Fertilization effects on the growth of common carp (*Cyprinus carpio*) and Nile tilapia (*Oreochromis niloticus*) and rice yields in an integrated rice-fish farming system

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Abstract. An investigation was accompanied in the rice field plots with developing an infrastructure of 30 m^2 to ascertain the felicitous fertilization effects of the Nile tilapia (*Oreochromis niloticus*) and the common carp (*Cyrprinus carpio*) cultured along with the rice fish farming system in the plots. There were setting up three systems to assess the effect of fish species on tiller yield, regarding for fish species i.e. no fish stocking with rice (C), *O. niloticus* with rice (F_T) and *C. carpio* with rice (F_C). Each treatment of fish species cultured with different doses of fertilizer such as (T_0) control: without any fertilization; (T_1) with 100% recommended fertilizer (RF); (T_2) with 75% recommended fertilizer (RF); (T_3) with 10 ton compost fertilizer; (T_4) with 5 ton compost fertilizer + 75% RF, and rice culture with 5 ton compost fertilizer + 50% RF. The maximum number of plant in the tiller were found in *C. carpio* (F_C) species (7.02 no/tiller and 82.95 cm/tiller) whereas lowest in F_T (6.40 no/tiller and 81.65 cm/tiller) during 75 DAT. In regards of fertilizer application, the highest values were observed in F_C with an average of 31.71, 53.28 and 73.06 cm/tiller during 30, 40 and 60 DAT respectively, followed by F_0 (31.92, 52.43 and 72.31 cm/tiller at 30, 45 and 60 DAT) and F_T (30.28, 49.76 and 67.25 cm/tiller at 30, 45 and 60 DAT) respectively, in which there was found negative significant differences (P>0.05) among different treatments. The rice production in *C. carpio* fertilizer treatment T_4 (7.30±1.86 kg/m^2) was significantly higher than those of other treatments (7.16±2.78, 6.83±2.88, 6.67±1.44, 6.17±1.84 and 4.06±1.76 kg/m^2 in treatments T_5, T_3, T_2, T_1, and T_0 respectively). The yields of fish were significantly higher (P<0.05) in treatments T_4, (11.70±3.86 kg/m^2) than other fertilizer treatments T_5 (11.25±3.56 kg/m^2), T_3 (10.85±5.76 kg/m^2), T_2 (10.80±5.55 kg/m^2), T_1 (9.90±4.66 kg/m^2), T_0 (4.78±3.48 kg/m^2) and in F_C and also compared to all other fertilizer treatments in F_T. In regards of straw, the yields were significantly higher (P<0.05) in treatments T_4, (13.76±6.24 kg/m^2) and followed by T_5 (13.55±4.42 kg/m^2), T_3 (12.88±6.24 kg/m^2), T_2 (10.75±4.65 kg/m^2), T_1 (10.65±3.36 kg/m^2), T_0 (4.28±3.86 kg/m^2) and in F_C and also compared to all other fertilizer treatments in F_T. The outcome in T_4 provided the maximum yields amongst all treatments, followed by treatments T_5, T_3, T_2, T_1 and T_0 representing that the amalgamation of basal fertilization and compost fertilizer are the furthermost suitable nutrient input regime aimed at the rice-carpi fish integrated culture scheme.
Key Words: production, propagation, impact, food security, rice-fish integration.

Introduction. As an essential food, rice is cropping in all round the globe, with distinguished diversities full-grown on 157 million ha global in a widespread variety of natural circumstances and water administrations. It is the foremost food for over 50% residents of the globe with annual harvests of 652 million t in 2007 (National Agricultural

