Chapter 4

RESULTS

1. Environmental factors

1.1. Soil

a. Soil samples before setting the experiment showed that the soil was acidic soil with pH = 4.22, high in total nitrogen (0.404 %), organic matter (5.56 %) and very high potassium (132.5 ppm) but low in available phosphorus (28.7 ppm P_2O_5).

b. Soil samples after harvesting rice and prawn showed pH around 5, high in total nitrogen 0.3 %, high organic matter 6.82 - 7.24 % with an average of 7.07 %, very high potassium 94.31 - 122.5 ppm with an average of 109.50 ppm but low to medium available phosphorus 27.74 - 49.67 ppm P_2O_5 with an average of 37.95 ppm. The value of soil nutrients among treatments were no significant difference.

1.2. Dissolved oxygen

During the prawn growing season from April to July 1992, the dissolved oxygen (DO) in plots with and without

prawn was observed at 6:00 a.m. in canals and in the rice field. In the canals, DO varied from 1 to 4 $mg.l^{-1}$ with an average of 2 $mg.l^{-1}$. In the field, DO ranged from 0.65 to 1.95 $mg.l^{-1}$ with an average of 1.4 $mg.l^{-1}$. There were no significant difference between plots with and without prawn. The concentration of DO both in the canals and in the rice field increased gradually during the daytime and reached maximum at around 2:00 p.m. The increase of DO concentration in the rice field during the daytime was higher than that in the canals (DO in the canals and in the rice field were 3.4 - 7.6 $mg.l^{-1}$ and 4.5 - 8.9 $mg.l^{-1}$, respectively). (Figure 2)

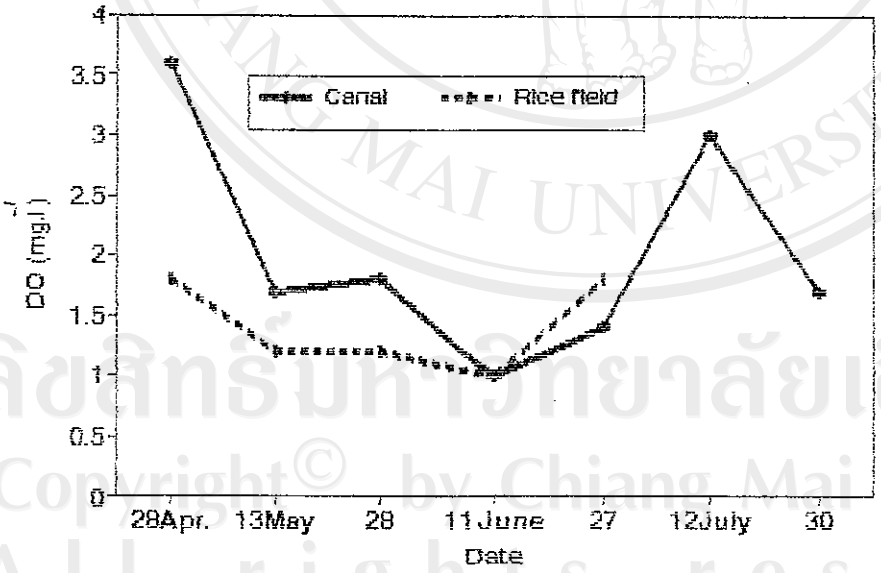

Figure 2. Dissolved oxygen (DO) in canal and rice field at 6a.m. in April - July 1992

During the prawn growing season from August to November 1992, DO in the canal varied from 0.1 to 3.5 $mg.l^{-1}$ with an average of 1.8 $mg.l^{-1}$ in which the lowest DO occurred on November 30, 1992. This lowest DO caused by water source from decay of rice plants damaged by Brown plant-hoppers in the field. In the rice field, DO ranged from 0.1 to 3.9 $mg.l^{-1}$ with an average of 1.7 $mg.l^{-1}$. However, DO measured in canal was generally higher than that measured in the rice field. These differences may be caused by the oxygen consumption of the mass vegetation in the field (rice plants, weeds, algae, mosses, etc.). The increase of DO concentration in the rice field during day-time was higher that than in the canal. The result recorded that DO increased from 1.5 to 7.1 $mg.l^{-1}$ in the rice field and from 2.7 to 4.2 $mg.l^{-1}$ in canal. However, DO were not significantly different among the treatments.

The similarity of DO in the field and canals might be due to free flow of water between plots which were not completely isolated by fences. The fluctuations of DO over time might be due to the fluctuations of the weather and the water movement at the sampling times.(Figure 3)

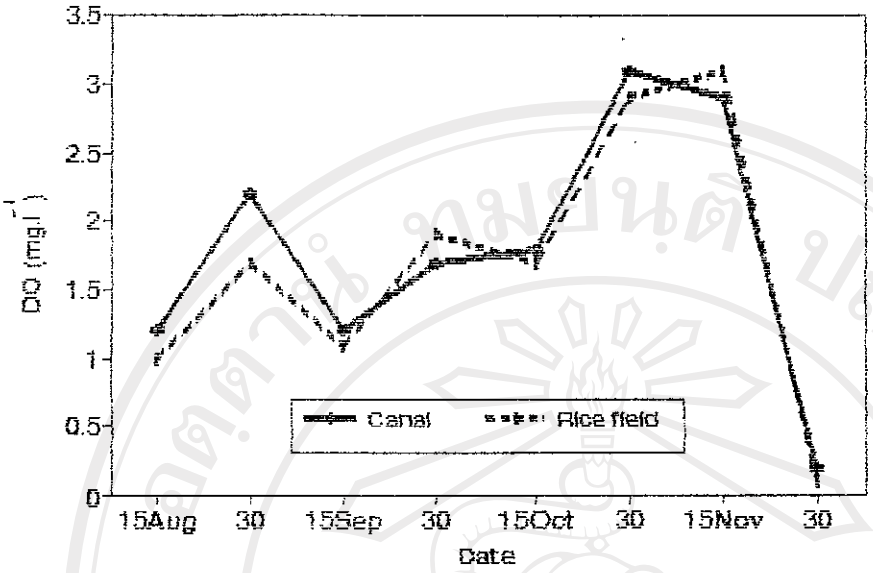

Figure 3. Dissolved oxygen in canal and rice field at 6 a.m. in August - November 1992

1.3. The pH of water

Both of the two prawn growing seasons from April to November 1992, pH of water varied from 6.0 to 6.5. No difference was observed between different treatments and times of sampling.

