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Technical and economic evaluation of different nutritional input strategies in fish farming.

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Abstract

This current study aimed to compare the performance of different fertilizers and feeding strategies as nutritional input options in fish farms. Twelve earthen ponds (1000 m^2 each) were assigned randomly into four treatments, with triplicates per treatment. The four fertilization treatments were: compost (T1); cow manure (T2); compost and urea plus superphosphate (T3); and cow manure and urea plus superphosphate (T4). Trial ponds stocked with mixed sex tilapia fry and silver carp at rate of (8400 and 100 fish/feddan, respectively). All treatments feed artificial feed 25% protein at 2% of live body daily after twelve of stocking to end of trial.

Mixed fertilizer treatments (T3 and T4) achieved significantly higher yield than organic fertilizer treatments (T1 and T2). Total fish yield in decreasing order was T4, T3, T2 and T1 (1559.3, 1539.3, 1402.7 and 1396 kg/feddan/year, respectively. Feed intake and feed efficiency parameters FE%; PER; PPV% were significantly higher in mixed fertilizers (T3 and T4) than organic fertilizers treatments (T1 and T2). Of water quality (WQ) parameters only available phosphorus was significantly higher in T 1 compared to the other treatments. Nutrient utilization estimation indicated that nitrogen utilization efficiency was significantly higher in T3 and T4 compared to T1 and T2. Phosphorus utilization rate was notably higher in T4 compared to other treatment but with no significant different among treatment. Partial economic analysis showed that benefit cost ratio was significantly higher ($P<0.01$) in T3 (54%) and T 4 (49 %) compared to T1 (36.4%) and T2 (25.8%).

The result of this experiment concluded that feeding strategy using mixed fertilizers and supplementary feed as feeding strategy performed better than organic fertilizers and supplementary feed, increased fish yield and farm revenue.

Keywords: Nutritional input, nutrient utilization, fertilizers, supplementary feed, Fish yield, Fish Body composition.

Introduction

There is an economic pressure for maximizing pond production and minimizing production cost for aquaculture crops (Nash and Brown, 1980). Natural food could be produced in ponds at almost no cost, replaces costly supplementary feed (Hepher and Bruginin, 1981). Ponds are fertilized to grow natural food, which in turn are used to grow natural feed, which in turn are used to grow cultured organisms (Knud-Hansen, 1998; Bhakta *et al*., 2004 and Kumar *et al*., 2004). Studies on the utilization of organic and inorganic fertilizers in fish ponds for sustained gross primary productivity, production of fish food organisms and fish production have been undertaken in several parts of the world (Abdel-Hakim *et al.,* 2000, Brumett, 2000, Veverica *et al*., 2001, Green *et al*., 2002, Ali, 2003, Kumar *et al*., 2004 and Osman *et al.*, 2008; Ibrahim et al., 2010, Soltan *et al.*, 2014). In many parts of the world organic manures and wastes are first biologically stabilized by aerobic composting or by anaerobic fermentation prior to application as pond fertilizers. Both these stabilization processes rely on the controlled microbial decomposition of an organic waste substrate, where former (composting) in the presence of atmospheric oxygen, and the latter (fermentation) in the absence of atmospheric oxygen (Tacon, 1988 and Tacon, 1990). And greater amount of compost than original wastes can be added to the fish ponds without adversely affecting the oxygen levels in the pond (Dalzell *et al*., 1987). For best management of tropical fish ponds for biologically optimal fish growth requires provision of necessary nutrients in a balanced manner via fertilization and supplementary feeding (Green, 1992; Green *et al*., 2002; Kumar *et al*., 2004; El-Sayed, 2006; Osman *et al.*, 2008; Ibrahim et al., 2010; Nasr-Allah, 2015). The current trial was designed to study the effect of the different treatments on fish production, nutrients utilization efficiency, pond water quality and economic performance of the different fertilizers strategies with supplementary feed.

Materials and Methods

Design of the experiment.

The current experiment was conducted at World Fish Centre research facility at Abbassa, Abou-Hammad, Sharkia. Twelve earthen ponds similar size (1000 m^2) each pond were used and selected on random basis. The experiment consisted of four treatments with triplicate as follows:

- T1: compost fertilization
- T2: cow manure fertilization
- T3: compost and chemical fertilization
- T4: cow manure and chemical fertilization

Cow manure used brought from fertilizers supplier while, compost used made compost used made in the site from poultry litter and mixture of cat-tails (*Typha* spp.) and Indian goosegrass (*Eleusine indica*) as described by (Ali, 1995). Fish feed and organic fertilizers samples were sent for analysis at the Central laboratory, Faculty of Agriculture, Zagazig University and the result are summarized in (Table 1 a,b). Quantity of fertilizers applied to each treatment was calculated according to level of nitrogen content in the organic fertilizers (Table 1a) to provide 10 kg N/ha/week (Veverica *et al*., 2001). For T3 and T4, half of the organic fertilizers were replaced by urea (45% N) and superphosphate (15% P_2O_5) to give the same level nutrients in organic fertilizers (Table 2).

