of 0-10‰) in 3 districts of Duyen Hai, Cau Ngang, and Tra Cu belonging to Tra Vinh province were selected for the trial in 2013. Each pond is 4000 m^2 in area with 1.5 m depth. After harvesting tiger shrimp in June, the ponds were prepared for prawn culture. Freshwater prawns (PL15) with initial body weight (BW) of 0.02 g were stocked at density of 7 inds/m^2, and fed with commercial feed (UP feed, 35% protein) 4 times a day at the rates of 15-10% of BW from the first to the fourth month and 2-3% BW from the fifth month onward. No water exchange was done in the first month. From the second month onward, 30% of pond water was exchanged twice a month. Water quality parameters were recorded every 2 weeks during culture period such as temperature, pH, and dissolved oxygen which were measured twice a day at 6:00 am and 2:00 pm; the concentrations of total ammonium nitrogen (TAN), nitrite, and alkalinity which was determined at 6:00 am. Growth performance, production, and yield of prawn as well as financial aspects were evaluated after six moths of culture.

3 RESULTS AND DISCUSSION

3.1 Development of freshwater prawn culture in the Mekong Delta

Prawn culture area, production and yields in the freshwater and coastal provinces in the Mekong Delta during 2010-2014 were presented in Fig. 1, 2, and 3. The results showed that total area of prawn culture in the Mekong Delta ranged from 11,225-15,270 ha during 2010-2014, of which coastal provinces cover for 83.7-90.9% of total culture area and tended to increase further in the areas. Ben Tre, Tra Vinh, Bac Lieu, and Ca Mau are the main coastal provinces for prawn culture, meanwhile Dong Thap and An Giang are the main freshwater provinces for prawn farming so far.

Total production of prawn recently ranged from 5,290-6,147 tons, of which the coastal province covered for 48.9-67.4% of production. Farms in the the freshwater provinces applied mainly semi-intensive prawn culture with high stocking densities on rice field giving relatively high yield (982-2,067 kg/ha/crop); meanwhile the farms in the coastal provinces applied mainly the integrated rice-prawn systems with low stocking densities giving sustainable yields of about 369-430 kg/ha/crop. Compared to the coastal areas, prawn culture in the freshwater region has been developed

rather slowly so far; this situation could be due to the unstable source of annual flooding water, due to economical consideration for many potential farming species or due to some problems occurred during prawn culture. Furthermore, the coastal provinces with large area seasonally affected with brackish and freshwater or low salinity year-round are increasingly promising for development of freshwater prawn culture. The Mekong Delta is very well-known with the alternative-rice shrimp farming system which has been developed for several decades (Preston and Clayton, 2003), and recently reached to over 160,000 ha (Hai *et al.*, 2015) together with a large area of low salinity in the intensive shrimp ponds. These indicate a great potential area for integration of the giant freshwater prawn culture in the systems.

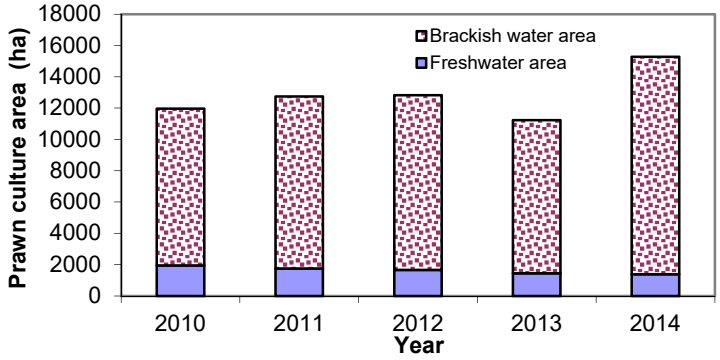

Fig. 1: Prawn culture area (ha) in the freshwater and coastal provinces in the Mekong Delta