Statistics Service 2007). The concurrent of rice-fish farming is one of the best prospects to boost food production from classified ecological agrarian land (Jintong 1995; Shugen et al 1995). This culture is practiced in various countries of the world, mainly in Asia (Halwart & Gupta 2004). There has been practiced rice-fish culture for at least 1,700 years in China (Li 1992; Cai et al 1995). According to Lu & Li (2006), it is documented by FAO (Food and Agriculture Organization) of the United Nations and the United Nations Educational, Scientific and Cultural Organization (UNESCO) as one of the Globally Important Ingenious Agricultural Heritage Systems (GIAHS) in 2005, attributable to its elongated history and prolonged examples and tactics (Lu & Li 2006). Farming of fish in rice fields expands the utilization of land and water and harvesting more fish and rice, collective with more financial yields than the monoculture of rice. Inside the rice-fish ecosystem, plants and fish accompaniment and intermingle with each other (Rothuis et al 1998; Rothuis et al 1999). Rice fields are outstandingly lucrative as far as together quantity and natural diversity of food organisms for fish. Utmost the Asian countries furthermore countersign fish farming in the rice fields through IPM (integrated pest management) and it is the real technique to upsurge the harvests in the rice fields by yielding both of rice and fish (Costa-Pierce 1992; Cai et al 1995). The recognition of rice-fish farming diminished due to usage of chemicals and pesticides in rice fields. Currently, it is up surging due to reduce the utilization of degrees of pesticide and the higher economic returns had received from fish and improved rice yield. In old-fashioned rice-fish farming, there are kept mainly herbivorous fish species for example grass carp *Ctenopharyngodon idella*, silver barb *Barbonymus gonionotus* and tilapia (*Oreochromis* sp). The revenues of rice-fish farming go elsewhere yielding additional fish in the rice field. In the rice fields, the fish can regulate the pests and weeds, acknowledging integrated pest management (IPM). The fertilizer effect from the fish manure, increase the availability of nutrient to the rice crop (Lightfoot et al 1992; Slugen et al 1995; Yinhe 1995; Frei & Becker 2005). Rice-fish farming conserves the ecological stability in rice field that may not only be a higher yielding but also a more sustainable farming system (Berg 2001, 2002). In case of China and Indonesia, the rice-fish integration scheme is recognized to upsurge yields of rice from 5% to 35% and production about 150 kg/ha/crop of fish in extensive culture systems, and up to 800 kg/ha/crop subsequently agrarian by-products are assumed as fish diet and fertilizer (Costa-Pierce 1992; Cai et al 1995). Fertilization in the rice-fish farming is as a crucial management exercise for enhancing rice and fish manufacture, though farmers are utilizing fertilizer at a diversity of doses which could occasionally be 3 or 4 times greater than typical dose, optimistic as more profit. However, currently, in several countries, we can talk about a catastrophe in term of the mineral fertilizers usage, where is a severe puzzling circumstance due to excessive and inappropriate use. As well, the agriculturalists are fronting monetary forfeiture to purchase additional fertilizer. However, there are very modest research works which regulates the standard quantity of fertilizer need for the supreme yields from the rice-fish farming. Consequently, it is significant to commence investigations to discover the standard fertilizer dose for greater fish and rice manufacture. Bearing in mind the above consequence, the current investigation was undertaken to determine the optimum dose of fertilizer practice in rice-fish farming.

Material and Method

Description of the study sites. The experimentation was directed by a completely randomized block design and the experiment was undertaken in 54 experimental plots which had a total size of 810 m^2. Each plot surrounded dikes with a height of near about 0.5 m, and an outlet, which linked them to two major irrigation channels. Those plots had fish; supplementary had a central refuge pond with an area of 3 m^2 and a depth of 0.5 m. Moreover, they were instrumented with a fine meshed nylon net neighboring the plots to resist the getaway of fish or invasion of predators such as snakes. The experimental field is located at 24°75′N latitude and 90°50′E longitude and altitude of 18 m above sea level. Here, the median monthly rainfall was approximately 330 mm during experiment. The monthly temperature varies from 17 to 32°C during the monsoon and 12 to 31°C during the dry season. Farming season was carried out from December 2017 to April 2018 (dry season). The soil at the study location was a non-calcareous deep grey flood plain soil; the consistency class was a silt clay loam, with an average soil pH 6.2, organic carbon occurred 1.4%, nitrogen content 0.25%, available phosphorus 16.72 ppm, exchangeable potassium 0.12 ppm and available sulfur 14.2 ppm respectively.

Experimental setup. The experiment was set with the variety of BRRI dhan-29 with two factors i.e. fish species and fertilizer rate. The experimental design is shown in Table 1. To evaluate the effect of fish species on tiller yield, no fish stocking with rice considered as the control (C), the treatment was rice + *Oreochromis niloticus* (F_T) and rice + *Cyprinus carpio* (F_C).

Table 1

Trials using different fish species

Treatment	*Stocking*
C	No fish stocking
F_T	*O. niloticus* stocking
F_C	*C. carpio* stocking

To evaluate the impact of fertilizer on tiller yield in the rice field, six treatments were designed as described in Table 2.