1.4. Water temperature

Daily water temperatures (WT) were observed at 2:00 p.m.. The variations of WT (28 - 33.5°C) in the middle of the canal over time from April-July were due to the

variations in the air temperature and the water movement. WT were higher in the surface (28.5 - 34.5°C) than in the bottom of canals (27 - 32°C). (Figure 4).

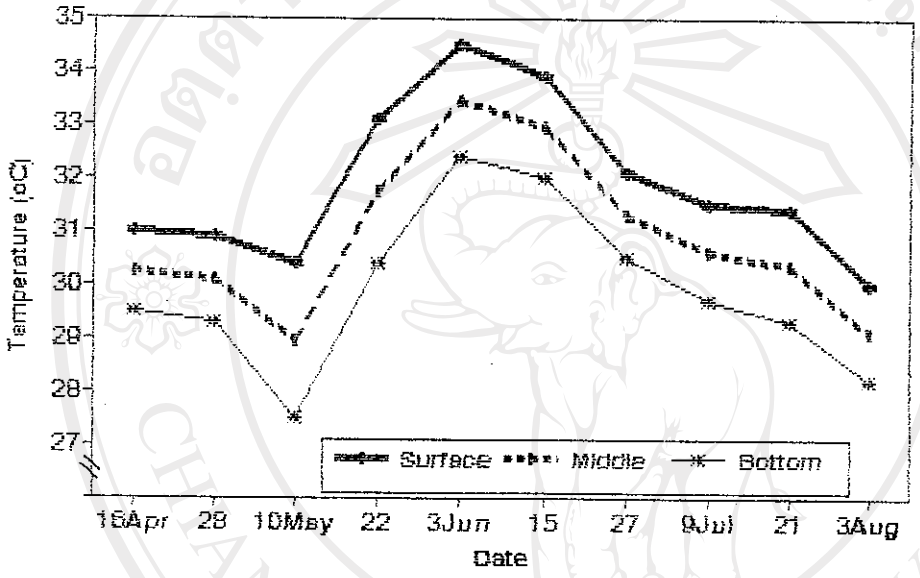

Figure 4. Water temperature in canal at 2 p.m. in April - July 1992

Similarly, there were variations of WT (28 - 32.5°C) in the middle of canal over time from August-November. WT were higher on the surface (28.8 - 33.5°C) than at the bottom of canal (27.1 - 31.8°C). There were no significant difference in WT among treatments from April to November 1992. (Figure 5)

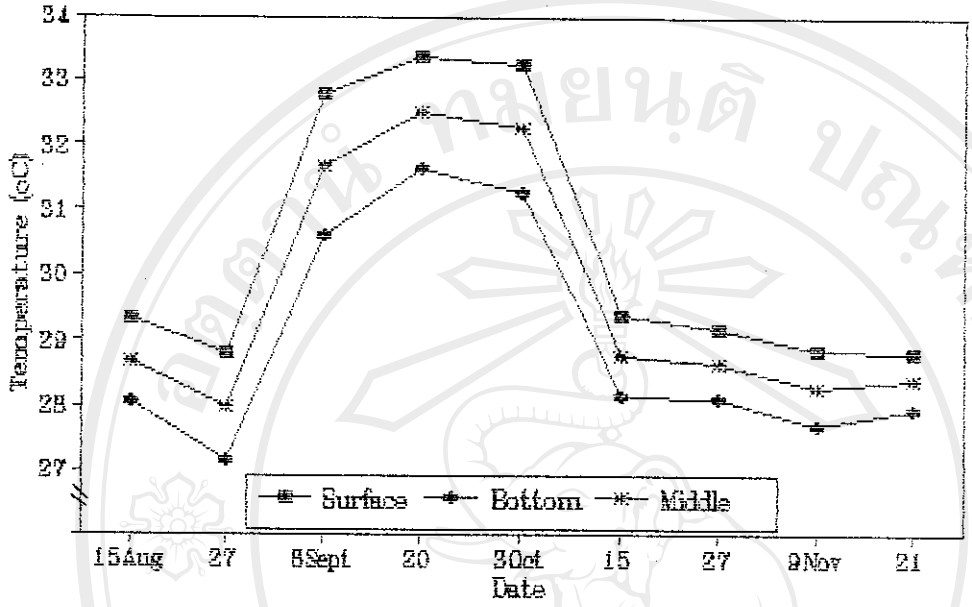

Figure 5. Water temperature in canal at 2 p.m in August - November 1992

1.5. Water transparency

Water transparency was decreased from 28 to 20 cm and the turbidity was becoming excessive in the canal during April-May. It might be caused by suspended soil particles from the near farming area. Then water transparency reduced continuously to 8 cm by July 24. Decreasing of water transparency occurred as the rice plant continued to grow and up to the period of rice harvested and rice transplanted

activities in the next crop season. In addition, the high rainfall during June to August (Appendix Figure 2 and Table 1) had made the water become turbid from suspended soil particles, prawn productivity was low in the first harvest. (Figure 6)