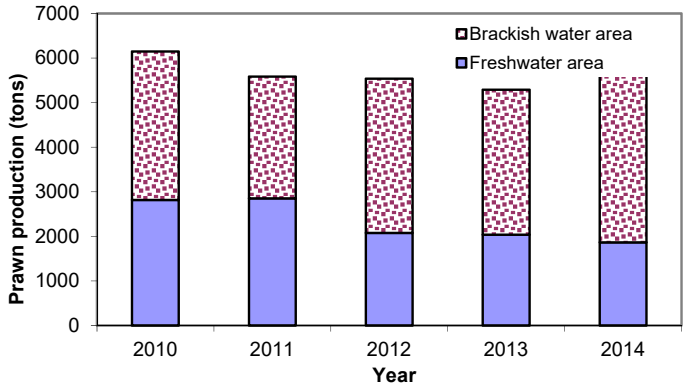

Fig. 2: Prawn culture production (tons) in the freshwater and coastal provinces in the Mekong Delta

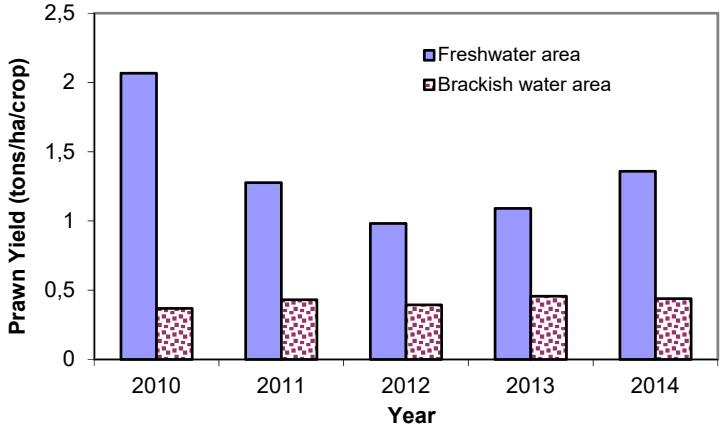

Fig. 3: Prawn culture yields (tons/ha/crop) in the freshwater and coastal provinces in the Mekong Delta

3.2 Current technical and financial aspects of some main prawn farming systems in the brackish water area of the Mekong Delta

3.2.1 Prawn and rice farming alternatively with tiger shrimp culture on the rice field

The results of the survey on the system (1) were presented in Table 1. The prawn farms had an average area of 2.15±1.07 ha, and peripheral ditch of 29.1±5.08% of the farm area. After harvesting tiger shrimp, prawn culture season was started from June when salinity still relatively high (salinity range of 5-10‰). Prawn postlarvae (PL) were stocked at average density of 1.05±0.6 inds/m^2. During culture, prawns only relied on natural feed, and water was exchanged casually. Especially, water salinity fluctuated from 2 to 10 ‰ during the culture, and during heavy rainy season (September-December) with salinity of lower than 4 ‰ that is the time for integrating with rice cultivation. After 6-8 months of culture, prawns were harvested at BW of 47.9±10.9 g with yield of 110±52.7 kg/ha/crop. Generally, the yield of prawn in this integrated system was similar to the yield of prawn in the integrated rice-prawn systems in freshwater area and lower than those of the alternative rice-prawn farming system in the area (Phuong *et al*., 2008, 2009; Salin *et al*., 2009; Long and Han, 2011).

Table 1: Technical characteristics of prawn-rice farming system

Technical characteristic	Unit	Average	Min-Max
Farm structure			
Farm area	ha	2.15±1.07	0.5-5.0
Ditch ratio	%	29.1±5.08	20.0-45.0
Ditch depth	m	0.967±0.060	0.8-1.0
Water level on flatform	m	0.457±0.056	0.4-0.6
Prawn stocking			
Prawn size at stocking	cm	1.26±0.105	1.1-1.5
Month of stocking	Lunar calendar		5-7
Stocking density	inds/m^2	1.05±0.602	0.2-4.0
Monitoring			
Salinity	‰	5.22±1.87	2.0-10.0
Water exchange interval	Days	18.3±6.23	15.0-30.0
Amount of water exchange	%/time	28.0±6.84	20.0-50.0
Feeding	No feeding or only supplementation		
Harvest			
Culture period	month	7.18±1.11	6.0-8.0
Size at harvesting	g/ind.	47.9±10.9	31.2-71.4
Productivity	kg/ha/crop	110±52.7	50-300
Survival rate	%	18.5±8.38	4.9-40.0

