Effect of cycle length, pond size and cause of mortality on economics of fish farms and their relation to veterinary management

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Abstract: This study was carried out to analyze economically the effect of some factors on fish farming in Kafrelsheikh governorate of Egypt in relation to veterinary management (drugs, disinfectants, and veterinary supervision). Data on (56) production cycles over a period of six years (2012-2017) were randomly collected from private earthen pond farms. The data were summarized and calculated for each 1000 fish. The results revealed that the net profit per 1000 fish was significantly affected (P<0.05) by the length of rearing cycle as it reached to 1126.90 LE for fish reared for 7-9 months and 803.26 LE in that kept for 4-6 months. Furthermore, the highest net profit (1177.10 L.E) was observed for the pond size of 2.5-4 feddan and 1703.00 L.E in farms that did not exposed to diseases. Also, the results showed that the maximum values of veterinary management (25.28, 28.94 and 27.43 L.E for each 1000 fish) were recorded for cycle length of 10-12 months, pond size of 5 feddan & more and farms exposed to Aeromonus infection respectively. It was concluded that rearing of fish for 7-9 months, using a pond size of 2.5-4 feddans and decreased mortality rate through prevention of diseases outbreaks are economically viable.
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1. Introduction

Fishery sector in Egypt contributes toward food security also to economic growth and poverty alleviation through creating job opportunities and increasing income. The main sources of fish production in Egypt include marine Fisheries, capture and aquaculture. Egypt's total fish production increased from 727,000 MT in 2000 to 1.1 million tons in 2009(GAFRD 2011).

The production from wild catch fisheries declines every year so aquaculture is the mean for providing a cheap source of animal protein.

Some factors were highlighted to affect the development of fish farms such as feed cost, cost of fingerlings as well as market price (Agboola 2011).

The duration of culture was detected as a management variable that has been shown to affect fish yield (Southworth *et al.* 2006). Furthermore, pond size and length of production cycle positively contributed to profitability in the study conducted by (Hyuha *et al.* 2011). It was observed that only pond size and source of water have positive and significant impacts on technical efficiency of fish farms (Roy and Jens 2008). The pond is a critical variable as pond size increases given other inputs, fish output will increase. A ten percentage increase in pond size will result in a 3% increase in fish output (Bukenya *et al.* 2013and Inoni 2007). Mortality is another constraint to the development of the aquaculture sector. The different causes of mortality include diseases (bacterial, parasitic and fungal infection) and unfavorable environmental conditions. The global estimate of disease losses in the range of several billion US$ per year (Subasinghe *et al.* 2001) which resulted from production losses, costs of investment in disease research and control and health management programs (Bondad-Reantaso *et al.* 2005).

There are several reports indicating the effect of cycle length, pond size and causes if mortality on fish farming. However, there is no report available on their relation to the usage of drugs, disinfectants, and veterinary supervision. Therefore, this study was conducted to investigate the effect of these factors on the fish farming enterprise in Kafrelsheikh governorate and their relationship to veterinary management with the purpose to determine various performance indicators of economic viability or profitability in the study area.

2. Materials and Methods

1. Area of the Study:

The area of study is Kafrelsheikh governorate which located in the north Delta of Egypt. It is the main area for fish production in Egypt with about 324,479 tonnes (55% of the national farmed fish production)(Macfadyen *et al.* 2011).

***2.* Data collection:**

The data on 56 production cycles over a period of six years (2012-2017) were utilized from a random sample of private fish farms in four different locations in Kafrelsheikh governorate namely Motobus, Baltim, Sidi Salem and Elhamoul. Only earthen pond farms were included in the study (which accounts for 85% of the total Egyptian aquaculture production).

Data were collected from two sources, the available records and a structured questionnaire made for the farms did not keep records. The quantitative and qualitative data collected included: length of the cycle, the cause of mortality, pond size production costs; costs of feed, fries and fingerlings, drugs, disinfectants, land, labor, equipment, fuel and other costs and output data; fish sales volumes and values. Other data included mortality rate, the number of fish stocked and time of stocking.