Table 1 a. Organic fertilizers analysis (dry mater basis).

Sample	Nitrogen %	Phosphorus %
Compost	1.96	0.55
Cattle Manure	2	0.48

Table 1 b. Proximate analysis of fish feed used in the study

Item	Percentage
Protein %	25.2
Energy Kc	2584
Fat %	4.94
Fibre %	5.7

1.1. Ponds preparation.

Before the start of experiment, the ponds were drained, cleaned and exposed to sun for two weeks. Ponds were assigned to different treatments on random basis. Initial dose (weekly dose), of fertilizers were applied to ponds according their relevant fertilizers application rate (Table 2) prior to pond filling of water. Ponds inlet and outlet pipes were covered with narrow mesh screen to prevent unwanted fish or predators to get into ponds. Partial filling of the ponds to 50% of target level started on the following day after applying the initial fertilization dose from relevant fertilizers. Five days prior to stocking tilapia fry, ponds water level increased and reached the maximum target water depth.

1.2. Cultured species.

Nile tilapia (*Oreochromis niloticus*) mixed sex fry were stocked at rate 2 fish/m^2 (8400 fry/feddan) with an average initial mean body weight 0.15g. Nile tilapia fry were obtained from private hatchery. In order to maintain water quality in ponds and avoid cyanobacteria bloom, silver carp (*Hypophthalmichthys molitrix*) was stocked at stocking rate 100fish/feddan at an average initial body weight of 50±5g. Silver carp fingerlings were obtained from General Authority for Fisheries Resources Development (GAFRD).

Table 2. Fertilizers application rate in (kg/feddan/week).

Fertilizers	Treatment			
	T1	T2	T3	T4
Compost	215		108	
Cow litter		210		105
Urea			4.6	4.6
Super phosphate			5.9	5.9

1.3. Fish pond management.

Fish ponds were fertilized for the first twelve weeks as shown in Table 2. Fertilizers application was done once a week by broadcasting the organic fertilizers and urea at pond surface, while superphosphate was dissolved in a bucket and spread over water. Twice a week water inlet pipes were adjusted to allow for new water to get into ponds to maintain water level in pond throughout the experiment duration. In order for determining the average weight of fish, monthly samples were taken by seining where 100 tilapia from each pond were collected and then returned to the pond after individual weight and length of fish recorded. While for silver carp because of difficulty in getting it in with the sample from earthen ponds, no attempt was done to make growth curve for it. A commercial artificial fish feed 25% protein floating was bought from local producer and delivered to fish at rate of 2% of their body weight for 6 days a week. The daily amount of feed required for fish in each pond was weighed and delivered to the fish by hand twice a day (equal portion) at 9.30 am and 2.00 pm. Feed quantity was adjusted according to average body weight of the sample in each pond. Feed ingredient as listed on the feed sack labels were; fish meal, meat meal, corn gluten, soybean meal, yellow corn, wheat bran, rice bran, calcium die phosphate, and a mixture of vitamins and minerals. Sample of fish feed was collected from several sacks and send for proximate analysis (Table 1b). At harvest ponds were drained and fish yield were collected and sorted to different marketing size classes (Table 3). Fish yield of each size class was weighed and counted then the survival rate was calculated.

Table 3. Size grades of tilapia at harvest time.

Size Grade	Super	1st	2nd	3rd	4th	trash
Weight (g)	>330	200 – 329	125 - 199	50 - 124	25 - 49	<24

1.4. Calculation and analysis procedures.

1.4.1. Growth Parameters:

Growth and feed efficiency parameters were calculated according to the following equation:

WG (g) = mean final fish wt (g) - mean initial fish wt (g).

ADG (g/ day) = Final fish wt (g) - Initial fish wt. (g)/ time (days).

SGR% = 100 (Ln W2- LnW1) / T Where W2 is the fish weight at the end and W1 is the weight at the start and Ln is the natural log.

Gross yield of fish: = harvested fish weight (kg)/ unit area

Net yield (kg/feddan) = harvested fish weight (kg) – initial fish stock biomass (kg) / unit area (feddan).

Survival rate % = Nt × 100 / NI Where: Nt = Number of fish at t days; NI = Number of fish initially stocked.

Condition factor (K) = (W / L^3) ×100 Where: W = Body weight (g); L = Body length (cm) FCR = Dry feed consumed (g) / Total weight gain (g)

PER = (Final body weight (g) – Initial body weight (g))/protein intake (g)

PPV = 100 × (protein retained in tissue (g) /protein intake (g).

1.4.2. Fish and diets analysis.

Proximate analysis of experimental diets and sample of market size fish were carried out according to AOAC (1990) to find out levels of protein, fat, ash, and moisture. While, for analysis of total phosphorus fish, feed and fertilizers samples were send to Agricultural Branch, National Research Centre, Cairo.