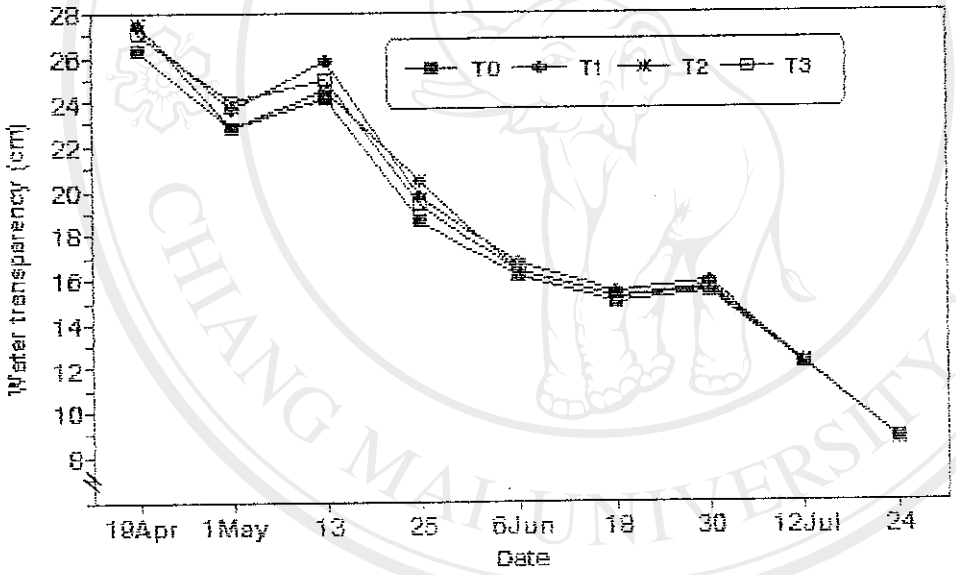

Figure 6. Water transparency in canal in April-July 1992

The water transparency was remained at 9 cm during August to Mid-September during the heavy rainfall.

However, the water transparency increased to 17 cm started from October to November because of water flood season. The range was still less than 20 cm. Therefore, the canal was too turbid by suspended soil particles. The water transparency was not significantly different among treatments over time of water sampling (Figure 7).

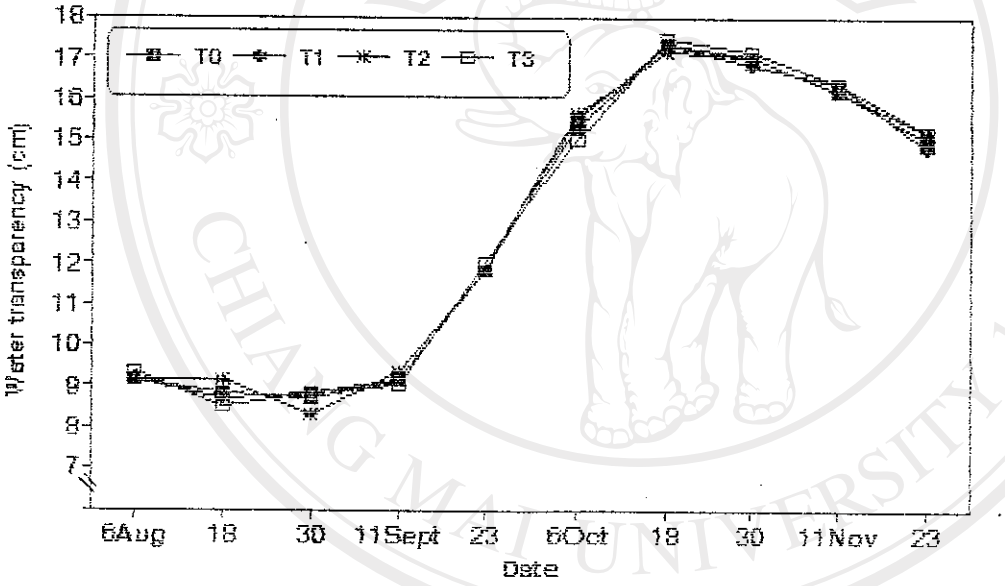

Figure 7. Water transparency in canal in August-November 92

2. Prawns and predators

2.1. Length and length growth rate

Average length of prawns increased linearly from 8.1 cm to 9.9 cm after 105-day stocking in April-July 1992 with

average length growth rate of 0.02 cm.day^{-1} (Figure 8). The average prawn length was no significant difference among the treatments (Table 3).

Table 3. Length of prawns (cm) over time in April-July 1992

Treatment	Days after stocking 15	30	45	60	75	90	105
T1	8.5	9.0	9.3	9.7	9.9	10.0	10.2
T2	8.1	8.6	8.8	9.1	9.2	9.3	10.0
T3	7.9	8.5	8.8	9.3	9.5	9.6	9.7
Mean	8.1	8.7	9.0	9.3	9.5	9.6	9.9
CV(%)	8.2	7.8	6.7	7.1	6.4	6.3	5.2
LSD .05	ns	ns	ns	ns	ns	ns	ns

During the prawn growing season from August to November 1992, the average prawn length in treatments T1, and T2 increased from 9.8 cm at period of prawn resupplying to 13.2 - 13.6 cm after 120-day stocking. In treatment T3, the length of prawns increased from 8.1 to 10.9 cm for the same period of time. There were no significant difference in length between treatments T1 and T2 because of similar prawn sizes from resupplying. The average length in T3 was significantly smaller than the rest of treatments ($P<0.01$) (Table 4). Length growth rate of prawn of treatments T1 was 0.028 cm.day^{-1}. Whereas length growth rate was highest in T2 (0.032 cm.day^{-1}) and lowest in treatments T3 (0.023 cm.day^{-1}) because prawn sizes of T3 were smallest among treatments from resupplying (Figure 9).

The prawn length growth rate during August-November also increased linearly as observed in April-July period.