Data handling:

The data were classified into:

a. According to cycle length: (4- 6, 7- 9 and 10- 12 months)

b. According to pond size: (1- 2,2.5 – 4 feddan and 5 feddan & more)

c. According to cause of mortality: (Motile Aeromonas Septicemia, Mycotic diseases, Parasitic diseases and No disease (control))

***3.* Data analysis**

The information obtained from the surveys was collated, tabulated sorted into different categories and all illogic data were rejected. The data were summarized and calculated for each 1000 fish to overcome the variation in the numbers of fish of the different farms.

Statistical analyses were conducted using IBM SPSS Statistics for Windows, Version 16.0 (SPSS. 2007).

- Analytical technique:

One way analysis of variance (ANOVA): to compare means of the effect of cycle length, pond size and cause of mortality on variables affecting fish production (feed consumption, drugs, disinfectants, veterinary supervision and quantity of fish produced).

- Calculations**:**

Economic indicators: including variable and fixed costs, quantity of fish produced sales prices LE / kg, net revenue, percentage of returns on total costs and percentage of net profit on total costs to determine the performance of the farmers with respect to efficiency in the usage of resources (Green *et al.* 2002).

Variable costs are those costs which differ according to the amount of fish production. They include costs of feed, drugs, disinfectants, fry, fuel, transport, labor and other costs. While fixed costs are those which do not change with production volumes. They are rents paid for land and buildings, and the depreciation costs of equipment. Calculation of the depreciation cost of equipment was computed according to(Sankhayan 1983).

$$\text{Depreciation rate} = \frac{\text{Value of asset}}{\text{Age of asset (years)}}$$

The standardized lifespans for assets are 25 years for buildings, 5 years for water pumps, 3 years for nets and 10 years generators and vehicles.

3. Results and Discussion

Effect of Cycle length on variables affecting fish production:

Table (1) represented the significant effect ($P < 0.05$) of Cycle length on feed consumption and veterinary management.

Table (1): Means ± SE of feed (kg) and veterinary management values (drugs, disinfectants, veterinary supervision and total veterinary management / L.E among different cycle lengths per 1000 marketed fish.

Cycle length	N	Feed (kg)	Drugs (LE)	Disinfectants (LE)	Veterinary supervision(LE)	Total veterinary management (LE)	Production amount (LE)
		Mean± S.E	Mean± S.E	Mean± S.E	Mean± S.E	Mean± S.E	Mean± S.E
4-6 months	8	270.72±27.27^{c}	10.75±2.80^{c}	4.57±1.14^{c}	3.53±0.81^{b}	18.85±3.67^{c}	128.26±7.57^{b}
7-9 months	45	284.17±9.35^{b}	16.58±1.54^{a}	5.45±0.37^{b}	5.23±0.59^{a}	27.26±2.14^{a}	177.23±3.73^{a}
10-12 months	3	398.80±45.71^{a}	14.37±6.06^{b}	8.08±3.54^{a}	2.83±1.17^{b}	25.28±8.62^{b}	131.72±27.58^{b}

The amount of feed consumed (kg) was ranged from 270.72 to 398.80 kg for Cycle length of 4-6 months and 10-12 months due to increase the age required for marketing either due to lower weight gain or the consumer prefer large size fish. In addition, some farmers stock their fish in winter season; in this case the fish take longer time to reach a marketable size. These results are in consistent with (Bromage *et al.* 2001) who stated that Seasonality dominates the life cycle of fish. It co-ordinates their reproductive activity, affects body weight and condition and influences food intake.

The drug value ranged from 10.75 to 16.58 L.E for each 1000 fish for Cycle length of 4-6 months and 7-9 months. The disinfectant value ranged from 4.57 to 8.08 L.E for each 1000 fish for Cycle length of 4-6

months and 10-12 months respectively and veterinary visits which ranged from 2.83 L.E for each 1000 fish farmed for 10-12 months to 5.23 L.E for each 1000 fish farmed for 7-9 months. The total veterinary management costs ranged from 18.85 to 25.28 L.E for each 1000 fish for Cycle length of 4-6 months and 10-12 months respectively. As a prolonged period of rearing give a chance for spreading of diseases which require more expenditure on veterinary management.