1.4.3. Water quality analysis.

Integrated water samples were taken on monthly basis during growing period (at 9.30 am). Water samples were analyzed for pH, alkalinity, total ammonia nitrogen (TAN), nitrate-nitrogen, available phosphorus, chlorophyll a, and Hardness according to APHA, (1998). In addition, biweekly water sample were taken for pH and total ammonia nitrogen analysis. Measurements of dissolved oxygen (DO), temperature, were taken twice a week. DO and temperature were measured in pond water (between 6.00 and 6.30 am) twice a week using Thermo Orion (model 835A, Orion Research Inc) oxygen meter.

1.4.4. Partial budget analysis.

Budget analysis was conducted to determine economic returns of the different fertilization regime tested (Shang, 1990). The analysis was based on farm-gate prices for harvested fish and current local market prices for all other items expressed in Egyptian pound (EGP).

1.4.5. Statistical analysis.

Data were analyzed statistically according to Steel and Torrie (1980) using SPSS, 1999 (version 10.0) statistical software package (SPSS, Inc., Chicago, Illinois, USA). Duncan's Post Hoc Multiple Comparisons Test was performed to evaluate the differences among treatments means (Duncan 1955).

Results and discussion

1.5. Fish yield

In this experiment tilapia growth parameters (final body weight, net weight gain and daily weight gain) affected significantly (P<0.05) by the experimental treatments, while in silver carp growth parameters were insignificantly affected (Table 4). Tilapia growth were significantly higher (P<0.05) in mixed fertilizers, compost and chemical fertilizers (T3) and cow manure and chemical fertilizers treatments (T4), compared to organic manures treatments, compost (T1) and cow manure (T2). These result agreed with what was reported by (Teichert- Coddington and Green, 1993 and Ali, 2003), they stated that tilapia yields was higher in ponds fertilized with mixed fertilizers (chicken manure plus inorganic nitrogen) than that received only chicken manure. On the other hand, Schroeder (1980) reported that yields of carp (*Cyprinus* spp.) and tilapia (*Tilapia* spp.) were not statistically different between inorganically fertilized earthen ponds with and without organic fertilizer. There were no significant differences in SGR for both tilapia and silver carp among treatments (Table 4). Similarly, Ali, 2003 found that ADG and SGR were higher in mixed fertilizers (chicken manure + Urea + superphosphate) than chicken manure treatments with no significant difference between treatments. Garg and Bhatnagar (1999) reported lower SGR value 0.71%/day, in Indian major carp (*Cirrhinus mrigalle*) grown in ponds enriched with mixture of cow dung, triple superphosphate and urea. In this respect, Soltan *et al.*, (2006) concluded that, organic fertilization by poultry litter can replace

100% of high cost pelleted feed in the first three months of growth season followed by applying pelleted diets to cover the increasing nutrient requirements of fish without adverse effect on growth performance and this feeding regime reduce feeding costs during the first three months of fish rearing.

The highest tilapia survival was in T3 treatment (94.3%) and the lowest was in T2 treatment (88%) with no significance difference among treatments. Similarly, there were no significance difference in silver carp survival among treatments and ranged from 58.3 % in T1 and T2 to 67.3 and 79.7% in T3 and T4 (respectively). Similar result reported by Milstein *et al.* (1995) they found that survival rate of *O. niloticus* in ponds received both organic and mineral fertilization ranged between 77 and 85% while those percentages for *C. carpio* ranged between 89 and 91%. The obtained results agreed with that reported by Liti *et al*. (2002) and Al-Kenawy e*t al*. (2008). On the other hand, this result disagree with Sudiarto *et al*. (1990) findings that in common carp survival and fry growth was better in ponds treated with compost than that treated with other fertilizers or used feed alone. Condition factor was significantly different among treatment at (P<0.05) (Figure 1). The obtained result shows that condition factor were higher in mixed fertilizers treatments compared to treatment received only organic fertilizers. The obtained results disagree with what was reported by Ali (2003), who stated that K was higher in ponds received chicken manure than the ponds received mixed fertilizers.

Table 4. Means (±SE) growth performance parameters for the different treatments.

Parameters	Fish Species	Treatments				Sig[2]
		T 1	T 2	T 3	T 4	
Initial weight (g/fish)	Tilapia fry	0.15±0.006	0.14±0.003	0.15±0.007	0.15±0.006	NS
	Silver carp	55.3±1.45	55.7±1.67	55.3±0.88	55.33±1.86	NS
Final weight (g/fish)	Tilapia	171.2±1.50 [b]	180.2±3.89 [ab]	182.8±4.71 [a]	187.1±3.06 [a]	*
	Silver carp	1863±92.17	1853±88.7	2043±30.4	2080±77.18	NS
Net weight gain (g/fish)	Tilapia	171.1±1.47 [b]	180.1±3.89 [ab]	182.7±4.69 [a]	186.9±3.09 [a]	*
	Silver carp	1807.6±91.17	1797.3±90.2	1987.9±31.1	2024.6±75.43	NS
Daily weight gain (g/fish)	Tilapia	0.81±0.007 [b]	0.86±0.019 [ab]	0.87±0.022 [a]	0.89±0.016 [a]	*
	Silver carp	8.63±0.426	8.57±0.433	9.47±0.145	9.63±0.376	NS
SGR	Tilapia	3.35±0.019	3.40±0.017	3.39±0.015	3.40±0.026	NS
	Silver carp	1.68±0.018	1.67±0.036	1.72±0.013	1.73±0.058	NS
Survival rate	Tilapia	90±3.383	88±7.506	94.3±3.712	91.7±1.856	NS
	Silver carp	58.3±5.46	58.3±3.18	67.3±7.26	79.7±9.39	NS
Yield (kg/feddan)	Tilapia	1288.3±6.44 [b]	1294.7±20.87 [b]	1401.7±33.23[a]	1394.3±5.24 [a]	**
	Silver carp	107.7±4.41 [b]	108.0±7.37 [b]	137.7±15.59 [ab]	164.7±15.02 [a]	*
	Total	1396.0±7.77 [b]	1402.7±15.30 [b]	1539.3±18.28 [a]	1559.3±9.82 [a]	***