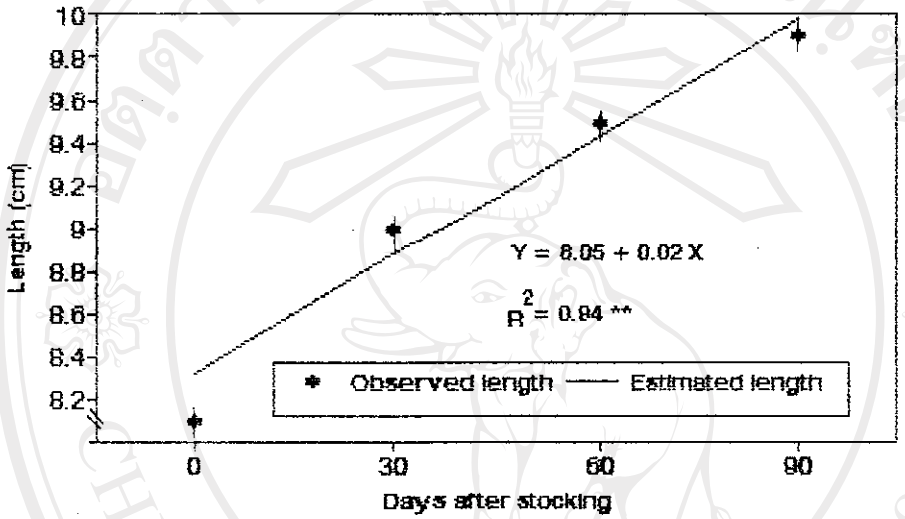

Figure 8. Average length of prawn in April-July 1992

Table 4. Length of prawn (cm) over time in Aug.- Nov. 1992

	Days after stocking								
Treat.	0	15	30	45	60	75	90	105	120
T1	9.8	10.2	10.6	10.8	11.3	11.7	12.2	12.7	13.2
T2	9.8	10.2	10.7	11.0	11.5	12.0	12.6	13.2	13.6
T3	8.1	8.3	8.6	8.7	9.1	9.5	10.0	10.5	10.9
Mean	9.2	9.6	10.0	10.2	10.6	11.0	11.6	12.1	12.6
CV(%)	8.6	8.9	9.1	9.5	9.5	9.6	9.4	9.2	9.1
LSD.05	0.5	0.5	0.4	0.4	0.5	0.5	0.6	0.7	0.8
LSD.10	0.7	0.7	0.6	0.6	0.7	0.8	0.9	1.0	1.2

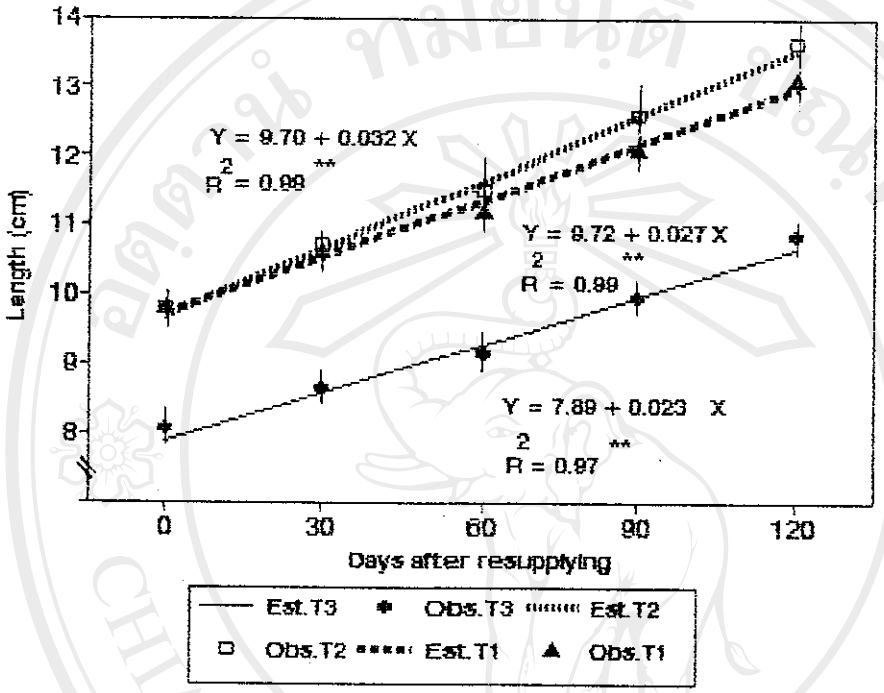

Figure 9. Prawn length of T1, T2, T3 in August-November 92

2.2. Weight and weight growth rate

Average prawn weight increased from 15.6 to 28.4 g after 105-day stocking in April-July 1992 with average weight growth rate of 0.14 g.day^{-1} (Figure 10). The average prawn weight was not significantly different among the treatments (Table 5).

Table 5. Weight of prawn over time (g) in April-July 1992

Treatment	Days after stocking 15	30	45	60	75	90	105
T1	15.6	22.1	25.1	27.1	27.8	28.8	29.6
T2	16.6	19.0	20.5	21.4	24.8	27.8	31.1
T3	14.7	18.8	20.4	23.6	25.2	26.4	27.6
Mean	15.6	19.9	22.0	24.0	25.9	27.6	29.4
CV(%)	12.6	24.3	22.6	19.6	14.4	10.4	10.3
LSD .05	ns	ns	ns	ns	ns	ns	ns

During the prawn growing season from August to November 1992, the average weight of prawns in treatments T1, and T2 increased from 29.3 - 29.9 g at a period of prawn resupplying to 56.1 - 58.6 g at harvest. There were no significant difference in weight between treatments T1 and T2 because of similar prawn sizes from resupplying. The weights of prawns in T1, T2 were significantly different ($P<0.01$) from T3 because the prawn sizes of T3 were smaller than those of T1, and T2 after resupplying (Table 6). Weight growth rates of prawn ranged 0.20 - 0.24 $g.day^{-1}$ and were highest and lowest in T2 and T3 respectively. Whereas weight growth rate of T1 was 0.22 $g.day^{-1}$ (Figure 11).

During August-November, the prawn weight growth rate also increased linearly in all treatments.

