Chapter 5

DISCUSSION

1. The production and prawn number of various sizes

1.1. Length, weight, growth rate and survival of prawn

The prawns were raised in the same condition for all treatments during the April-July growing season. The prawn density started with 1 prawn.m^{-2} in different treatments. Therefore, the length, weight, growth rate and survival of prawn were not affected by the treatments after the three and a half month stocking.

The length and weight of prawns increased over time. However, these increases were not met with the expectation. Since there were low growth rate and very low survival of prawn in the experiment. This was caused by less favorable conditions for prawn growth, for instance, low dissolved oxygen of an average 1.4-2.0 mg.l^{-1}, high temperature varied from 28.5 to 34.5°C in the water surface and increasing turbidity from April to July.

However, the growing condition for prawn was improved during August-November due to the suitable conditions such as the water level, space, transplanted rice culture, temperature in the experiment field. The length, weight growth rate and survival of prawn were more promising than those in the April-July growing season. The average weight growth rate was of 0.22 g.day^{-1} and the average prawn survival was 63 percent. In comparison to the results obtained by Danh et al. (1989), the survival percentage in this study was higher, but the weight growth rate was lower.

The length, weight of prawn of the treatment T3 were smaller than those of the treatments T1, T2 when prawns were resupplied in August season. The prawns in treatment T3 had the advantage because the cycles of moulting in the younger prawns were shorter than those in the older prawns. Can (1989) also indicated that the increase in individual weight of prawns was related to cycles of moulting (numbers of moulting). The variations in growth rate between the treatments were due to the variation in prawn sizes from resupplying of prawn.

The survival percentage was not affected by treatments, although the size of prawn in treatment T3 was smallest among the treatments. The high survival rate might be due to less competition among prawn themselves, as density was too low 0.2, and 0.3 prawn.m^{-2} in treatments T1, and T2 respectively and low density at 0.6 prawn.m^{-2} in the treatment T3, with the same predator control. High water temperature and low level of DO may affect the survival percentage of prawn.

There was no significant difference in means of prawn length but significant difference ($P<0.05$) in mean of weight in T3 between two growing seasons. Length and weight growth rate of prawn were not significantly different in T3 between two seasons. The length and weight growth rate of prawn seemed to increase linearly during the time given. R^2 was less than 50 % for fitting curve of non linear regression.

1.2. Prawn production and prawn number of various sizes

Prawn yield and growth in size depended on feed availability, population density, water environment, predator etc. (New et al.,1985). In this experiment, supplementary feeding was given to all treatments. The effective population density was different between two seasons. In the early wet season where rice was broadcasted the water environment (dissolved oxygen, water temperature, turbidity) in the rice field was less favorable for prawn movement and growth than the August season. It was observed that prawn population was concentrated in the canal thus providing more crowding effect. This could cause competition for food among prawn individuals. In addition it was found that the prawn population was disturbed by predator such as snake head fish. Thus the season gave low survival rate and low prawn yield, averaging 54 kg.ha^{-1}.

In the main wet rice season in August, the growing environment for prawn was improving. The prawn was able to move more freely in the rice stand and the canal. The estimated population densities of 0.2 prawn.m^{-2} for T1, 0.3 prawn.m^{-2} for T2 and 0.6 prawn.m^{-2} for T3 were generally too low to permit strong competition. Even with high population of predator, the yield of prawn was much higher than the April-July season,averaging 107 kg.ha^{-1}. New (1990) found that the total harvest weight increased with increasing stocking density, to an optimum level. This was coincided with this experimental result that prawn yield in T3 was two-third higher than those in T1 and T2 in August-November season when prawn population in T3 was double than those in T1 and T2.

As the rice environment in April-July season was less optimum for prawn growth, there was insignificant amount of size 1 prawn in this season. On the contrary, as the rice environment was improving in August-November season, more size 1 prawns were developed. It was observed in T3 that 9 percent of young prawn could be matured into size 1 prawn within 4 months. The contribution of high prawn productivity in T3 was mainly due to large proportion of size 2 prawn. There was no size 1 prawn produced in T1 for harvest in the first season. But T2 , with harvest of size 1 and size 2, could provide additional income derived from size 2 prawn. When resupplying the young prawn, T2 showed that similar proportion of size 1 (36 percent) was developed during August-November season as found in T1. From this experiment it was apparent that the maximum proportion of prawn developed into size 1 under rice-prawn system was about 36 percent.