[1]Values with the same letter within the same row are not significantly different.
[2] Sig = Significant levels: * at P<0.05; ** at P<0.01; *** at P<0.001.

Tilapia and silver carp yield were significantly (P<0.05) higher in T3 and T4 than that yielded in T1 and T2 (Table 4). Mixing fertilizers in T3 and T4, significantly (P<0.001) improved total fish production (1559.3 and 1539.3 kg/fed. respectively) compared to organic fertilizers only in T1 and T2 (1396 and 1402.7 kg/fed. respectively), Table 4. This result agreed with what was reported by (Green *et al*., 2002; Ali, 2003; and Al-Kenawy *et al*., 2008). Ibrahim *et al.,* (2000) found that, the largest fish production for tilapia and silver carp cultured in polyculture was recorded from the ponds that received supplementary feed and the lowest fish yield obtained from the pond fertilized with poultry litter. On the other hand, obtained result disagrees with what reported by Shaker (1998) who reported that organic fertilizers produced higher fish yield than mixed fertilizers or chemical fertilizers ponds.

The increase in fish yield in this experiment may be attributed to the difference in fertilizers nutrients input sources since all treatments offered similar type of fish feed. In mixed fertilizers treatments, nutrients such as N and P compounds from chemical fertilizers dissolve in water in ionic forms available for phytoplankton production (Kumar *et al*., 2004).

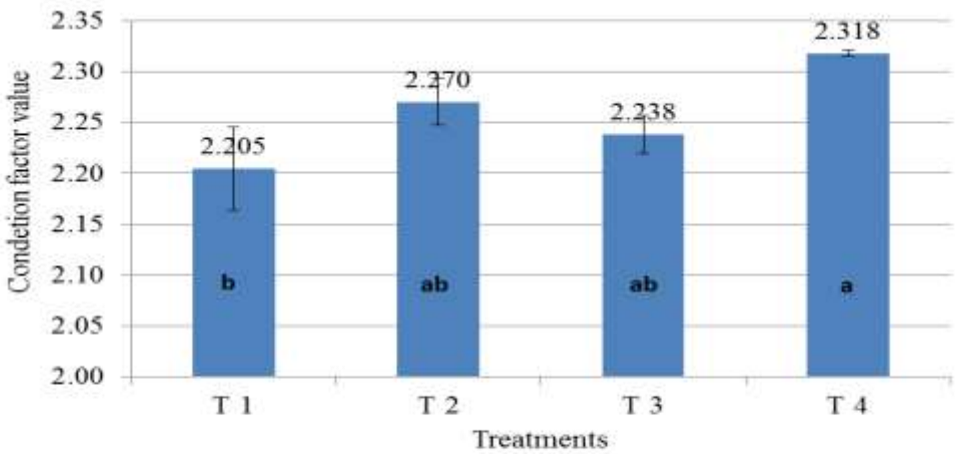

Figure 1. Condition factor value for tilapia reared in different treatments over the experimental period (Mean ± SE) [1].
[1] Values with the same letter are not significantly different.

1.6. Feed intake and feed efficiency parameters:

Stock biomass, fish yield, net fish yield, daily fish weight gain, feed given, feed conversion ratio (FCR), protein efficiency ratio (PER) and protein productive value (PPV) are presented in Table 5. Fish yield, net fish yield, daily fish weight gain, feed given, food conversion ratio, protein efficiency ratio and protein productive value were affected significantly (P<0.001 or 0.01) by the experimental treatments. Duncan test showed that for both fish yield and net fish yield, T3 and T4 were significantly higher than T1 and T2. This results are in agreement with what reported by (Shaker 1998) who found that mixed fertilizers or chicken manure treatment were significantly higher in daily fish weight gain as kg/fed compared to feed only or chemical fertilizers only.

In this experiment, there were significant different (P<0.01) among treatments in artificial fish feed consumed (Table 5). FCR were significantly differ among treatments (P<0.001) T3 and T4 achieved better FCR (1.02 and 1.00, respectively) compared to T1 and T2 (1.1 and 1.12, respectively). Similar FCR values were reported by (Al-Kenawy *et al*., 2008 and Osman *et al*., 2008) from pond received mixed fertilizers and artificial feed 25% protein. Comparable results were reported by Thakur *et al.* (2004) they reported that FCR from 0.87-1.1 in simultaneous fertilization and feeding or fertilized for 80 days then fed artificial feed 30% protein.