The total fish production (kg) ranged from 128.26 to 177.23 Kg for each 1000 fish for Cycle length of 4-6 months and 7-9 months respectively because longer time for rearing allow fish to gain more weigh so increases production at harvest.

The significant differences ($P < 0.05$) between different length of cycles, for return, total cost, net profit, percentages of total return to total costs and net profit to total costs were cleared in (Table 2).

Table (2): Means ± SE of return, total cost, net profit (L.E), TR/TC Percent and Net profit/TC percent among different cycle lengths per 1000 marketed fish.

Cycle length	N	Return	Total cost	Net profit	TR/TC percent	Net profit/TC percent
		Mean± S.E	Mean± S.E	Mean± S.E	Mean± S.E	Mean± S.E
4-6 months	8	2837.60±165.28^{c}	2034.40±236.17^{b}	803.26±184.62^{c}	148.53±14.99^{b}	48.53±14.99^{b}
7-9 months	45	3121.10±78.88^{b}	1982.20±59.12^{b}	1126.90±63.98^{a}	160.35±3.99^{a}	59.78±4.07^{a}
10-12 months	3	4556.30±485.65^{a}	3548.50±416.79^{a}	1007.80±403.57^{b}	130.18±14.57^{c}	30.18±14.57^{c}

TR= Total Return TC= Total cost

Returns ranged from 2837.60 to 4556.30 L.E per 1000 fish for Cycle length of 4-6 months and 10-12 months respectively. Total costs ranged from 1982.20 to 3548.50L.E per 1000 fish for Cycle length of 7-9 months and 10-12 months respectively due to high costs of feed and veterinary management. Moreover the net profit ranged from 803.26 to 1126.90 L.E for each 1000 fish for Cycle length of 4-6 months and 7-9 months respectively. The results of total return to total cost percentage showed that, the higher percentage recorded for Cycle length of 7-9 months as 160.35 % and lower percentage for Cycle length of 10-12 months was 130.18 %. The percentage of the net profit to total cost ranged from 30.18 to 59.78 % for Cycle length of 10-12 months and 7-9 months respectively. As the costs were higher in longer cycle lengths which take large part of the profit. These results are agreed with (Hyuha *et al.* 2011). They mentioned that length of production cycle is one of the most important determinants of profitability.

Effect of Pond Size on variables affecting fish production:

Regarding to Table (3), the Pond Size significantly affected ($P<0.05$) on the total amount of ration consumed which ranged from 280.39 to 330.95 kg / 1000 fish for pond size of 1-2 feddan and 5 feddan & more respectively. This result attributed to high stocking rate of fish in the bigger size of ponds.

The value of drugs were found to be nearly the same for pond size of 1-2 feddan and 2.5-4 feddan (15.21 and 15.37 LE/1000 fish) but for 5 feddan & more it was found to be the highest (18.18 LE/1000 fish). The value of disinfectants ranged from 5.15 to 6.57LE LE/1000 for 2.5-4 feddan and 5 feddan & more respectively. The value of veterinary supervision ranged from 4.19 LE /1000 fish for 2.5-4 feddan and 5 feddan & more to 5.36 LE /1000 fish for 1-2 feddan.

Moreover, the value of total veterinary costs ranged from 24.72 to 28.94 LE /1000 fish for 2.5-4 feddan and 5 feddan & more respectively because the high stocking density in large pond size lead to increased incidence of diseases. Hence, more costs on veterinary management.

Table (3): Means ± SE of feed (kg) and veterinary management values (drugs, disinfectants, veterinary supervision and total veterinary management / L.E among different size**s** of pondper 1000 marketed fish.

