KSÜ Tarım ve Doğa Derg 23 (5): 1257-1269, 2020
KSU J. Agric Nat 23 (5): 1257-1269, 2020
DOI:10.18016/ksutarimdoga.vi.692756

Economic Analysis of Fish Farming in the Northern Region of Iraq

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ABSTRACT
In the '80s, Kuwait operations and the conflict between Iran and Iraq negatively affected the aquaculture and especially fish farming. This study was carried out to analyze fish productions and advancements in its development in the Northern Region of Iraq. Also, this study was aiming at obtaining the estimates of the production function for fish production and total income. The study involved 60 farms. Data were analyzed by using descriptive statistics, variance analysis and multiple regression. According to results, the benefit-cost ratio was 1.8, and it indicates that fish farming in the region was profitable. Results demonstrated that farmers' age, educational status and fish farming experience, size and number of ponds, total fingerlings stocked, age of ponds, time of fish production, the weight of the sold-fish, fish mortality rate, and price of fish sale have statistically significant effects on fish production. According to the estimated production function, if all inputs are increased by 1%, then output increases by only 0.92%.

Research Article

Article History
Received :
Accepted :

Keywords
Fish farming
Socio-economic patterns
Aquaculture
Production function
Erbil

Kuzey Irak Bölgesinde Balık Yetiştiriciliğinin Ekonomik Analizi

ÖZET
Irak'ta 1980'lerde meydana gelen İran-Irak savaşı ve Kuveyt operasyonları nedeniyle su ürünleri sektörü ve özellikle balık yetiştiriciliği olumsuz yönde etkilenmiştir. Bu çalışmanın amacı Irak'ın kuzey bölgesinde yer alan Erbil ilçesinde balık üretimi ve üretimde etkili olan faktörleri analiz etmektir. Ayrıca, araştırmada işletmelerin balık üretim maliyetleri ve balık üretim fonksiyonu tahmin edilecektir. Araştırmada 60 işletmeden elde edilen veriler kullanılmıştır. Veriler tanımlayıcı istatistikler, varyans analizi ve çoklu regresyon kullanılarak analiz edilmiştir. Araştırma sonuçlarına göre, işletmelerde fayda-masraf oranı 1.8 olarak tespit edilmiştir. Bu da bölgede balık yetiştiriciliğinin karlı olduğunu göstermektedir. Elde edilen sonuçlara göre, balık üretiminde etkili faktörler; üretici yaşı, eğitim durumu, deneyim, üretim alanı, gölet sayısı, toplam balık sayısı, proje zamanı, balık üretim zamanı, balık ağırlığı, balık ölüm oranı ve balık satış fiyatlarıdır. Tahmin edilen üretim fonksiyonu sonuçlarına göre, tüm girdiler %1 artırılırsa, balık üretim miktarı sadece % 0.92 artmaktadır.

Araştırma Makalesi

Makale Tarihçesi
Geliş Tarihi :
Kabul Tarihi :

Anahtar Kelimeler
Balık yetiştiriciliği
Sosyo-ekonomik özellikler
Su ürünleri
Üretim fonksiyonu
Erbil

To Cite : Maaruf HT, Akbay C 2020. Economic Analysis of Fish Farming in the Northern Region of Iraq. KSU J. Agric Nat 23 (5): 1257-1269. DOI: 10.18016/ksutarimdoga.vi.692756.

INTRODUCTION

Aquaculture is the breeding, rearing and harvesting of aquatic organisms such as fish, shellfish, algae crustaceans, molluscs, and aquatic plants. Production of the world aquaculture is noticeably increasing faster than animal husbandry. Aquaculture is increasingly becoming important sources of seafood production, and ultimately the primary source of proteins and also crucial sources of micronutrients, namely fatty acids, iron, zinc, omega-3 and vitamins (Lucas and Southgate, 2012; Pauly and Froese, 2012; Akbay et al., 2013; Tacon and Metian, 2013; Bennett, 2018).