There were a significance differences (P<0.001) among treatments in PER Table 5. PPV result showed significant differences (P<0.05) among treatments. It was notable that PPV were significantly higher in T4 and T3 (56.1 and 56.01, respectively) compared to T1 and T2 (52.9 and 51.8 respectively). Osman *et al*. (2008) reported that there were inverse correlation between level of feeding and efficiency of feed utilization. They reported that both PER and PPV% were in the following decreasing order 3 month fertilization then 1 month feed, 2 month fertilization then 2 month feed, 1 month fertilization and 3 month feed and feed only (7, 5.25, 4.16 and 3.54, respectively) and (121, 88.9, 60.9 and 44.8, respectively). The authors explained the higher figure of PPV in restricted feed treatments due to the utilization of natural food in ponds.

Table 5. Means (±SE) [1] feed intake and feed efficiency parameters at different treatments.

Parameters	Treatments				Sig[2]
	T1	T2	T3	T4	
Initial weight (kg/feddan)	6.79±0.178	6.77±0.195	6.76±0.142	6.79±0.225	NS
Yield (kg/feddan)	1396.0±7.77[b]	1402.7±15.30[b]	1539.3±18.28[a]	1559.3±9.82[a]	***
Net Fish Yield (kg)	1389.2±7.68[b]	1395.9±15.42[b]	1532.6±18.26[a]	1552.5±9.82[a]	***
Daily Fish weight gain (Kg/fed/day)	6.62±0.039[b]	6.65±0.072[b]	7.30±0.085[a]	7.39±0.046[a]	***
Fish feed provided (kg/fed)	1518.5±3.94[b]	1556.3±6.33[a]	1560.0±4.08[a]	1554.5±6.44[a]	**
FCR	1.1±0.003[a]	1.12±0.009 [a]	1.02±0.015[b]	1.00±0.006[b]	***
PER	3.66±0.014[b]	3.59±0.025[b]	3.93±0.057[a]	3.99±0.009[a]	***
PPV%	52.87±0.233[b]	51.83±0.56[b]	56.01±1.328[a]	56.10±0.341[a]	*

[1]Values with the same letter within the same row are not significantly different.
[2] Sig = Significant levels: * at P<0.05; ** at P<0.01; *** at P<0.001.

1.7. Nutrients inputs and utilization efficiency.

Estimation of nutrient budget for total N and P inputs through fertilizers and feed and nutrient recovery in the harvest fish yield of current experiment are presented in Table (6). Obtained result showed that total N inputs (fertilizers and artificial feeds), did not vary significantly among treatments (P<0.05). Total N inputs to fish ponds ranged between 103.2 and 104.7 kg/fed in T1 and T3, respectively. On the other hand, N gain in harvested tilapia were significantly higher in T3 and T4 (33.61 and 33.44 kg/fed, respectively), compared to T1 and T2 (30.89 and 31.05 kg/fed, respectively). Nitrogen gain in harvested silver carp fluctuated between treatments with no significance difference among treatments (*P*<0.05). The lowest N gain in silver carp was in 3.11 kg in T1 and the highest was 4.82 in T4. Total N gained in total harvested fish varied significantly among treatments (P<0.001). Mixed organic and inorganic fertilizer (T3 and T4) showed higher N gain in harvested fish (37.63 and 38.26 kg/fed, respectively), compared to T1 and T2 (34.0 and 34.2 kg/fed respectively). Nitrogen waste to the environment, showed reverse trend to N gained in harvested fish. Wasted N was significantly higher in T1 and T2 (69 and 70 kg/fed) compared to T3 and T4 (67and 66.37 kg/fed, respectively). There were very high significance difference among treatments (P<0.001) in percentage of N utilization/gain in harvested fish. N utilization efficiency was significantly higher in T3 and T4 (36 and 36.7 %) compared to T1 and T2 (33 and 33%, respectively).

Mixing inorganic fertilizers with organic fertilizers reduced phosphorus inputs to fish ponds (Table 6) and there were a high significance difference among treatments (P<0.001) in P inputs to ponds. The higher P inputs were in T1 (22.34), followed with T3 (21.38), then T2 (21.1) and the lowest were in T4 (20.65 kg/fed). The results showed that P gained in harvest fish (tilapia and silver) or their sum did not show significance difference among treatments (P<0.05). It was notable that P waste were higher in compost treatments (T1 and T3) compared to cow manure treatment (T2 and T4), with no significance difference among treatments (P<0.05). P utilization rate were higher in cow manure treatments T2 and T4 (30.97 and 34.63%), compared to compost treatments T1 and T3 (29.7 and 28.37%), with no significance difference among treatments (P<0.05).

Table 6. Nitrogen and phosphorus inputs and gain in harvested biomass, and waste generated from various treatments (Mean±SE) [1].