Data are shown as mean value± standard deviation

Financial analysis (Table 2) showed that in this system, production cost and gross income of tiger shrimp and rice farming were higher than those of prawn farming. However, the benefit per cost ratio (B/C) of these crops (160% and 130% respectively) was much lower than that of prawn (390%). Of 50.9 million VND/ha/year in total net income, tiger shrimp, rice, and prawn accounted for 44.9%, 32.4%, and 22.7%, respectively. This showed various products and the important role of prawn in this system.

Table 2: Financial efficiency of prawn-rice-shrimp farming system (million VND/ha/year)

Criteria	Giant Fresh water prawn	Tiger shrimp	Rice	Total
Total production cost	3.50±2.30 (0.71-13.1)	14.2±2.90 (10.0-25.0)	12.6±0.982 (10.0-16.6)	30.5±4.8 (23.7-47.10)
Gross income	15.1±8.40 (6.00-51.0)	37.1±8.50 (22.8-60.0)	29.1±1.60 (23.7-36.6)	81.4±14.6 (61.7-131)
Net income	11.5±6.80 (3.10-37.9)	22.8±6.10 (12.5-36.6)	16.5±1.40 (12.5-20.0)	50.9±10.6 (33.7-90.0)
B/C (%)	390±206 (60-790)	160±28 (100-200)	130±15 (100-180)	170±20 (120-260)

Data are shown as mean value± standard deviation (min-max)

Regression analysis indicated that prawn yield (Y, kg/ha) in the system is significantly affected by 5 factors, including X_1: Years of culture experience (years), X_2: stocking density (PL/m^2); X_3: culture period (months); X_4: survival rate (%); X_5: harvesting size of prawn (g). Equation is expressed as follows:

$Y = -99,37 + 3\ X_1 + 68\ X_2 - 2X_3 + 4,0\ X_4 + 1,2\ X_5$ (1)

($R= 0,85$; $R^2= 0,72$; $P=0,00$)

Effect of other factors such as prawn seed sources, nursing, and harvesting methods on prawn yield were also analyzed but did not show significant differences.

3.2.2 Prawn culture in pond alternatively with tiger shrimp culture

The results of the survey (Table 3) showed that area of the ponds for prawn culture are in common size of 0.6±0.588 ha and 1.32±0.108m in depth. After harvesting tiger shrimps, the ponds were prepared for prawn culture which usually started from June annually. Prawn postlarvae were normally stocked at 8.97±3.58 inds/m^2. During culture, prawns were fed with commercial feed alone or commercial feed combined with trash fish or home-made feed. Water exchange was conducted every two weeks follow spring tide. Since the ponds located in the coastal area where salinity varied in range of 1-10 ppt with average of 5 ppt. After 5-6 months of culture, prawns were harvested at 34.9±9.23g in BW with average yield of 886±642 kg/ha/crop.

For this system, total production cost was 208±164 million VND/ha/year, of which cost for prawn and tiger shrimp farming were 59.4±37.1 million VND/ha/year and 149±158 million VND/ha/year, respectively. Production cost for freshwater prawn was very low; however, net income for prawn was comparable and B/C was much higher than those of tiger shrimp farming (Table 4). In freshwater area, depending on stocking densities on rice fields or in ponds, production of prawn also varies in the range of 500-1500kg/ha/crop (Phuong *et al*., 2008, 2009; Long and Han, 2011).