Pond Size	N	Feed	Drugs	Disinfectants	Veterinary supervision	Total veterinary management	Production amount
		Mean± S.E	Mean± S.E	Mean± S.E	Mean± S.E	Mean± S.E	Mean± S.E
1-2 feddan	32	280.39 ± 11.56^{b}	15.21±1.64^{b}	5.39±0.48^{b}	5.36±0.77^{a}	25.96±2.41^{b}	132.89±4.81^{b}
2.5-4 feddan	17	283.32±14.98^{b}	15.37±2.03^{b}	5.15±0.65^{b}	4.19±0.60^{b}	24.72±2.79^{b}	129.27±4.94^{c}
5 feddan & more	7	330.95±37.42^{a}	18.18±6.50^{a}	6.57±1.49^{a}	4.19±1.28^{b}	28.94±8.12^{a}	147.86±15.49^{a}

Table (4): Means ± SE of return, total cost, net profit (L.E), TR/TC Percent and Net profit/TC percent among different size**s** of pond per 1000 marketed fish.

Pond Size	N	Return	Total cost	Net profit	TR/TC percent	Net profit/TC percent
		Mean± S.E	Mean± S.E	Mean± S.E	Mean± S.E	Mean± S.E
1-2 feddan	32	3038.20±94.25^{c}	2027.40±83.60^{b}	1010.90±85.00^{b}	154.11±5.58^{b}	54.11±5.58^{b}
2.5-4 feddan	17	3111.50±138.81^{b}	1902.90±96.32^{b}	1177.10±102.52^{a}	166.27±6.03^{a}	64.75±6.52^{a}
5 feddan & more	7	3814.20±325.45^{a}	2699.30±353.14^{a}	1114.90±180.76^{a}	148.09±11.41^{c}	48.09±11.41^{c}

The production significantly differed (P<0.05) among pond sizes and it ranged from 129.27 to 147.86 kg /1000 fish for pond of 1-2 feddan and 5 feddan & more respectively.

The results in table (4) indicated that, there were significant effects of pond size on return which ranged from 3038.20 to 3814.20 L.E per 1000 fish for 1-2 feddan and 5 feddan & more respectively. This is due to higher fish production from larger ponds. While the net profit ranged from 1010.90 to 1177.10 L.E per 1000 fish for 1-2 feddan and 2.5-4 feddan respectively. This result may attribute to economies of the scale so lesser costs.

The percentage of the total return to total cost ranged from 148.09 to 166.27 % for 5 feddan & more and 2.5-4 feddan respectively while the percentage of the net profit to total cost ranged from 48.09 to 64.75 % for the same sizes respectively. This result attributed to higher total costs for pond size of 5 feddan & more. These results are in agreement with those of (Olagunju *et al.* 2007). They reported that there is a significant relationship between total revenue and variable cost and size of pond.

Effect of cause of mortality on variables affecting fish production:

Table (5) showed the significant (P < 0.05) effect of different causes of death on feed consumption, veterinary management and total amount of fish produced.

Feed consumption ranged from 256.85 to 294.74 Kg for each 1000 fish which cause of death was due to environmental conditions (as cold) and pond condition (as oxygen) i.e. no disease (control) exposed to Mycotic diseases, respectively. This result may be due to mycotic infection specially saprolegniasis more common in winter season. Stocking of fish in winter prolong the period of rearing which demand increased amount of ration.

The drug values ranged from 8.20 to 16.89 L.E for each 1000 fish for control one and fish exposed to Aeromonus disease respectively. The disinfectant value ranged from 3.55 L.E for each 1000 fish for control one to 6.10 L.E for each 1000 fish exposed to parasitic disease, respectively, and veterinary visits which ranged from 4.15 to 5.67 L.E for each 1000 fish same causes of death. The total veterinary management costs ranged from 15.90 to 27.43 L.E for each 1000 fish in control and in fish exposed to Aeromonus infection, respectively due to uses of large quantities of antibiotics and frequent visits of veterinarian for diagnosis of diseases. Bacterial infections increase morbidity, mortality and costs of treatment (Kapil 2005).