Table 2

Trials using different fertilizer as a nutrient

Treatment	*Fertilizer dosages*
T_0	No fertilizer
T_1	100% recommended fertilizer (RF)
T_2	75% Recommended fertilizer (RF)
T_3	10 t compost fertilizer
T_4	5 t compost fertilizer + 75% Recommended fertilizer
T_5	5 t compost fertilizer + 50% Recommended fertilizer

There were some six treatments in triplicate: (T_0) control: culture of rice lacking any fertilization; (T_1) rice culture with 100% recommended fertilizer (RF); (T_2) rice culture with 75% recommended fertilizer (RF); (T_3) rice culture with 10 t compost fertilizer; (T_4) rice culture with 5t compost fertilizer + 75% recommended fertilizer, and (T_5) rice culture with 5 t compost fertilizer + 50% Recommended fertilizer. Fertilization rate was measured founded on rice platform area. The application of recommended fertilizer (RF) is given in the Table 3.

Table 3

Recommended fertilizer dose (g/plot)

Name of fertilizer	*Fertilizer dose (g/plot)*		
	100%	*75%*	*50%*
Urea	375	2810	187.50
TSP	180	1350	90
MOP	150	112.50	75
Gypsum	90	67.50	45
$ZnSo_4$	15	11.25	7.50

The rice fields were waterlogged with channel water to immerse the soil for a week, then tilled frequently up until the soil converted to puddle. L-shaped canal was assembled at the edge of field (*chatal*) of every plot with similar area. Before two days transplanting, lime was putted at an amount of 6 kg $CaCO_3$ each plot. Plastic sheets were fixed up nearby every single plot (50 cm above and 30 cm beneath the platform level) to avoid escape and predator incursion. The mesh size (2 x 1 m) nets were fencing surrounding the fields from escaping and also protecting the fish from the predators. Rice seedlings (BRRI dhan – 29) were transferred at 25 x 25 cm layout at a rate of 4 seedlings apiece hill (a minor cluster of rice seedling thrust into the mud is named a 'hill'). Water profundity in rice fields and trenches was upheld at 5-10 cm and 75-80 cm throughout the first month, and 10-15 cm and 80-85 cm throughout respite of the culture period respectively. Labor-intensive weeding was done at the 20^{th} and 40^{th} days after transplanting (DAT). Fingerling of fish on an typical size 1.5 g were kept in the rice fields with a denseness of 6 fingerlings/m^2 of entire area (10 prawns/m^2 of trench area) on the third DAT. Rice growth performance was measured by counting the number and altitude of tillers each hill in arbitrarily nominated 10 slopes per plot at 30, 45, 60 and 75 DAT. Rice harvested from each plot was freshen, dehydrated and weighed upon drying. The grain weight was balanced to 14% dampness content (Gomez 1972).

Water quality parameter measurement. Water quality in trenches was determined for dissolved oxygen (DO) and temperature at 06:00-07:00 hours, at 10 cm underneath water with an YSI oxygen meter (model 58 Yellow Springs Instruments, Yellow Springs, OH, USA). Integrated water samples of the whole water column were occupied biweekly near the epicenter of every trench at 08:00 hours for analyses of pH, total solids (TS), nitrate-N (NO_3-N), total alkalinity, total hardness, total ammonia nitrogen (TAN), nitrite-N (NO_2-N), total phosphorus (TP), total volatile solids (TVS), dissolved orthophosphate (PO_4-P) and chlorophyll-a (APHA, AWWA & WPCF 1985). Unionized ammonia nitrogen was measured by a conversion table for individual pH and temperature (Boyd 1990). Water transparency was estimated utilizing a Secchi disk at the time of water inspecting. Water was provided to the rice-fish plots by shallow pump once the water level was released and continuously upheld at 40 cm to 50 cm of the field altitude throughout the experimental period. Dissolved Oxygen was measured each fortnight at 7 AM and once more at 4 PM. Value of pH was likewise documented at the similar times correspondingly. Temperatures were documented fortnightly through a thermometer at the similar time. Ammonia was logged at 8 AM fortnightly. All the parameters for observing the water quality were evaluated utilizing the HACH test Kit (model FF1A). The information was computing and investigating.

Data analysis. The results of rice and fish growth performance and quality of water data were analyzed for substantial variances amid treatments utilizing ANOVA (Steele & Torrie 1980). Variances were considered to be significant at the level of 0.05. All means were assumed through standard error (SE).