Yield (kg/ha/crop) of giant freshwater prawn pond culture in Tra Vinh province depended on some major factors including time of experience - X_1 (years); stocking density - X_2 (PL/m^2); culture period - X_3 (months); survival rate - X_4 (%); harvesting size - X_5 (g) following the equation $Y= 25\ X1 + 103\ X + 2,7\ X3 + 31\ X4 + 31\ X5 - 2.151$ ($R= 0,94$; $R^2=0,88$; $p=0,00$).

Table 3: Technical characteristics of semi-intensive prawn culture (alternative with tiger shrimp)

Technical characteristics	Unit	Average	Min-Max
Pond			
Pond area	ha	0.6±0.588	0.2-4.2
Pond depth	m	1.32±0.108	1.0-1.5
Liming	kg/ha	39.3±4.9	0-125
Prawn stocking			
Size of postlarvae	cm	1.21±0.068	1.1-1.5
Stocking density	inds./m^2	8.97±3.58	2.8-15.6
Management			
Feeding	Commercial feed combined with homemade food and trash fish		
Water salinity	‰	5.0±2.19	1.0-10.0
Water exchange	time/day	20.1±7.20	15-30
Water exchange rate	%/time	27.4±7.47	10-50
Culture period	months	5.6±0.7	3-6
Harvest			
Prawn size at harvest	g	34.9±9.23	18.2-58.8
Yield	kg/ha/crop	886±642	125-2.812
Survival rate	%	28.2±14.6	4.0-58.8

Data were shown as average value± standard deviation (min-max)

Table 4: Financial efficiency of prawn-shrimp farming system

Criteria	Freshwater prawn	Tiger shrimp	Total
Unit (million / ha / year)			
Production cost	59.4±37.1 (18.0-176)	149±158 (5.6-667)	208±164 (26.6-735)
Gross income	127±104 (21.3-478)	234±271 (0-1.040)	362±309 (23.1-1.300)
Net income	68.0±86.9 (152-393)	86.0±12.8 (0,10-440)	154±174 (223-611)
B/C ratio (%)	120±100 (90-460)	40±80 (100-230)	70±60 (90-260)

Data were shown as mean value± standard deviation (min-max)

3.3 Trial on prawn culture in brackish water ponds in Tra Vinh province

3.3.1 Water quality parameters during culture of prawn

Table 5 presents the average and variation of some major water quality parameters during culture of the giant freshwater prawn in Tra Vinh (rainy season) after culture of tiger shrimp (dry season). Average temperature (27.4-28.13ºC), pH (7.69-7.76) and alkalinity (78.86-83.92) were in suitable ranges for prawn. Water salinity during culture fluctuated from 0 to 10 ‰ (Fig. 4). The lowest salinity of 2-4 ppt was found from the second to the fourth month of culture during heavy rainfall period. In early and later stage of the culture period, the culture ponds normally had higher salinity (4-10 ‰). Prawn ponds in Duyen Hai district had higher salinity compared to those in Cau Ngang and Tra Cu districts. Generally, two important factors such as alkalinity and salinity in the culture ponds were in the optimal ranges (20-60 mg $CaCO_3$/L and 0-15‰, respectively) for prawn culture (Boyd and Zimmemann, 2000; Cheng *et al*., 2003; Huong *et al*., 2010; Habashy *et al.*, 2011).

Table 5: Water quality parameters during culture of giant freshwater prawn in Tra Vinh province

Sites	Temperature (ºC)	pH	Salinity (‰)	Alkalinity (mg $CaCO_3$/L)
Cau Ngang	28.13±0.53 (27-29)	7.69±0.32 (7.0-8.5)	3.36±2.15 (2.0-7.0)	78.86±13.50 (72-85)
Tra Cu	27.40±0.73 (25.5-28.5)	7.76±0.30 (7.5-8.5)	4.14±0.04 (0-10.67)	83.53±14.50 (72-136)
Duyen Hai	27.83±0.57 (27-29)	7.75±0.25 (7.5-8.0)	6.33±0.04 (3.33-9.67)	83.92±12.74 (72-136)