	Treatment				Sig.
	T1	T2	T3	T4	
Nitrogen Input (Kg/feddan)					
Fertilizers	41.74±0.00	41.46±0.21	41.59±0.50	41.72±0.50	NS
Feed	61.47±0.16[b]	63.00±0.26[a]	63.15±0.16[a]	62.93±0.26[a]	**
Total N input	103.2±0.16	104.46±0.19	104.74±0.64	104.65±0.72	NS
Nitrogen Output					
Tilapia	30.89±0.15[b]	31.05±0.50[b]	33.61±0.80[a]	33.44±0.13[a]	**
Silver Carp	3.11±0.1	3.16±0.26	4.02±0.47	4.82±0.48	NS
N gained in harvest	34.00±0.21[b]	34.20±0.27[b]	37.63±0.36[a]	38.26±0.35[a]	***
N Waste	69.2±0.17[a]	70.25±0.25[a]	67.1±0.90[b]	66.37±0.44[b]	***
Gain in harvest %	33.0±0.00[b]	33.0±0.003[b]	36.0±0.006[a]	36.67±0.003[a]	***
Phosphorus Inputs (kg/feddan)					
Fertilizers	11.71±0.00[a]	10.20±0.05[c]	10.46±0.11[b]	9.77±0.11[d]	***
Feed	10.63±0.03[b]	10.89±0.04[a]	10.92±0.03[a]	10.88±0.05[a]	**
Total	22.34±0.03[a]	21.10±0.04[c]	21.38±0.14[b]	20.65±0.15[d]	***
Phosphorus Output					
Tilapia	5.98±0.19	5.87±0.56	5.22±0.17	6.16±0.60	NS
Silver carp	0.66±0.03[b]	0.67±0.08[b]	0.86±0.08[ab]	1.00±0.08[a]	*
P gained in harvest	6.64±0.17	6.54±0.49	6.07±0.098	7.16±0.55	NS
P Waste	15.7±0.15	14.56±0.45	15.31±0.23	13.5±0.65	NS
Gain in harvest %	29.7±0.007	30.97±0.023	28.37±0.006	34.63±0.028	NS

[1] Values with the same letter within the same *row* are not significantly different.

The result of this study disagree with what was reported by Yi *et al*. (2005) that nutrient inputs in heavily fertilized ponds fertilizers were the major source of both nitrogen and phosphorus, accounting for 63.63–75.23% N and 65.64–71.84% P in different treatments, while nutrients from pelleted feed represented 24.77–36.37% N and 28.16–34.36% P. In a culture system with high fertilization rates, nutrients assimilated in harvested tilapia biomass was estimated to be 16-22% for nitrogen (N) and 10-16% for phosphorus (P) (Edwards, 1982; Thakur *et al*., 2004; Yi *et al*., 2005) of total nutrient inputs through fertilizers and feed. Moreover, in intensive system nutrient assimilation in hybrid tilapia body were 21.4% of nitrogen and 18.8% of phosphorus Siddiqui and Al-Harbi (1999). Vymazal (1995), attributed the increase of crude protein content in whole fish bodies of the mixed fertilization treatment on dry matter basis compared to fish of chicken manure treatment due to that algae can use ammonia and other nitrogenous compounds, converted to ammonia, to produce amino acids and the increase in N level coming or resulting from urea in mixed fertilizers enhance the growth of plankton which represents a good protein food source. The significant higher nitrogen utilization efficiency obtained in mixed fertilizers treatments could be attributed to the higher fish yield obtained from in T3 and T4, since total nitrogen inputs form both feeds and fertilizers was not significantly different among treatments.

1.8. Pond water quality

The water temperature recorded in the morning at 6.30 hr, mean water temperature fluctuated from 24.79 in T1 to 24.62 in T4, with no significance difference among treatments (Table 7). Water temperature is one of the most influential environmental factor affecting the metabolism and growth of fish (Boyd, 1990). DO measured on the morning at 6.30 hr, varied between treatments, with no significant difference among treatments at (P<0.05). The lowest DO was in T2 (1.97) and the highest was in T3 (2.13), with no significant difference between treatments. Green *et al*. (1990) reported that mean early morning DO (1.2mg/L) in organically fertilized ponds in Honduras was significantly less than in chemically fertilized pond (2.3mg/L).

Table 7. Mean (±SE) [1]water quality parameters for different treatments.

Parameters	N	Treatments				Sig[2]
		T1	T2	T3	T4	
Temperature	52	24.47±0.051	24.65±0.108	24.72±0.055	24.62±0.055	NS
DO (mg/l)	52	2.09±0.321	1.97±0.249	2.13±0.157	2.11±0.097	NS
pH	11	8.41±0.010	8.47±0.108	8.48±0.003	8.57±0.048	NS
Available phosphorus (mg/l)	6	0.47±0.047 [a]	0.31±0.043 [b]	0.24±0.067 [b]	0.25±0.030 [b]	*
Nitrate (mg/l)	6	0.50±0.090	0.57±0.104	054±0.068	0.43±0.105	NS
NH_4 (mg/l)	11	0.26±0.012	0.22±0.013	0.23±0.019	0.23±0.010	NS
NH_3 (mg/l)	11	0.05±0.002	0.05±0.012	0.04±0.003	0.05±0.010	NS
Alkalinity (mg/L as C_aC_{O3})	6	178.2±6.87	183.5±7.52	164.4±2.79	171.3±14.59	NS
Chlorophyll a (μg/L)	6	34.89±12.45	26.28±3.13	21.78±2.27	28.70±4.97	NS
Hardness (mg/L as C_aC_{O3})	6	212.9±10.91	208.1±9.72	179.5±0.58	199.9±14.96	NS

[1]Values with the same letter within the same row are not significantly different.
[2] Sig = Significant levels: * at P<0.05; ** at P<0.01; *** at P<0.001.