Results

Effects of fish on plant height. The effects of fish species on tillers quantity of rice in each hill was amplified in the vegetative stage and reached in supreme value during the reproductive stage and then also shortened in the ripening phase. In respects of tiller quantity in every hill, no significant differences ($P>0.05$) were found amongst dissimilar treatments. The maximum number of plants in the tiller were found in (F_C) *C. carpio* (7.02 no/tiller) followed by F_0 (6.07 no/tiller) and F_T (6.40 no/tiller) during 75 DAT (Figure 1).

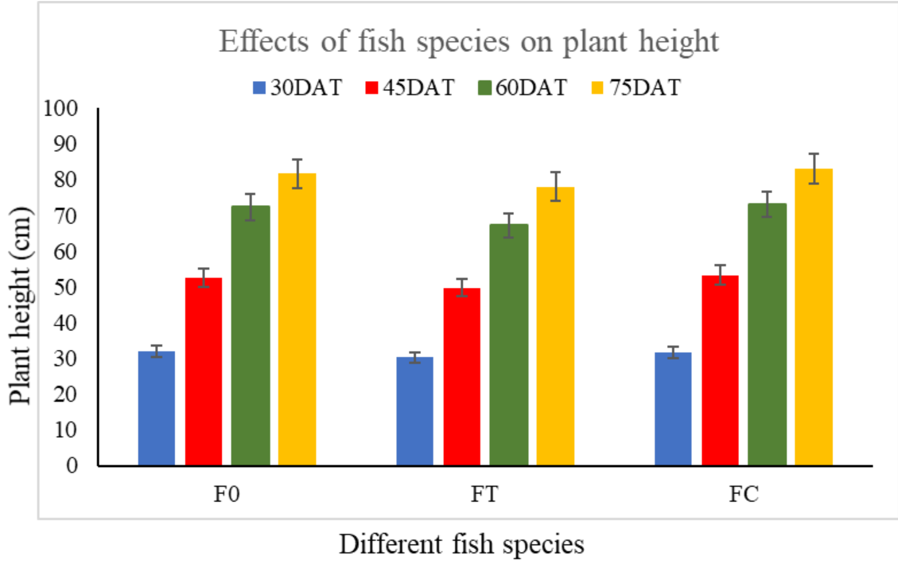

Figure 1. Effects of fish on plant height in each tiller of the rice fish field.

Effects of fish on tiller number. The highest number were measured in F_C on an average of 4.05, 5.86 and 6.61 no/tiller during 30, 40 and 60 DAT respectively, followed by F_0 (4.05, 5.85, 6.34 and 6.76 no/tiller at 30, 45, 60 and 75 DAT) and F_T (3.84, 5.62, 6.01 and 6.4 no/tiller at 30, 45, 60 and 75 DAT) respectively. On the other hand, the impacts of fish species on tillers height of rice in each hill were also rapidly increased in the vegetative stage and attained in maximum height during the reproductive phase and then also reduced in the ripening phase. In respects of tiller altitude in every hill, no significant differences (P>0.05) were found among different treatments. The maximum altitude of the plants in the tiller were found in (F_C) *C. carpio* (82.95 cm/tiller) followed by F_0 (81.65 cm/tiller) and F_T (78.04 cm/tiller) during 75DAT (Figure 2). The tallest height were observed in F_C with an average of 31.71, 53.28 and 73.06 cm/tiller during 30, 40 and 60 DAT respectively, followed by F_0 (31.92, 52.43 and 72.31 cm/tiller at 30, 45 and 60 DAT) and F_T (30.28, 49.76 and 67.25 cm/tiller at 30, 45 and 60 DAT) respectively (Figure 2).