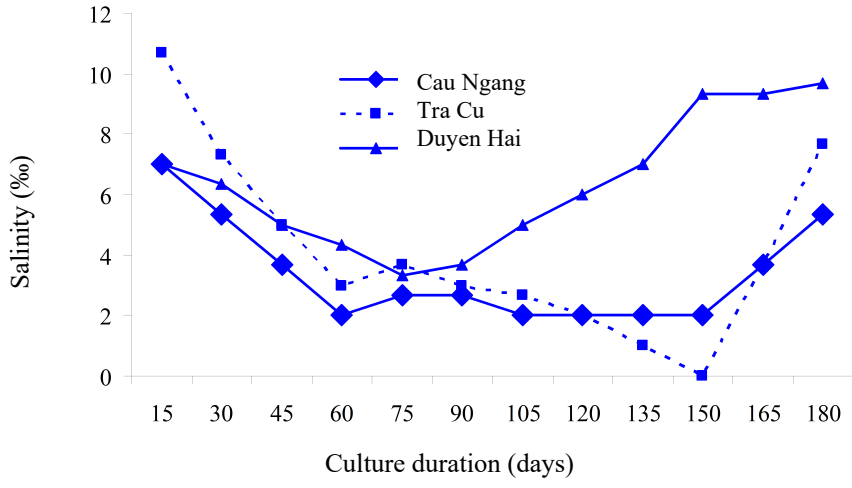

Fig. 4: Variation of salinity during culture of giant freshwater prawn in Tra Vinh province

3.3.2 Growth of prawn after 180 days of culture

After 180 days of culture, prawn attained to commercial size with average BW of 26-39 g (Table 6). Prawn growth was found better in Duyen Hai and Tra Cu district where have higher salinity compared to that in Cau Ngang district with lower salinity. Since the trial was conducted by selected farmers with general standards and technical guideline as mentioned in the methodology, different factors of environment and pond management may affect to the results, particularly prawn growth, survival, and yields. However, the correlation analysis showed that at average salinity range of 2-7‰ during culture period, the final weight of freshwater prawn had positively and significantly correlated with water salinity in the culture ponds (Fig. 5). The current result is in agreement with previous findings (Cheng et al., 2003; Huong et al., 2010; Habashy et al., 2011) who reported that growth rates of prawn increased with increasing salinity from 0 to 9‰. This indicated that brackish water during the rainy season in the study areas is suitable for culture of the giant freshwater prawn.

Table 6: Growth performance of prawn after 180 days of culture

Sites	Wi (g/ind)	Wf (g/ind)	DWG (g/day)	SGR (%/day)
Cau Ngang	0.02	26.5±9.27[a]	0.15±0.01[a]	3.99±0.03[a]
Tra Cu	0.02	36.1±15.80[b]	0.20±0.01[b]	4.16±0.02[b]
Duyen Hai	0.02	39.5±15.71[b]	0.22±0.01[c]	4.21±0.03[b]

Wi: Initial weight of prawn. Wf: final weight of prawn at harvest.

The mean values in the same column with the same superscript were not significant differences (p >0.05.)

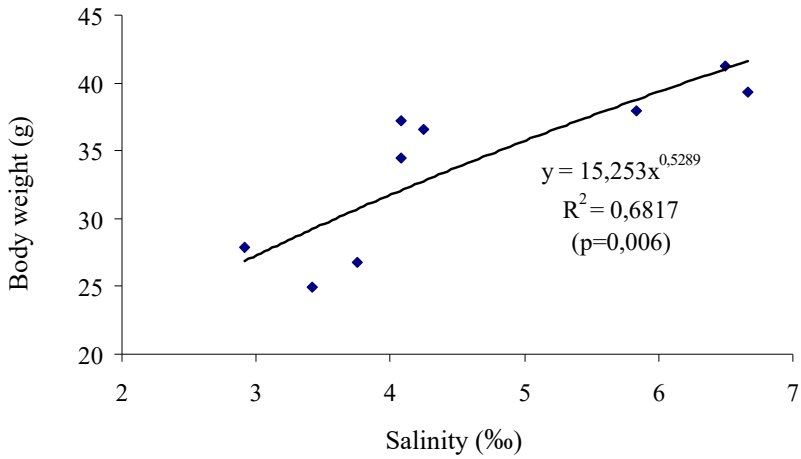

Fig 5: Correlation between prawn BW and average water salinity after 180 days of culture