Mean water pH values were not significantly different among treatments (Table 7). Kurten *et al*. (1999) reported that pH values in only organic fertilizer inputs ponds were significantly lower than those recorded in ponds received both organic and inorganic fertilizers. Available phosphorus varied significantly among treatments at (P<0.05). The highest available phosphorus level in pond water was T1 (0.47), compared to the other treatments T2, T4 and T3 (0.31, 0.25 and 0.24 mg/l). In organically fertilized ponds organic P level in pond water was relativity high due to dissolving of inorganic fertilizers in water, after word the nutrient release rate governed by quality of manure (Kumar *et al.*, 2004).

Nitrate nitrogen ranged between 0.43 in T4 and 0.57 in T2, with no significant difference among treatments. These results are in agreement with Ali (2003) who reported that there were no significant difference in NO_3 concentration in ponds received mixed organic and inorganic fertilizers or that received only organic fertilizers. Lower NO_3 mean value were reported by Shaker (1998) for mixed fertilizers plus feed; chicken litter for 60 days then feed; mineral fertilization and feed only treatments (0.19; 0.26; 0.19 and 0.19 mg/L, respectively). Ammonium and Ammonia nitrogen ranged were not significantly different among treatments. Ammonia nitrogen values were similar 0.05 mg/l in T1, T2 and T4, and 0.04 in T3. Un-ionized ammonia at a concentration of 0.06 mg/L had no effect on growth at water temperature between 28 and 33°C (Boyd, 1990). Ibrahim et al. (2015) reported that increasing fertilization dose lead to significant increase in total ammonia nitrogen compared to control ponds. In this experiment NH_3 values were within the acceptable limit for optimum tilapia growth.

1.9. Partial economic analysis.

Economic evaluation for fish production performance under different treatments inputs are presented in Table 8. In this experiment it was notable that mixing chemical fertilizers with organic fertilizers reduced fertilization cost significantly (P<0.001). Due to the difference in fish growth and quantity of fish given there were a high significant difference in fish feed costs (P<0.01) among treatments. The difference among treatments in fertilizers and feed cost contributed to significance differences among treatments (P<0.001) in total variable cost. It was notable that production cost in T3 and T4 (6101 and 6257 EGP/fed, respectively) were lower than T1 and T2 (6239 and 6620 EGP/fed, respectively). Progressively increasing nutrient inputs resulted in the increased fish yields, and also caused corresponding increases of production cost (Yi and Lin 2000). Yi and Lin (2000) reported that when pelleted feed was supplemented to inorganically fertilized ponds, the feed cost accounted for more than 85% of the total production cost. But for the “feed alone” input, the feed cost reached 96% of the total production cost.

Gross revenue varied significantly among treatments (P<0.05). Both T3 and T4 (9402 and 9328 EGP/fed, respectively) were significantly higher compared to T1 and T2 (8513 and 8330 EGP/fed, respectively). Net farm income showed a high significance difference among treatments (P<0.01) following the same pattern of growth revenue. Benefit cost ratio were high significantly (P<0.01) higher in T3 and T4 (54 and 49 %) compared to T1 and T2 (36 and 26 %). Comparable result were reported by Green *et al*. (2002) who reported that fertilization then feed strategy was more economical compared to feed only or chemical fertilized pond. Nasr-Allah (2015) reported that culture of tilapia and mullet increase rate of return on operation compared to tilapia monoculture and tilapia polyculture with mullet and catfish and/or carp.

Obtained results are in agreement with what was reported by Yi and Lin (2000) who mentioned that when chicken manure was supplemented with urea, net revenues increased with increasing rates of both chicken manure and urea. Moreover the net revenue reached 5,029 $/ha/year when ponds fertilized initially with urea and TSP, then fed at 50% satiation level starting feeding at 100 g size. While in “feed alone” input ponds was not profitable. The higher economic return found in mixed fertilizers treatment in this experiment may be explained by increasing nitrogenous nutrients availability for primary productivity and consequently increasing fish yield and thus increase farm revenue at low production cost. Obtained result support findings of Nabil et al. (2010), who concluded that good fertilization and feeding strategy achieve higher economic returns and reducing nutrient inputs which also provide an environmentally friendly fish culture.

Table 8. Means (±SE) [1] Economic evaluation of fish performance in different treatments.