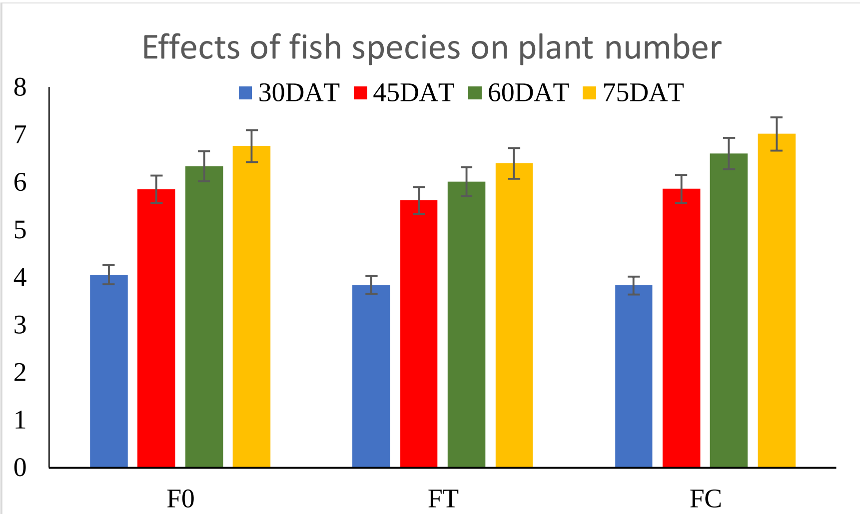

Figure 2. Effects of fish on plant number in each tiller of the rice fish field.

Effects of fertilizer on plant height. In respects of fertilizer application, the impacts of fertilizer on the tillers quantity of rice plants in every hill showed similar growth condition in the vegetative stage and touched in maximum number throughout the reproductive stage whereas progressively reduced in ripening phase. In regards of tiller number per hill, no significant differences (P>0.05) were found among different treatments. The maximum number of plants in the tiller were found in T_4 (6.06, 7.06, 7.86 and 9.53

no/tiller in different 30, 45, 60 and 75 DAT respectively) whereas lowest values were found in T_0 (4.46, 5.26, 6.66 and 7.53 no/tiller in different 30, 45, 60 and 75 DAT respectively) (Figure 3).

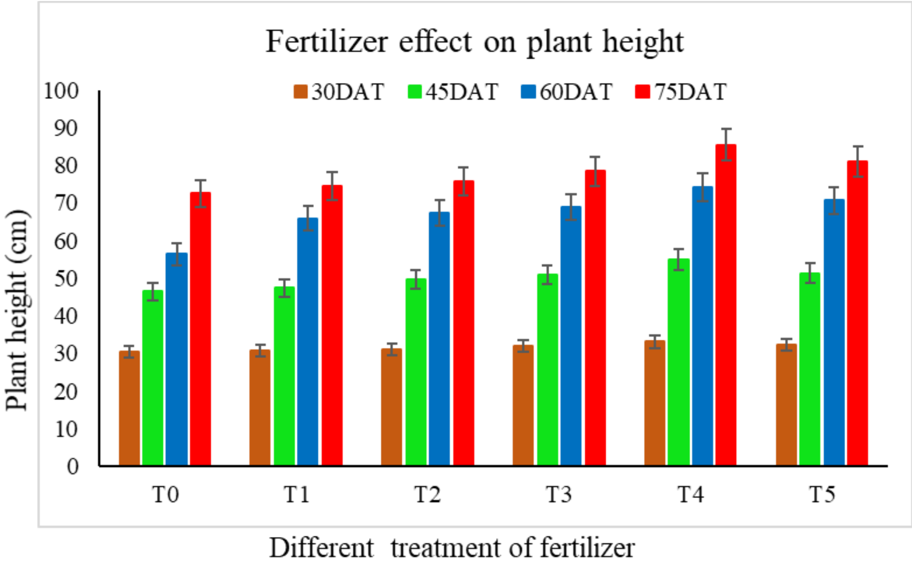

Figure 3. Effects of fertilizer on plant height in each tiller of the rice fish field.

Effects of fertilizer on tiller number. The highest number of tillers were found in T_5 (5.20, 6.80, 7.13 and 8.06 cm/tiller), T_3 (4.80, 6.20, 6.86 and 7.86 cm/tiller), T_2 (4.73, 5.86, 6.73 and 7.73 DAT) and T_1 (4.6, 5.46, 6.80 and 7.66 DAT) during 30, 40, 60 and 75 DAT respectively (Figure 3). On the other hand, the impacts of fertilizer on tillers height of rice per hill were also growing fast and the maximum was found in the vegetative and reproductive stage and then likewise abridged in the ripening phase. In respects of tiller altitude in each hill, no significant differences ($P>0.05$) were found amongst dissimilar treatments. The highest height was found in T_4 (33.06, 54.93, 74.26 and 85.46 cm/tiller), followed by T_5 (32.33, 51.33, 70.60 and 80.86 cm/tiller), T_3 (32.00, 50.93, 68.93 and 78.40 cm/tiller), T_2 (31.06, 49.66, 67.26 and 75.66 cm/tiller), T_1 (30.73, 47.33, 65.86 and 74.33 cm/tiller) and T_0 (30.53, 46.46, 56.33 and 72.53 cm/tiller) during 30, 40, 60 and 75 DAT respectively (Figure 4). The highest growth plant in height were observed in T_1 than the other treatments but there was negative significant differences ($P>0.05$) (Figure 4).