3.3.3 Survival rate, productivity, feed conversion ratio (FCR), and financial efficiency

The results showed that the highest survival rate (53.3±1.24%) was found in Cau Ngang district where has lowest salinity compared to those in Duyen Hai (48.5±2.03%) and Tra Cu district (44.4±6.40%) with higher salinity. However, yields of prawn cultured in Duyen Hai (1.342±69.7kg/ha/crop) and Tra Cu (1.269±48.5 kg/ha/crop) were significantly higher than those in Cau Ngang district (988±33.1 kg/ha/crop) with lower salinity (Table 7). Feed conversion ratio (FCR) was found lowest for prawn culture in Duyen Hai district (1.59±0.13) with highest salinity.

Table 8 showed that with similar production cost (93.7-98.4 million VND/ha/crop) for the three districts, the highest net income and B/C ratio were found for Duyen Hai district (199±17.0 million VND/ha/crop and 206±27.6%) with highest salinity, and the lowest for Cau Ngang district (74.2±4.50 million VND/ha/crop and 79.2±4.90%) with lowest salinity. This reflected that salinity maybe one of factors affecting the income of the farming.

When comparing the trial results with the surveyed results above, it was found that the prawn yields and incomes from the trial were much higher than those from the survey. This could be due to proper pond preparation and management, better quality of prawn seeds, and high-quality feed (industry

feed) applied in the trial. Consequently, these technical aspects should be further studied to improve the present culture technology. In addition, the yield and income from the survey and the trial on prawn culture in brackish region were comparable or even much better than those from prawn culture in freshwater area. Phuong *et al*. (2008) reported that, prawn culture in Can Tho at 3-10 inds/m^3 gave production of 534-1519 kg/ha/crop and 17.4-49.9 million VND/ha/crop. According to Long and Han (2009), prawn culture in Dong Thap province at 9-15 inds/m^2 gave production of 2.056-2.906 kg/ha/crop, and income of 61.6-69.0 million VND/ha/crop.

Table 7: Survival rate, productivity, and FCR of prawn after 180 days of culture

Site	Survival rate (%)	Productivity (kg/ha/crop)	FCR
Cau Ngang	53.3 ± 1.24^{b}	988 ± 33.1^{a}	2.05 ± 0.08^{b}
Tra Cu	44.4 ± 6.40^{a}	1.269 ± 48.5^{b}	1.73 ± 0.12^{a}
Duyen Hai	48.5 ± 2.03^{ab}	1.342 ± 69.7^{b}	1.59 ± 0.13^{a}

Mean values in the same column with different superscripts are significantly different ($p < 0.05$)

Table 8: Financial efficiency of prawn culture in different districts of Tra Vinh

Site	Cau Ngang	Tra Cu	Duyen Hai
Total cost (million VND /ha)	93.7 ± 2.70^{a}	98.4 ± 3.50^{a}	96.6 ± 1.8^{a}
Gross income (million VND /ha)	168 ± 5.60^{a}	254 ± 9.70^{b}	295 ± 15.3^{c}
Net income (VND million/ha)	74.2 ± 4.50^{a}	156 ± 10.6^{b}	199 ± 17.0^{c}
B/C ratio (%)	79.2 ± 4.90^{a}	158 ± 13.7^{b}	206 ± 27.6^{c}

Mean values in the same row with different superscripts are significantly different ($p < 0.05$)