The amount of fish produced ranged from 126.47 to 142.33 Kg for each 1000 fish for fish exposed to mycotic diseases and control respectively. This is due to high mortality rate caused by mycotic diseases. Fungal infections cause low productivity of fry and low production in both natural and commercial fish farms(Bangyeekhun *et al.* 2001and Kwanprasert *et al.* 2007).

Table (5): Means ± SE of feed (kg) and veterinary management values (drugs, disinfectants, veterinary supervision and total veterinary management / L.E among different causes of mortality per 1000 marketed fish.

Cause of mortality	N	Feed	Drug	Disinfectants	Veterinary supervision	Total veterinary management	Production amount
		Mean± S.E	Mean± S.E	Mean± S.E	Mean± S.E	Mean± S.E	Mean± S.E
Motile Aeromonas Septicemia	41	291.03±7.99^{a}	16.89±1.60^{a}	5.67±0.40^{b}	4.86±0.44^{b}	27.43±2.10^{a}	126.47±3.85^{c}
Mycotic diseases	6	294.74±40.20^{a}	9.73±4.06^{c}	4.37±1.03^{b}	4.37±1.32^{b}	18.47±5.95^{c}	131.99±14.85^{b}
Parasitic diseases	6	279.76±58.04^{b}	11.62±3.20^{b}	6.10±1.97^{a}	5.67±3.54^{a}	23.39±7.03^{b}	140.00±17.31^{a}
No disease (control)	3	256.85±38.16^{c}	8.20±3.87^{c}	3.55±1.26^{c}	4.15±1.75^{b}	15.90±8.88^{c}	142.33±10.06^{a}

Table (6): Means ± SE of return, total cost, net profit (L.E), TR/TC Percent and Net profit/TC percent among different causes of mortality per 1000 marketed fish.

Cause of mortality	N	Return	Total cost	Net profit	TR/TC percent	Net profit/TC percent
		Mean± S.E	Mean± S.E	Mean± S.E	Mean± S.E	Mean± S.E
Motile Aeromonas Septicemia	41	2978.50±98.22^{c}	2072.90±86.51^{b}	905.6±69.68^{b}	143.68±4.52^{b}	43.69±4.61^{b}
Mycotic diseases	6	2989.40±260.53^{c}	2020.60±171.66^{b}	968.80±166.30^{b}	147.94±8.26^{b}	47.95±8.26^{b}
Parasitic diseases	6	3168.90±341.04^{b}	2351.00±348.03^{a}	817.90±293.24^{c}	134.78±18.19^{c}	34.79±18.19^{c}
No disease (control)	3	3336.80±182.46^{a}	1633.80±158.24^{c}	1703.00±37.84^{a}	204.23±7.73^{a}	104.24±7.73^{a}

Table (6) illustrated the significant effect (P < 0.05) of different causes of death on return, total costs, net profit, percentages of total return to total costs and net profit to total costs.

Returns ranged from 2978.50 to 3336.80 L.E per 1000 fish for fish that exposed to Aeromonus and control, respectively. Total costs ranged from 1633.80 to 2351.00 L.E per 1000 fish for control and that exposed to parasitic disease, respectively. The net profit ranged from 817.90 to 1703.00 L.E per 1000 fish for fish exposed to parasitic disease and control, respectively. The higher total return to total costs percentages were found in control as 204.23%, while the lower one showed in fish exposed to parasitic disease as 134.78%. The results demonstrated higher net profit to total costs that recorded for in control (no

disease) as 104.24% while the lower one was for fish exposed to parasitic disease as 34.79 %. this result attributed to parasitic diseases losses through occurrences of deaths and loss of fish productivity (Khan 2009). Hence, high costs and losses in return and profit. Also, analogous results mentioned by (Khalil *et al.* 2001) they reported that, fish diseases had significant effects on profitability of fish farms.

Conclusion

This study concluded that economics of fish farming in Kafrelsheikh province and veterinary management in terms of drugs, disinfectants and veterinary supervision were significantly affected by cycle length, pond size and cause of mortality. Based on these results, rearing of fish for 7- 9 months, construction of ponds with 2.5-4 feddan in size and low mortality rate were found to be more profitable and recommended.

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