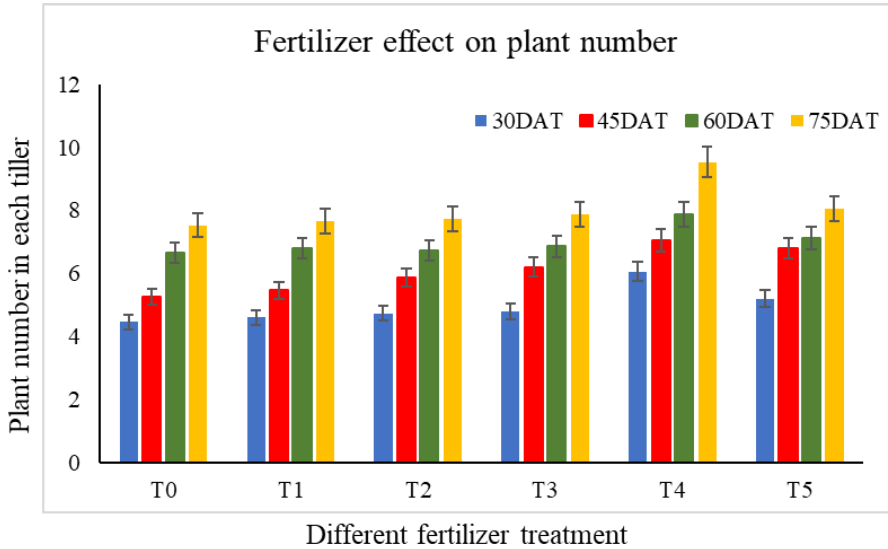

Figure 4. Effects of fertilizer on plant number in each tiller of the rice fish field.

Productivity of rice-fish farming with different fish species. Table 4 shows that the average higher yield of fish was acquired from fertilizer treatment (T_4) in stocking *C. carpio* (F_C) 7.30±1.86 kg/m^2 compared to all other fertilizer treatments in stocking *C. carpio* and *O. niloticus*. The yield of fish in F_C with T_4 was significantly different ($p<0.05$) among all other fertilizer treatments in F_C and F_T fish species. The mean gross yield of rice was documented significantly higher ($P<0.05$) in treatment T_4, (11.70±3.86 kg/m^2) than other fertilizer treatments T_5 (11.25±3.56 kg/m^2), T_3 (10.85±5.76 kg/m^2), T_2 (10.80±5.55 kg/m^2), T_1 (9.90±4.66 kg/m^2), T_0 (4.78±3.48 kg/m^2) and in F_C and also compared to all other fertilizer treatments in F_T.

Table 4

Details productivity of rice-fish farming with different fish species

Details productivity of rice-fish farming (No fish stocking) in F_0						
Parameters	T_0	T_1	T_2	T_3	T_4	T_5
Rice (kg/m^2)	4.00±4.56	8.08±3.86	9.45±6.32	9.63±6.66	9.72±4.86	9.72±5.35
Straw (kg/m^2)	4.60±3.24	8.70±1.45	13.50±2.85	12.60±3.54	14.40±4.68	13.50±4.32
Details productivity of rice-fish farming (*O. niloticus* stocking) in F_T						
Average initial weight of fish (g/fish)	12.48±1.32	12.40±1.52	12.24±0.97	12.57±1.22	12.24±1.07	12.35±1.13
Average final weight of fish (g/fish)	52.07±6.74	56.46±13.88	51.53±7.50	52.61±7.26	66.94±11.69	51.64±4.56
Gross fish production (Kg/m^2)	4.64±2.64	4.65±2.22	4.68±2.25	4.73±1.88	6.02±1.45	5.08±2.28
Gross Production of rice (kg/m^2)	4.82±5.54	8.55±3.48	9.00±3.65	9.18±3.38	9.90±4.45	9.18±4.48
Gross Production of straw (kg/m^2)	4.70±5.32	8.6±5.86	10.5±4.55	13.5±2.66	14.4±3.86	14.4±5.65
Details productivity of rice-fish farming (*C. carpio* stocking) in F_C						
Average initial weight of fish (g/fish)	25.15±1.54	25.37±1.76	25.33±1.81	25.19±1.35	24.87±1.78	25.45±1.74
Average final weight of fish (g/fish)	67.36±10.32	68.56±6.65	74.12±3.81	75.92±7.59	81.17±12.39	80.68±5.86
Gross fish production (Kg/m^2)	4.06±1.76	6.17±1.84	6.67±1.44	6.83±2.88	7.30±1.86	7.16±2.78
Gross Production of rice (kg/m^2)	4.78±3.48	9.90±4.66	10.80±5.55	10.85±5.76	11.70±3.86	11.25±3.56
Gross Production of straw (kg/m^2)	4.28±3.86	10.65±3.36	10.75±4.65	12.88±6.24	13.76±3.95	13.55±4.42