2. The environment of rice-prawn system

The results of soil analysis at the experiment field showed that soil characteristics are as follows: light acidic soil, high total nitrogen, high organic matter, very high potassium but low available phosphorus. After a year of rice-prawn farming, the pH was improved. This is because the field was kept flooding and water exchange in operating the rice-prawn system.

The total nitrogen tended to reduce since nitrogen was taken by rice plants after the two rice crops and an amount of nitrogen flushed out during water exchange for growing prawn. The potassium decreased after the two rice crops due to the uptake of potassium by rice plants. However, the amount of organic matter from rice plants was released considerably into the soil. The increase in available phosphorus after 10 months might be created by the fast mineralization in the flooded soil condition of the rice-prawn system.

The values of soil nutrients were not affected by the treatments. This was because a small amount of nutrients might flow freely to the treatments as the bamboo fence and nylon net could not keep them without moving. In addition, waste and feces of prawns in the short period of time could not release an amount of nutrient large enough to affect soil nutrient values.

The water exchange regulated during the prawn growing season from April to November provided enough for rice plant requirement through the two rice crops. However, the water level was low with the maximum water body of 20 cm from the rice field in the April-July growing season while the high water level appeared with the maximum water body of 50 cm from the rice field in the August-November growing season. This was one of the factors resulting in faster prawns growth in the second season. The water management in the rice-prawn system provided more suitable environment for both the rice and prawn production. However, small constraints appeared some times such as water drainage after broadcasting fertilizer, water drainage for spraying insecticides or rice harvesting.

Table 13. The growing condition for prawn in the rice-prawn field experiment during April-November season 1992

Factors	April-July	Effects[1]	August-November	
1.Water level	low	–	high	+
2.Rice cultivation	broadcasting		transplanting	
	less space	–	more space	+
3.Dissolved oxygen	less stable	–	less stable	–
4.Turbidity	more	–	less	+
5.Water temperature	high	–	optimal	+
6.pH of water	medium	0	medium	0
7.Predator	less (8kg.ha^{-1})	+	more (25kg.ha^{-1})	–
8.Pesticide	less use	+	more use[2]	–
9.Rice production	high (5.2t.ha^{-1})		low (2.8t.ha^{-1})[3]	
10.Prawn production	low (54kg.ha^{-1})		high (107kg.ha^{-1})	
11.Survival	low (18%)	–	high (84%)	+
12.Growth rate	low (0.14g.day^{-1})	–	high (0.22 g.day^{-1})	+

Rice was also a major component for prawn growing in the rice-prawn system because rice density is likely a habitat providing a good niche for prawns and vice versa. Both rice plants and prawns raised together in the community of the rice-prawn system creating a sound ecological feature.

The prawn raised in the April-July growing season with the broadcasting rice had less space to move inside the rice field for feeding and hiding predators when the water

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1 – Less favorable
0 Favorable
+ More favorable

2 More pesticides used because of brown plant-hopper problem

3 Low rice production harvested due to brown plant-hopper damage

level was limited and rice plants were too dense. The prawns lived in the canal with high surface water temperature, even in the middle of water depth during day-time of this growing season. On the contrary, the prawns were free to move within the rice-prawn system in which rice were transplanted in the August-November growing season. This suitable niche might provide advantages for prawns to increase weight, length and survival rate.