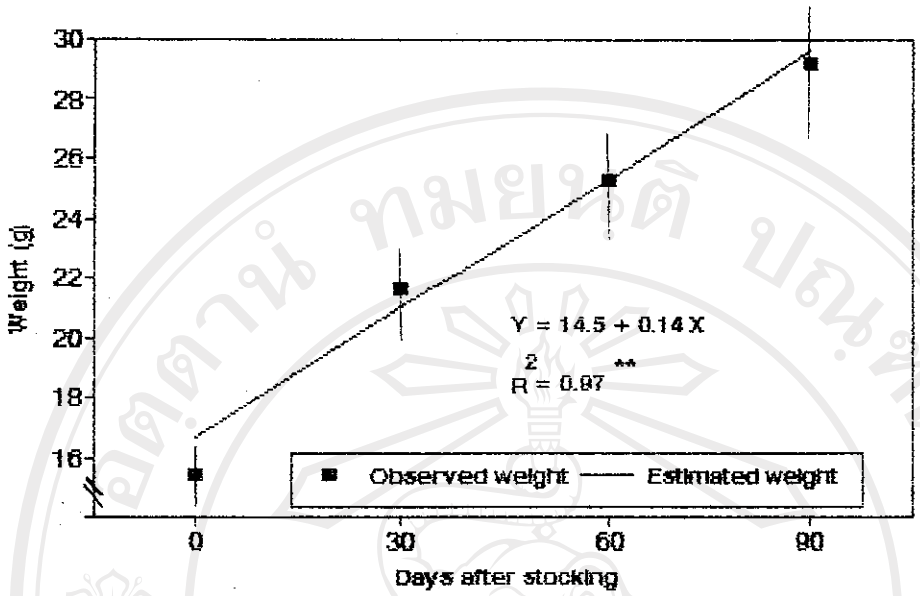

Figure 10. Average weight of prawn in April-July 1992

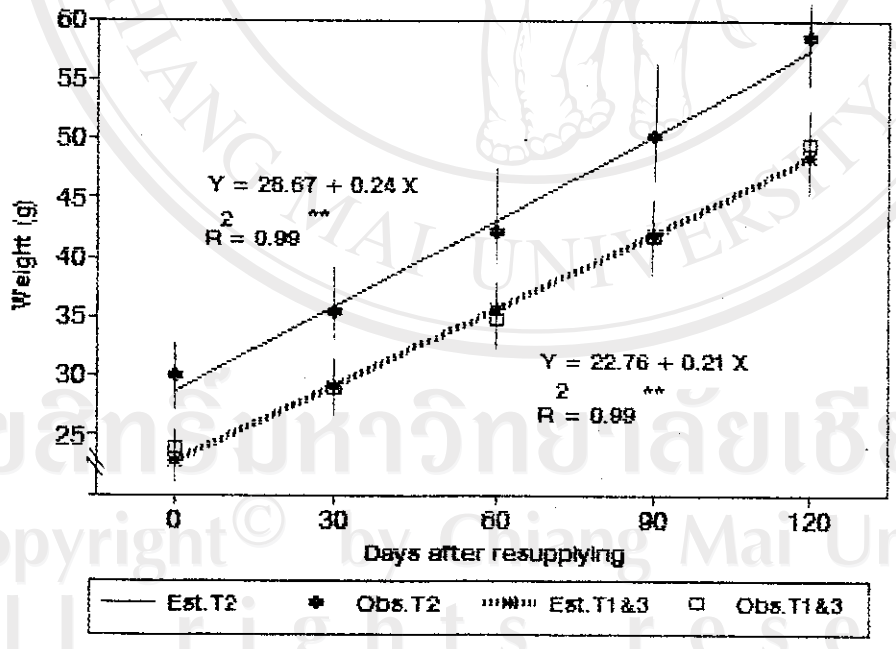

Figure 11. Prawn weight of T1,T2,T3 in August-November 92

Table 6. Weight of prawn (g) over time in August-November 1992

Treat.	Days after stocking 0	15	30	45	60	75	90	105	120
T1	29.3	31.9	34.4	37.3	40.6	44.2	47.9	52.0	56.1
T2	29.9	32.6	35.4	38.5	42.2	46.1	50.1	54.4	58.6
T3	15.2	17.5	19.7	22.2	25.2	28.6	32.2	35.7	39.5
Mean	24.8	27.4	29.8	32.7	36.0	39.6	43.4	47.3	51.4
CV(%)	25.0	23.4	21.9	20.8	19.3	18.0	16.8	15.8	15.0
LSD.05	2.4	2.4	2.4	2.3	2.1	2.1	2.2	2.5	3.0
LSD.10	3.6	3.6	3.7	3.5	3.2	3.3	3.4	3.8	4.7

2.3. Survival percentage

During the prawn growing season from April to July, the survivals were too low in all treatments and tended to reduce from T3, T2 to T1 (21, 18, and 16 respectively). However, there was no significant difference in survival among treatments (Table 7).

In the August-November growing season, the survival of prawns varied around 60 - 67 % and was not significantly different among the treatments (Table 8).

Table 7. Prawn production, survival, number of prawns of different sizes, and rice production during April-July 1992

Treatment	Prawn ($kg.ha^{-1}$)	Survival (%)	Size 1	Size 2	Size 3	Total	Rice[1]
			($number.ha^{-1}$)				($t.ha^{-1}$)
To	-	-	-	-	-	-	5.5
T1	48	18	0	1088	585	1851	4.9
T2	56	18	0	1190	648	1838	5.2
T3	58	21	10	1220	851	2071	5.2
Mean	54	18	3	1159	694	1853	5.2
LSD .05	ns	ns	ns	ns	ns	ns	ns

Table 8. Prawn production, survival, number of prawns of different sizes, and rice production during August 1992 - January 1993

Treatment	Prawn ($kg.ha^{-1}$)	Survival (%)	Size 1	Size 2	Total	Rice ($t.ha^{-1}$)
			($number.ha^{-1}$)			
To	-	-	-	-	-	2.77
T1	88	87	533	1036	1569	2.84
T2	94	84	595	1015	1610	2.82
T3	139	80	318	3200	3518	2.88
Mean	107	84	482	1750	2232	2.77
LSD .05	34	ns	ns	405	853	ns
LSD .01	51	ns	ns	814	990	ns

2.4. Number of prawn of various sizes

In the April-July prawn growing season, the numbers of size 1 prawn was only 10 prawns.ha^{-1} in T3, and zero in the other treatments. Numbers of size 2 prawn ranged from 1066 to 1220 prawns.ha^{-1} and numbers of size 3 prawn varied from 585 to 851 prawns.ha^{-1}. The totals of prawn numbers

1. Rice production accounted for 100% of rice area to treatment To (rice monoculture), but for 88% of rice area to treatments T1, T2, and T3 (integrated rice-prawn cultures)

ranged from 1651 to 2071 prawns.ha^{-1}. The lowest and highest prawn numbers were recorded in T1 and T3 respectively. There were no significant difference in all three sizes of prawn and the total prawn number between the treatments. (Table 7)