Water quality parameter. The average DO was documented a slight higher in T_4 followed by T_5, T_3, T_2, T_1 and T_0, mutually in morning as well as afternoon. Alternatively, the pH value of the treatments was also originated to be a slightly higher in T_4, next to T_5, T_3, T_2, T_1 and T_0 (equally in morning as well as afternoon). Temperature was chronicled at around 28^{o}C in the morning and nearby 30.5^{o}C in the afternoon (Tables 5 & 6). The average ammonia content was originated to vary between 0.0016 mg/L and 0.0026 mg/L throughout the progression of the experiment (Tables 5 & 6).

Table 5

The water quality parameters (mean ± SE) of rice-fish field during the culture period

Specification		T_0	T_1	T_2	T_3	T_4	T_5
Oxygen (mg/L)	At 7 am	4.00±0.29	4.10±0.21	3.90±0.16	3.80±0.19	4.50±0.19	4.45±0.13
	At 4 pm	6.68±0.14	6.68±0.15	7.20±0.10	7.50±0.35	7.56±0.17	7.10±0.22
pH	At 7 am	7.40±0.90	7.72±0.40	7.10±0.45	7.30±0.52	7.80±0.22	7.50±0.72
	At 4 pm	7.80±0.65	7.85±0.40	7.35±0.45	7.40±0.40	8.12±0.35	7.65±0.40
Temperature (^{o}C)	At 7 am	28.10±0.50	28.0±0.75	27.70±0.75	27.80±0.90	27.80±0.90	28.00±0.80
	At 4 pm	31.00±1.20	31.10±1.00	30.50±1.20	30.60±1.10	30.40±1.30	30.60±1.40
Ammonia (mg/L)		0.0018±0.0004	0.0016±0.0009	0.0026±0.0011	0.0026±0.0015	0.0021±0.0005	0.0024±0.0018

Table 6

The water quality parameters (mean ± SE) of rice-field after application of fertilizer

Specification		T_0	T_1	T_2	T_3	T_4	T_5
Oxygen (mg/L)	At 7 am	4.42±0.15	4.55±0.20	3.95±0.20	3.85±0.20	4.15±0.25	4.05±0.30
	At 4 pm	7.55±0.40	7.60±0.20	6.70±0.20	6.70±0.15	7.15±0.25	7.25±0.15
pH	At 7 am	7.85±0.25	7.75±0.45	7.15±0.50	7.35±0.60	7.55±0.75	7.45±0.95
	At 4 pm	8.15±0.40	7.90±0.45	7.40±0.50	7.45±0.45	7.85±0.70	7.70±0.45
Temperature (^{o}C)	At 7 am	28.15±0.55	28.05±0.80	27.75±0.80	27.85±0.95	27.85±0.95	28.05±0.85
	At 4 pm	31.15±1.25	31.15±1.15	30.55±1.25	30.68±1.18	30.45±1.35	30.65±1.45
Ammonia (mg/L)		0.0018±0.0004	0.0016±0.0009	0.0026±0.0011	0.0026±0.0015	0.0021±0.0005	0.0024±0.0018