Nevertheless, there was also disadvantages for prawn in the flooding season. First, the water was not drain freely. It leveled up to the rice-prawn field due to tidal rising. Second, the predators moved in freely from the adjacent fields to the rice-prawn field putting more stress on the prawn survival. (Can,1989)

The dissolved oxygen (DO) was similar with an average of 1.9 $mg.l^{-1}$ and 1.6 $mg.^{l-1}$ in the canal and the rice field respectively early in the morning during April-November prawn growing season. However, DO increased gradually to more than 3 $mg.l^{-1}$ during day-time. It could reach up to 7.6 $mg.l^{-1}$ and 8.9 $mg.l^{-1}$ in the canal and in the rice field respectively at 2 p.m. The DO was not affected by treatments during the growing season due to the homogeneous growing condition. Can (1989) reported that the concentration of DO required for normal growth of prawns, should not fall below 3 $mg.l^{-1}$ for a long time. Danh (1989) also reported that young prawns sized of 5 g could die if DO level was below 0.69 $mg.l^{-1}$. This result coincided with the observation that adult prawns floated with their heads along canal and rice field at DO level of 0.1 $mg.l^{-1}$. Therefore, low level of oxygen occurred during early mornings could affect growth rate of prawns in this experiment.

The results of water transparency during the April-November prawn growing season showed that the excessive turbidity and the too turbid water in the canal occurred in April-May and June-November respectively. However, the turbidity tended to be improved over time during the flooding season. The main cause of this problem was the density of suspended soil particle in the water appeared within the rice-prawn field coming from outside of the experiment field. Particularly, the turbidity increased during the period of rice harvesting at the end of the early wet season rice crop, of rice transplanting in beginning of the wet season rice crop, and of prawn harvesting at the end of the first season, all of these activities lasted from mid-July to August. Every time for prawn sampling also made water turbid. The turbidity from the suspended soil particle in the water could affect the prawn production. The turbidity of water was not affected by treatments.

The high water temperature (WT) was higher than 31°C on the surface of canals at 2 p.m. It occurred for two months from May 22 to July 21 out of 3-month growing season. However, the water temperature became optimal for prawns growth throughout the August-November growing season.