In the August-November prawn growing season, numbers of prawn size 1 ranged from 318 to 595 prawns.ha^{-1} and were not significantly different among the treatments. Prawn number in size 1 was lowest in treatment T3 because of its smallest size to the other treatments. On the contrary, prawn number in size 2 was highest in treatment T3 since more numbers of young prawn were resupplied in T3 than those in treatments T1, and T2. Numbers of prawn size 2 varied from 1015 to 1036 prawns.ha^{-1} and were not significantly different between T1 and T2. However, there was significant difference ($P<0.01$) in numbers of prawn size 2 between T3 and other treatments. It meant that young prawns at the weight of 15.2 g.prawn^{-1} could grow faster to get in size 2 after 4 months of feeding in the wet season. Totals of prawn number ranged 1569 to 1610 prawns.ha^{-1} and were not significantly different between T1 and T2. However, there were significant difference ($P<0.01$) in total numbers of prawns between T3 and other the treatments (Table 8).

2.5 Prawn production

In the April-July growing season, prawn production tended to reduce from T3, T2 to T1 (58, 56, and 48 kg.ha^{-1} respectively), but there was no significant difference among treatments (Table 7).

In the August-November growing season, prawn production varied from 88 to 139 kg.ha^{-1} and ranked in increasing order from T1, T2 to T3. The treatment T3 provided significantly higher prawn yield than T1 and T2 ($P<0.05$). In T3 the numbers of size 2 were highest among the treatments; but numbers of prawn size 1 were not much different as mentioned above.

2.6 Predators

Total fish gathered by using of "derris root" in controlling harmful fish in the April-July growing season were 7, 12, and 7 kg.ha^{-1} in T1, T2, and T3 respectively. The snake head fish, the main predator accounted for more than 80 percent of total fish. The silver barb fish was less than 20 percent.

In the August-November growing season, total harmful fish harvested at the end of season were 21, 37, and 21 kg.ha^{-1} in T1, T2, and T3 respectively. Similarly, the snake head fish contributed the same percentage as the first

growing season.

3. Rice production

In the early wet season rice (EWSR) crop from April to July, the yields of rice (IR 19660) were not significantly different among the treatments, including monoculture. Rice yields varied from 4.9 to 5.2 $t.ha^{-1}$ with an average of 5.1 $t.ha^{-1}$ in rice-prawn culture. This figure was lower than those in rice monoculture in which an average of 5.5 $t.ha^{-1}$ was recorded because 11 percent of rice area were replaced by canal area for growing prawn (Table 7).

In the wet season rice (WSR) crop, there were no significant difference in rice yields among treatments, including monoculture. Rice productions varied from 2.62 to 2.88 $t.ha^{-1}$ with an average of 2.78 $t.ha^{-1}$ in rice-prawn culture and in rice monoculture. Normally, Trang Phuoc rice variety could give average of yield 4 $t.ha^{-1}$. However, its yield was lower, approximately 40 %, than that in previous years because of damage caused by brown plant-hopper in the Mekong Delta during the 1992 wet season (Table 8).

4. Rice-prawn production

Treatment To, rice monoculture, yielded a total rice

production of 8.2 $t.ha^{-1}.yr^{-1}$. The rice production of the other treatments in integrated culture were 7.7, 7.8, and 8.0 $t.ha^{-1}.yr^{-1}$ in T1, T2, and T3 respectively. Rice and prawn productions of 10 representative farms from 100 farmers who participated in rice-prawn farming project of the Mekong Delta Farming Systems Research and Development Center of University of Cantho were also recorded. Generally, rice yield in this study area tended to decrease in 1992 due to the damage from the outbreak of brown plant-hopper. Many farmers did not have rice to harvest in the wet season. In this experiment the insect control was carried out. Therefore, rice production in the wet season crop lost only 40 percent of total expected production. Rice production of farmers was 4.5 $t.ha^{-1}.yr^{-1}$ in 1992.

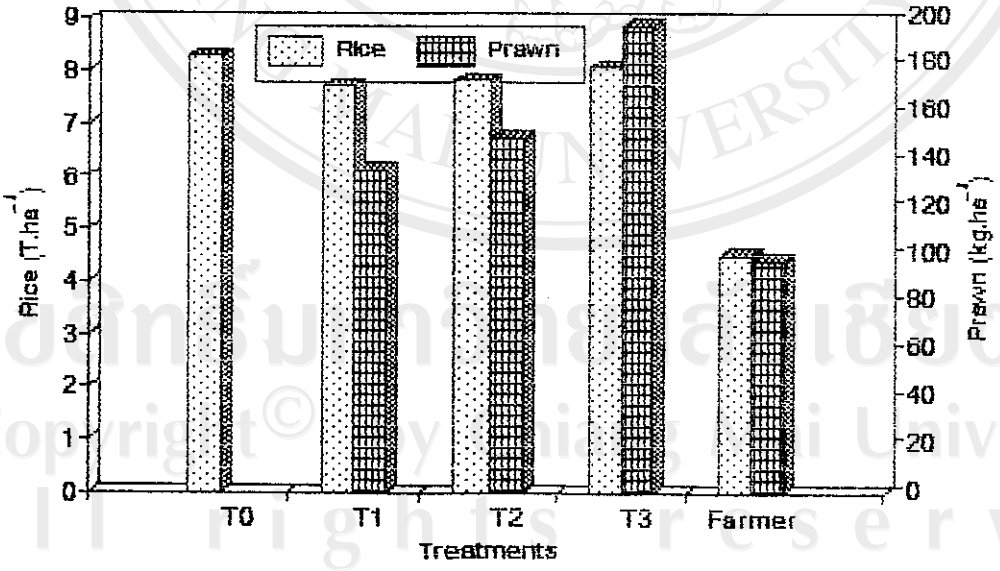

Figure 12. Rice and prawn production in April 92-January 93

In this experiment, the total prawn production of T1 was 136 $kg.ha^{-1}.yr^{-1}$ while total prawn production of the farmers was 98 $kg.ha^{-1}.yr^{-1}$. However, the average prawn yields were 150, and 197 $kg.ha^{-1}.yr^{-1}$ in treatments T2 and T3 respectively. The total prawn production was not reached the level as expected due to low prawn production in the first harvest of the April-July growing season. Low prawn survival might be caused by some constraints in environment and experiment conditions from keeping prawn only in the separated rice plots to the experiment. Normally, farmers provide connection between the rice-prawn field with another canal system. This enabled the prawns to freely move for feeds and hiding predators. With the natural rice prawn fields as those of farmers, the prawn production from the experiment results would be expected to increase significantly (Figure 12).