Discussion. Fish production can be increased with accurate application of fertilizers and supplementary feeds in carp polyculture system. The main purpose of pond fertilization is to augment the production of plankton which serves as natural food of the fishes; because fertilization stimulates equally the autotrophic and heterotrophic stages which upsurge fish yield (Grag & Bhatnagar 2000). Fish production can be boosted equal to 5,000 kg/ha by feeding as well as fertilization (Ekram 2002). Additionally, prawn culture toward rice farming has been originated to be ecologically comprehensive and is a good method of diversification. Prawns predate on insects, expand soil fertility as well as establish a high-value money trim (New 1995) which regularly enhances the rice yield. In the present investigation, a relatively comparative rice yield was obtained from the rice-fish integrated culture through consistent fertilization likened with rice monoculture, in spite of the fact that the planted region in rice-fish culture was a smaller amount by 20% due to the zone utilized for trenches. Comparable results in rice-fish culture were reported by Costa-Pierce (1992) and Cai et al (1995). Regarding of rice culture alone is taken into assumed; the rice production from rice-fish culture through consistent fertilization was expressively higher than those of rice monoculture. The wellsprings of supplements going into the rice-fish fields were after fertilizers and diets (Grist 1986; Boyd 1995), but these nutrients were collected into the water column of the trench. From the current study result presented that a direct relationship between nutrient supplies and yielding of rice could be observed; increasing nutrient supply highlighting an increase of yielding rice and fish. These are indicated by the significantly greater fish yield at treatment T_4 followed by treatment $T_{5,}$ $T_{3,}$ T_2, T_1 and T_0 in *C. carpio* with rice culture. Concerning *O. niloticus* with rice culture, the same occurrence was observed. The rice yields in rice monoculture (9.72±5.35, 9.72±5.35, 9.63±6.66, 9.45±6.32, 8.08±3.86 and 4.00±4.56 kg/m^2) and rice-fish culture with regular fertilization and feeding obtained in the present study (11.70±3.86, 11.25±3.56, 10.85±5.76, 10.80±5.55, 9.90±4.66 and 4.78±3.48 kg/m^2) are similar to the production from the rice-prawn system (about 4.3 ton/ha/crop) obtained by Nguyen et al (1993). In regarding the fertilization effects, in the inorganic and organic fertilizer dose was higher in gross production than that of other fertilizer treatments. Thus, inorganic and organic fertilizer dose 100 kg/ha/month is superior to those of others and can be prescribed at simply carp poly-culture. Miah et al (1997) obtained 3,434.07 kg/ha fish in 10 months by applying cow dung, additional diet and 50 kg/ha inorganic fertilizer in carp poly-culture scheme. Dissolved oxygen concentrations in all treatments were minor than the optimal level of 4 ppm for prawn growth afterward the 5th week. In case of a rice-prawn culture through consistent fertilization alone, and that with together regular fertilization and feeding, dissolved oxygen concentration was often underneath the precarious level of 2 ppm (Thang 1996) after the 7th week. Low dissolved oxygen concentrations in those treatments might be owing to the blooming of duckweed and algae that sheltered the trench and water surface of the rice field, ensuing in the decrease of phytoplankton in the water column, and averting oxygen diffusion from the atmosphere. Even though rice production was lowermost in the rice-prawn culture with basal fertilization and dieting, prawn yield was uppermost in this system. These outcomes designated that the prawn resourcefully consumed the feed, but the nutrients accessible for rice plants were not satisfactory for optimal rice production. Lee & Wickins (1992) conveyed that the remaining yield in widespread prawn culture was around 200-300 kg/ha/year, which is noticeably not as much of as the existent yield of 816-1,268 kg/ha/year. This designates that prawn culture in rice fields is additional productive and is an improved scheme than extensive monoculture. Although the day-to-day weight expansion of prawns in this rice-prawn culture is low compared with the data from pond culture, which is about 0.4 g/prawn/day, survival rates are more or less similar to that in intensive prawn culture in ponds, which is 60% (Lin & Boonyaratpalin 1988). The size circulation of the freshwater prawns was pragmatic designate skewed, and then males proliferated sooner than females. Analogous outcomes were detected by Sampaio & Valenti (1996).

Conclusions. Integrated rice fish farming in rice fields expands the utilization of land and water and leads to higher fish and rice yield, achieving higher economic gains than in the rice monoculture. Rice monoculture cannot alone provide a sustainable food supply, while integrated rice-fish farming would be the best in terms of resources exploitation, food supply and productivity thus makes the rice field ecosystem with an efficiently and environmentally comprehensive production system for rice and fish.

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