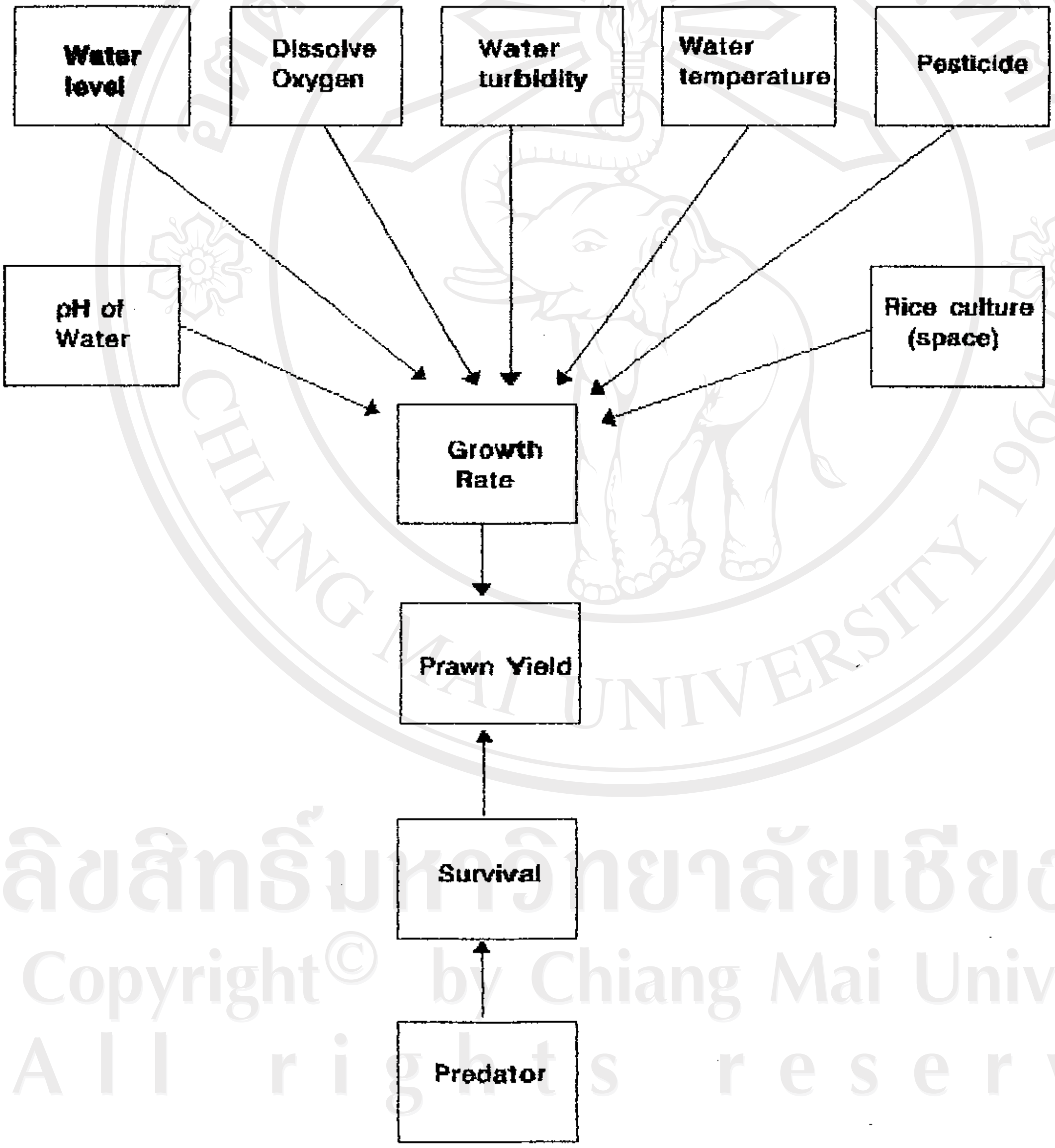

Figure 13. Factors affecting prawn yield in rice-prawn system during April-November 1992

Nevertheless the high water temperature occurred for 25 days from September 8 to October 3. The water temperature was not affected by the treatments over time due to the homogeneous growing condition. Can (1989) reported that WT of 27 - 31°C were suitable for prawns. Prawns could die at WT of 38°C (Science and Technology Council of Cuu Long Province, 1988).

Generally, prawn grew better in the wet season (August-November) than those in early wet season (April-July). Therefore, prawn could suffer stress in high WT for the two thirds of the April-July growing season and certain stress for the short time period during September 8 and October 3, 1992. This might cause the low survival percentage and prawn production in all treatments in the April-July growing season.

The pH of water varied around 6.0 - 6.5 during the April-November growing season, such pH range was considered as suitable condition for prawn (Science and Technology Council of Cuu Long Province, 1988). The pH of water was not affected by the treatments.

Predator was perhaps the greatest problem for any aquaculture enterprise, including freshwater prawn farming. The most troublesome predator in Southeast Asia was the snakehead fish (New et al., 1985). The predator was another factor reducing the survival of prawn in the April-July growing season. The young prawns with small size were easy for snakehead fish to catch for feed . Especially when the prawns and predators lived together in the canal where the low water level was difficult for prawns to move in the broadcasting rice fields. In the August-November season the prawns could either live in the canal or in the transplanted rice field with more space for prawns to move for feed. Although the amount of snakehead fish during this period was three times higher than that of April-July season the prawn survival was not decreased.

Water pollution is also an important problem for aquacultural farming. The water pollution might be caused by industrial waste, agricultural and aquacultural activities.

In the Mekong coastal deltas, rice was not grown intensively and almost free from water pollutants. Some places rice was grown in rainy season, farmers avoided using pesticides because they thought the chemicals would affect prawn in fields (Xuan et al., Tuan et al., 1992b). However, in the Mekong freshwater deltas, rice was grown intensively and certain pollutants could occur in rice fields. The rice-freshwater prawn culture could distribute in the area along the two main rivers of the Mekong delta called "Song Tien" and "Song Hau". But not all this area practiced the rice-prawn farming. Therefore, the rice farmers used pesticides with high concentration to control insect and disease in their rice fields, they practiced many kinds of pesticides to get the high rice production without caring of pollutants. Not all of farmers practiced in the rice-prawn farming knew what kinds of pesticide were needed and how to use them without causing water pollution. All of these could create problems to prawn production when the pest control for rice cultivation became intensive. Normally, the insect damage appeared in the early wet season rice with the modern high yielding rice varieties, and there was less insect damage to the local transplanted rice in the wet season. But at present as the spread and damage of brown plant-hopper occurred throughout the year in the intensive rice culture area in the Mekong Delta, pesticides and water pollution on the rice-prawn system needed careful attention.