5. Economic analysis

5.1. The rice-prawn system during April-July 1992

Gross margins of the rice-prawn system varied from US $ 153 to $ 465.ha^{-1}. The treatments T3 and T2 provided the highest, while treatment T1 was the lowest due to negative gross margin from prawn production because of investment but no harvest of prawn in April-July season. (Table 9)

Table 9. Summary of the economic analysis of rice-prawn system during April-July 1992 (US $.ha^{-1})

Economic terms	Treatment To (R)[a]	(P)[b]	(S)[c]	T1 (R)	(P)	(S)	T2 (R)	(P)	(S)	T3 (R)	(P)	(S)
1.Quantity sold[d]	5500	0		4900	0		5200	58		5200	58	
2.Expenses	275	0	275	247	293	541	249	293	542	249	293	542
3.Gross return	555	0	555	490	0	490	519	278	798	519	286	805
4.Gross margin	422	0	422	373	-220	153	399	58	457	399	88	465
5.Net return	280	0	280	243	-293	-50	270	-16	254	270	-7	263
6.RRCE[e]	4.2	0	4.2	4.2	0	2.1	4.3	1.3	2.8	4.3	1.3	2.8
7.RR[f]	2.0	0	2.0	2.0	0	1.0	2.1	0.9	1.5	2.1	1.0	1.8
8.RLS[g]	422	0	422	373	-224	149	399	54	453	399	82	461
9.RLD[h]	4	0	4	3	-3	0	4	1	2	4	1	2

Note: (Appendix Table 18 and 18) The number were rounded

a. (R) : Rice culture
b. (P) : Prawn culture
c. (S) : Rice-prawn farming system
d. Kg
e. RRCE : Rate of return to cash expenditure
f. RR : Rate of return
g. RLS : Return to labor per season
h. RLD : Return to labor per day
5 = 3-2

Net returns ranged from US $ - 50 to $ 280.ha^{-1}. The treatment To provided the highest due to the highest net return in rice production, and T1 gave the lowest because of the lowest net return for rice production and negative net return for prawn due to no harvest of prawn.

Rates of return to cash expenditure varied from 2.1 to 4.2, with treatment To returned the highest due to the highest rate of return to cash expenditure from rice. Treatments T2 and T3 resulted in the same rate of 2.8

because of the similar rate of return to cash expenditure from rice and prawn. That of T1 was lowest rate of 2.1 than those of T2 and T3 due to zero return to cash expenditure from prawn production.

Rates of return ranging from 1.0 to 2.0 was observed in ascending order from T1, T2, T3 and To respectively. The highest obtained from the high rate of return from rice.

Returns to labor per season varied from US $ 149 to $ 461.ha^{-1}. Treatment T3 provided the highest due to high return to labor from rice and prawn production, and T1 returned the lowest due to lowest return to labor from prawn production.

Returns to labor per day ranged from US $ 0 to $ 4.ha^{-1} Treatment To provided the highest because of the highest return to labor from rice. And T2, T3 provided the same return due to the similar return to labor per day from rice and prawn production. However, T1 resulted in lowest return to labor per day.

In April-July season, the economic indicators such as GM, NR, RRCE, RR, RLS, and RLD were lower in T1 than those in To, T2 and T3 because there was not harvest of prawns in T1. The net return and some forms of returns to To were

higher than those of treatments T2 and T3. Since T2 only parts of prawns were sold and low prawn production was harvested in T3. (Table 9)

5.2. The rice-prawn system during August-November 92

In contrast to the April-July rice-prawn system, the gross margins and net returns of the August-November rice prawn system varied from US $ 193 to 635.ha^{-1} and varied from US $ 28 to $ 408.ha^{-1} respectively. Treatments T1 and T3 provided the highest because of the highest gross margin and net return of both rice and prawn production, and To was the lowest.

Rates of return to cash expenditure of treatments To, T2, and T3 were about the same (2.7 to 2.9). Treatment T1 provided the highest among the treatments because of the highest rate of return to cash expenditure from prawn.

Rates of return ranged from 1.1 to 2.1. Treatment T1 provided the highest because of the highest rate of return both rice and prawn production, and To returned the lowest.

Returns to labor per season and per working day varied from US $ 170 to $ 608.ha^{-1} and varied from US $ 1 to $ 4.ha^{-1} respectively. Treatments T1 and T3 provided the

highest because of the highest return to labor per season and per working day from rice and prawn production, and To returned the lowest due to the low return to labor per season and per day from rice. (Table 10)

Table 10. Summary of the economic analysis of rice-prawn system during August 1992-January 1993 (US $.ha^{-1})

Economic terms	Treatment To (R)[a]	To (P)[b]	To (S)[c]	T1 (R)	T1 (P)	T1 (S)	T2 (R)	T2 (P)	T2 (S)	T3 (R)	T3 (P)	T3 (S)
1.Quantity sold[d]	2770	0		2840	88		2820	94		2880	139	
2.Expenses	277	0	277	251	173	424	250	314	564	251	370	621
3.Gross return	305	0	305	312	519	832	288	571	859	317	704	1021
4.Gross margin	193	0	193	210	425	635	188	335	522	215	413	627
5.Net return	28	0	28	61	347	408	39	257	295	66	335	401
6.RRCE[e]	2.7	0	2.7	3.1	5.5	4.3	2.9	2.8	2.9	3.1	2.4	2.8
7.RR[f]	1.1	0	1.1	1.2	3.0	2.1	1.2	1.4	1.3	1.3	1.9	1.6
8.RLS[g]	170	0	170	187	421	608	165	331	495	192	408	600
9.RLD[h]	1	0	1	2	8	4	1	5	3	2	8	4