Items	Treatments				Sig[2]
	T1	T2	T3	T4	
1- Revenue					
Fish sales (EGP/feddan)	8513.3±29.88	8330.2±347 ^{b}	9402.3±242.1 ^{a}	9327.9±44.93 ^{a}	*
Production cost					
Fry (EGP/feddan)	445	445	445	445	
Fertilizers (EGP/feddan)	638.8±0.00 ^{b}	956.6±4.78 ^{a}	431.7±2.52 ^{d}	596.8±2.52 ^{c}	***
Feed (EGP/feddan)	2505.5±6.49 ^{b}	2567.9±10.45 ^{a}	2547±6.74 ^{a}	2565±10.63 ^{a}	**
Other cost[3] (EGP/feddan)	2650	2650	2650	2650	
2- Production Cost (EGP/feddan)	6239.3±6.51 ^{b}	6619.6±7.96 ^{a}	6100.7±8.74 ^{c}	6256.8±12.68 ^{b}	***
3- Net revenue (EGP/feddan) (1-2)	2274.0±23.4 ^{b}	1710.6±339.6^{b}	3301.5±250.7 ^{a}	3071.1±45.40 ^{a}	**
4- Benefit cost ratio % (2/3)	36.4±0.32 ^{b}	25.8±5.00 b	54.1±4.18 ^{a}	49.1±0.74 ^{a}	**

[1]Values with the same letter within the same row are not significantly different.
[2] Sig = Significant levels: * at P<0.05; ** at P<0.01; *** at P<0.001.
[3] Other cost include (land rent, labor and water pump and fish harvest costs).

1.10. Conclusion and Recommendation.

In conclusion the result of this study concluded that nutritional feeding strategy using mixture of chemical and organic fertilizers and supplementary feed performed better than organic fertilizers and supplementary feed, in terms of increasing fish yield and generating higher income to producer. The implication of this study is that adopting proper nutritional input strategy could increase farm yield and generate more income for fish farmers.

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التقييم الفنى والاقتصادى لإستراتيجيات التغذية المختلفة فى مزارع الاسماك

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تهدف هذه الدراسة التعرف على افضل استراتجية تغذية بمقارنة الكفاءة الانتاجية للتسميد بالاسمدة العضوية او استبدال 50% من السماد العضوى بسماد كيماوى مع التغذيه بألاعلاف من الاسبوع الثانى عشر وكانت معاملات التجربة كالتالى (1 تسميد بالكمبوست، 2 تسميد بسبلة المواشى، 3 تسميد بخليط كمبوست + يوريا + سوبر فوسفات ، 4 تسميد بخليط من سبلة المواشى + يوريا + سوبر فوسفات). وتم اجراء التجربة فى احواض ترابية مساحتها 1000 م^2 زرعت بزريعه بلطى نيللى 0,15 جم بمعدل 2 سمكة للمتر مع اضافة 25 اصبعيات مبروك فضى (55 جم) لكل حوض لتفادى النمو الغزير للطحالب الذى قد يظهر مع التسميد.

اظهرت الدراسة ان التسميد بخليط السماد العضوى والكيماوى مع التغذية بعد ذلك ادى الى زياده الانتاج معنويا (0,05%). وكانت انتاجية الفدان مرتبة تنازليا كالتالى، معاملة 4 ثم 3 ثم 2 ثم معاملة 1 (1559 ، 1539، 1403 ثم 1396 كجم/ للفدان، على التوالى). وكذلك فى مقياس معدل الاستفادة من الغذاء وكانت المعاملة 4 يليها معاملة 3 أعلى عند مستوى معنوية (0,05 %) من المعاملات 1، 2. وزاد معدل الاستفادة من وحدة البروتين فى المعاملات 4،3 زيادة معنوية عند مستوى (0,001 %) مقارنة بالمعاملات 1، 2. وأظهرت النتائج ان معدل الاستفادة من النيتروجين المضاف كان أعلى معنويا فى معاملة 3، 4 مقارنة بالمعاملة 1، 2.

التقييم الاقتصادى اظهر انخفاض تكاليف الانتاج عند التسميد بالسماد العضوى والكيماوى مقارنتة بالتسميد العضوى فقط مع التغذية بعد 6 أسابيع من الاستزراع. بينما زادت الايرادات معنويا فى المعاملات 3 ، 4 مقارنة بالمعاملات 1، 2. وأظهرت الدراسه ان أعلى عائد على مصروفات الانتاج كان فى المعاملة 3 يليها معاملة 4 (54 ، 49 % على التوالى) حيث كانت اعلى معنويا عند مستوى (0,01%) من معاملة 1 ، 3 والتى حققت نسبة ايرادات (36 ، 26 % على التوالى).

خلصت الدراسة إلى أن إستراتجية التغذية التى تعتمد على التسميد بخليط من السماد العضوى والكيماوى مع التغذية الصناعيه لاحقا حققت انتاجية افضل وزاد معدل الاستفادة من النيتروجين المضاف فى السماد والعلف، وكذلك زادت ربحية النشاط مقارنتا بتلك الاستراتجية التى تعتمد على التسميد بالسماد العضوى مع التغذية.