In general, the environment factors were not affected by the prawn harvesting management as summarized in Table 13. However, Figure 13 showed the various factors affecting the yield of prawn during the growing seasons. Those factors may be the favorable conditions indicated by positive sign and also the constraints made by negative sign for prawn yield in which water temperature, dissolved oxygen together with predators were the main factors affecting prawn production.

3. Production on rice-prawn system and economic return

3.1. Production on rice-prawn system

The total rice production obtained 8.0 $t.ha^{-1}.yr^{-1}$ in this experiment whereas total rice production averaged 4.5 $t.ha^{-1}.yr^{-1}$ from farmers. Both rice production of the experiment and farmers in the same study area were reduced by brown plant-hopper damage in 1992. However, total rice production in this experiment was higher than that of farmers in 1988 (Tuyen et al., 1991), but lower than that of farmers in 1990 (Dung et al., 1991). The total annual rice production was not affected by the treatments.

The total prawn production averaged over all treatments 161 $kg.ha^{-1}.yr^{-1}$ in this experiment whereas prawn production yielded 98 $kg.ha^{-1}.yr^{-1}$ from farmers in the same study area in 1992. The total prawn production in this experiment was higher than those of studies in 1988, 1990 respectively (Tuyen et al., 1991 and Dung et al., 1991).

3.2. Economic returns to rice-prawn system

In the rice-prawn system in April 1992 - January

1993, the economic return of investment for this system could be indicated by some indexes, namely, gross margin (GM), net return (NR), rate of return to cash expenditure (RRCE), rate of return (RR), return to labor per season (RLS), return to labor per day (RLD), and cash balance (CB) at the end of the investment year.

The treatments with the highest value of these indexes would be expected to introduce to farmers for further testing.

Treatment T3 provided the highest gross margin, net return and return to labor among the treatments because prawn population of T3 was double of those of T1 and T2 after resupplying of young prawn in August-November season. Therefore, economic return of T3 obtained mainly from a large amount of size 2 prawn whereas there was comparable amount of size 1 prawn in T1, T2 and T3. The return to labor and the accumulative cash balance were higher in T3 than those in To, T1 and T2 because T3 provided the highest gross return among the treatments at each time of rice and prawn harvest. Therefore, T3 has proved to be the desirable harvesting management practice.

The economic indicators were generally higher in T2 than those in T1 and its economic returns of T1 and T2 were attributed by a large amount of size 1 prawn because of large size prawn. The value of return to labor was high in T1 and T2. Therefore, T2 was the second best in terms of economic return and cash flow. Whereas, To attributed the smallest economic returns as compared to treatments T1, T2 and T3 because of no prawn production.

Treatments of T2 and T3 may be preferable in terms of cash flow and net return in comparing among the treatments.

Lightfoot et al., (1990) informed that net return was 2 - 3 times higher in rice-prawn culture than those in rice-monoculture and the loss of rice production from canal area was compensated by much higher gain from prawn culture. A formal survey (Sanh et al., 1991) of the rice farmers in the study area in the Mekong Delta showed that the farmers also obtained more net return in rice-prawn system than that in rice monoculture. A case study performed by Tuyen et al., (1991) found that net return earned from rice-prawn culture was two times higher than those of rice-monoculture $.ha^{-1}.yr^{-1}$. The reported results also confirmed the present results of this experiment. However, net return of US $ 663.ha^{-1} in the treatment T3 of this experiment was lower than US $ 1040.ha^{-1} in the result from formal survey by Sanh et al., (1991). The reason for that was because of the low prawn production in the early wet season from April to July in 1992 and low rice production in the wet season due to the damage of rice from brown plant-hopper.