Huong *et al*. (2010) reported that prawn growth and survival at salinity of 15‰ were comparable to those cultured in freshwater (0‰); however, growth rate and survival rate were reduced at 25‰. The findings indicated that prawn can be cultured up to 15‰. Huong *et al*. (2015) found that within salinity range of 0-15 ppt, at higher salinity, lower ratio of berried female was observed, and prawns took longer time for maturation and re-maturation, and had lower fecundity compared to those in lower salinities. Especially, at salinity of 15‰, prawn did not spawn after 120 days of culture indicating suitable salinity for commercial prawn farming since it improves the growth, production, and quality of products. The study also found that growth rates of prawns in salinity of 5 ‰ and 10 ‰ were faster than those in 0 ‰ and 15 ‰; and the survival rates of prawn at 5 ‰, 10 ‰ and 15 ‰ were higher than those in 0‰. Moreover, protein contents of prawn meat cultured at 5‰ and 10‰ were higher than those at 0‰. These findings strongly supported the surveyed results and the trials on prawn culture in Tra Vinh and Bac Lieu province.

For the two farming systems (1) and (2), each has typical advantages and disadvantages. The system (1) aims to maximize the income by integrating prawn with rice during rainy season. Since the Mekong Delta has large area of over 152,000 ha of the rice-shrimp farming system which is planned to be more extended to adapt to saline water intrusion, it indicates high potential for further development of the prawn culture. This system characterized by low investment on production cost and technology, and is considered as the environmentally-friendly farming system. However, the system (1) also has some disadvantages that culture period for prawn is relatively short and needs nursing phase to obtain bigger prawn seeds; prawn production in this system is also low. For the system (2), it aims to diversify culture species and farming systems to reduce to risks of disease and financial lost due to focus on shrimp culture. Since prawn culture is conducted in ponds, it can be invested in higher technology and capital for higher production and income. In case of the system (1), rice can not be planted due to increasing salinity trend, the system (2) may be the good alternative. However, it is also necessary to carefully consider environmental and disease issues in the coming time due to semi-intensive and intensive practices.

The results from the survey and from the trials on culture of giant freshwater prawn with different systems in brackish water area (salinity less than 10 ppt) indicated that prawn can survive and grow well and give high production and income. These results illustrated a great potential for expansion of prawn culture in the Mekong Delta where has more than 600,000 ha of brackish water bodies and are struggling with extreme saline intrusion and sea level rise caused by climate change.

Although the data from the survey and trials indicated a high potential for prawn culture especially in the brackish water area, the study also found several limitations of the current practices that need to be addressed. Prawn seed quality and quantity

were the most important issues that 75-83.3% of surveyed farmers were not satisfied. Prawn feed and feeding technology were also the problems that is claimed by 16-18% households. Selling products and market issues were sometimes also faced (15-16% households). Shrimp diseases were occurred casually but were not treated. Additionally, production seasons of the farming systems were sometimes conflicted with different reasons such as salinity intrusion could be sooner during the year, availability of seeds on time. The culture techniques of prawn were relatively new to farmers with only 2-5 years of experience. These limitation and gaps in prawn farming must be considered to contribute the sustainable development of prawn culture in the Mekong Delta.

4 CONCLUSIONS AND RECOMENDATIONS

The results from survey on prawn culture indicated that two important farming systems (1) prawn and rice farming alternatively with tiger shrimp culture on the rice field, and (2) prawn culture in pond alternatively with tiger shrimp culture are feasible in scientific, technical and financial aspects.

The trial on prawn culture in different districts of Tra Vinh province proved that (i) giant freshwater prawn can be farmed well in brackish water of 0-10‰; prawn growth performance and yield positively correlated to observed water salinity; and (ii) prawn yields from the trial with proper management were better than those from the survey.

The success of the systems can be an appropriate solution to adapt to saltwater intrusion and sea level rise caused by climate change in the coming time. However, it is needed for further studies, especially improvement of farming technology (seed quality and quantity, feed, disease control, etc), processing and marketing, as well as zoning and planning for sustainable development of prawn culture.

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