Note: (see Appendix Table 17 and 18). The numbers are rounded.

a. (R) : Rice culture
b. (P) : Prawn culture
c. (S) : Rice-prawn farming system
d. Kg
e. RRCE : Rate of return to cash expenditure
f. RR : Rate of return
g. RLS : Return to labor per season
h. RLD : Return to labor per day
5 = 3-2

5.3. The whole rice-prawn system during April 1992 - January 1993

Gross margins varied from US $ 615 to $ 1093.ha^{-1} and net returns varied from US $ 308 to $ 663.ha^{-1} respectively. Treatment T3 provided the highest gross margin and net

return because of the highest gross margin and net return from prawn and high gross margin from rice. While To provided the lowest due to no gross margin and net return from prawn. (Table 11)

Rates of return to cash expenditure varied from 2.8 to 3.5. Treatment To and T1 provided the highest because of the high rate of return to cash expenditure from rice and prawn respectively, whereas T2 and T3 were the same rate of 2.8.

Rates of return of all treatments were about the same (1.4 to 1.6). Treatments To, T1, and T3 provided the highest. Treatment To was rice monoculture while T1 and T3 were integrated rice-prawn system, therefore, T1 and T3 provided more potential in investment because of more valuable prawn production.

Returns to labor per two seasons varied from US $ 592 to $ 1061.ha^{-1}. Treatment T3 provided the highest because of the highest return to labor per two seasons from prawn and rice. To returned the lowest due to no return to labor from prawn, although it provided the highest return to labor from rice production.

Table 11. Summary of the economic analysis of rice-prawn system during April 1992 - January 1993 (US $.ha^{-1})

Economic terms	Treatment To (R)[a]	(P)[b]	(S)[c]	T1 (R)	(P)	(S)	T2 (R)	(P)	(S)	T3 (R)	(P)	(S)
1.Quantity sold[d]	8270	0		7740	138		7820	150		8080	187	
2.Expenses	552	0	552	498	468	964	498	607	1105	500	663	1163
3.Gross return	860	0	860	802	519	1321	807	848	1655	836	990	1826
4.Gross margin	615	0	615	583	205	788	587	393	980	614	479	1093
5.Net return	308	0	308	304	54	358	308	241	550	336	327	663
6.RRCE[e]	3.5	0	3.5	3.7	2.8	3.3	3.6	2.1	2.8	3.7	1.9	2.8
7.RR[f]	1.8	0	1.8	1.6	1.5	1.6	1.7	1.2	1.4	1.7	1.5	1.6
8.RLS[g]	592	0	592	312	197	756	564	384	948	591	470	1061
9.RLD[h]	2	0	2	2	2	2	2	3	3	3	3	3

Note: The numbers were rounded

a. (R) : Rice culture
b. (P) : Prawn culture
c. (S) : Rice-prawn farming system
d. Kg
e. RRCE : Rate of return to cash expenditure
f. RR : Rate of return
g. RLS : Return to labor per season
h. RLD : Return to labor per day
5 = 3-2

Returns to labor per day from prawn production was generally higher than that rice by US $ 1. However, T3 showed the highest return to labor per day from rice production. Therefore, T3 provided more potential for investment in both rice and prawn. On the other hand, To and T1 resulted in the lowest return to labor per day due to no return to labor per day from prawn and lowest return to labor per day from prawn and rice culture respectively.

Cash balance on rice monoculture in treatment To

higher than those of treatments T2 and T3. Since T2 only parts of prawns were sold and low prawn production was harvested in T3. (Table 9)

5.2. The rice-prawn system during August-November 92

In contrast to the April-July rice-prawn system, the gross margins and net returns of the August-November rice prawn system varied from US $ 193 to 635.ha^{-1} and varied from US $ 28 to $ 408.ha^{-1} respectively. Treatments T1 and T3 provided the highest because of the highest gross margin and net return of both rice and prawn production, and To was the lowest.

Rates of return to cash expenditure of treatments To, T2, and T3 were about the same (2.7 to 2.9). Treatment T1 provided the highest among the treatments because of the highest rate of return to cash expenditure from prawn.

Rates of return ranged from 1.1 to 2.1. Treatment T1 provided the highest because of the highest rate of return both rice and prawn production, and To returned the lowest.

Returns to labor per season and per working day varied from US $ 170 to $ 608.ha^{-1} and varied from US $ 1 to $ 4.ha^{-1} respectively. Treatments T1 and T3 provided the

Table 12. Accumulated cash balance of rice monoculture and rice-prawn culture during April 92-January 93 (US $.ha^{-1}

Treat.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.[1]
To	-86	-110	-119	358	239	239	239	210	210	500
T1	-368	-408	-441	-42	-174	-184	-195	285	285	581
T2	-368	-408	-441	214	-73	-84	-96	434	434	708
T3	-368	-408	-441	263	-96	-109	-124	536	536	837

from rice farming in the EWSR crop was high enough to compensate for the negative cash balance from prawn farming at that time. The cash balance continued decreasing from August to October due to the prawn growing and second rice crop investment. The positive cash balance was created at the prawn harvest in November.

Analyzing the cash flow of whole system found that the high expenses occurred during April to July because of more initial investments in the first rice crop and prawn growing season. However, the cash balance maintained during July to January of the following in the rice-monoculture system due to high yield of the first rice crop. Whereas, the negative cash balance remained continuously for three

[1] Accumulative cash balance was derived from each month during April 1992 - January 1993. Table 12 summarized from the appendix table: 41-44

months after rice and prawn harvested in rice-prawn system due to low yield of the first prawn growing season. Indeed, in the control treatment, the one time of batch-harvesting at the end of prawn growing season caused the continuing negative cash balance from the beginning towards the last three months of the whole season. As compared to one time harvesting mentioned above, cull-harvesting a certain size of prawn or batch-harvesting all sizes at the end of the first prawn growing season in July reduced the shortage of cash flow for farm activities in the next season. However, the results of experiment showed the benefit from prawn harvesting in July did not reach up to the expected value. That was indicated by the shortage of cash flow in several months after the first prawn harvest.