According to the State of World Fisheries and Aquaculture, a global population is expected to be 9.7 billion by 2050. This report highlights the potential effect of inland waters and fish farming to participate effectively to global food security and to provide required foods for such a high population (Seggel and Young, 2016). Due to the population explosion, important roles of fish farming, and dramatic alterations of the aquatic ecosystem such as climate change, pollution, mismanagement, invasive species, eutrophication (Dudgeon et al., 2006; Gray, 1997), efforts to manage and maintain small-scale fish farming have become a global priority (Cooke et al., 2017). As farmers are commonly facing inadequate and conflicting information, these factors are complicating the implementation of important changes or effective modifications to fish productions, cost reductions and profit increases (Drolet et al., 2015; Cooke et al., 2017).

According to the Food and Agricultural Organization (FAO), most activities constituting production of aquaculture are namely (1) hatchery rearing of spat and fry etc. (2) stocking of ponds, tanks, cages, temporary and raceways (3) barrages including dams with wild-caught (4) culture in ponds as a private tidal (5) fish culture are stocked in paddy fields (FAO, 2006). Domestications over thousands of year were carried out by selecting desirable traits without any scientific and economic basis. As consequences of environmental factors, developments of aquaculture programs relatively took a longer period than other forms of food production. Even the adoption of tested technologies, the physical facilities construction particularly pond farms, solution for site-specific problems, the building of the system productivity, and above all, workers skills attainment has increased (Pillay, 1990; Pillay and Kutty, 2005).

However, modern aquaculture currently depends on species (such as common carp, atlantic salmon, rainbow trout, tilapia species, channel catfish) possessing strong selections which are subjected to hybridization, molecular and genomic techniques (Lucas and Southgate, 2012). Despite the modernizations of aquatic culture, there are several environmental factors (for example, pH, salinity, buffering capacity, dissolved nutrients, turbidity, and etc.) that might profoundly influence aquatic organisms.

Although Iraq is an oil-rich country and its climates are arid, fish farming plays effective roles in the country's economy. It is also reported that the inland fisheries are greatly based on carps *Cyprinus spp* (Kitto and Tabis, 2004). Aquaculture sector and specifically fish farming in Iraq has been severely affected as consequences of the Iran–Iraq war in the 1980s and the invasion of Kuwait operation (Desert Storm). Both disruptions and arising of environmental effects from oil pollution have significantly decreased fish farming. Today's outlook for international food relief and agricultural technology does not bode well for short- or long-term community or national food security in Iraq (Kitto and Tabish, 2004; Obeed and Ward, 2017).

Aquaculture in Iraq is limited to pond culture of common carp (Cyprinus carp iocarpio), despite the availability of water resources and freshwater. While investments in fish farming, particularly in shrimp by Iraqi's neighbors including Kuwait, Bahrain and the UAE (Kitto and Tabish, 2004), total fish production of Iraq in 2017 was only 31814 tons (FAO, 2020). The available collected data indicates that the total fish farming area is 7500 ha, including almost 1900 farms. Such farms are mostly near to freshwater sources. Unless the Babel fish farm, those farms are earthen ponds with no adequate lining or insulation. Most farms are small-scale, owned and managed by private companies or individuals. Productivity in most fish farms is relatively low, which are ranged from 1400 to 2000 kg/ha (El Gamal, 2001). Tigris and Euphrates supply Iraq with copious amounts of water for fisheries. Besides, there are other resources of water, especially in the northern region of Iraq; these sources are in the form of lakes and ponds which are suitable for fish farming. Now, more than ever, aquaculture, including fish production, might be an area of serious growth as the country looks for ways to feed itself (Kitto and Tabish, 2004).

As stated above, the northern region of Iraq mostly depends on ponds culture in fish farming. Farmers mainly use groundwater to irrigate their farms. In regards to water sustainability, a relevant study by Obeed and Ward (2017) estimate characteristics of groundwater use for food-production in the southern region of Iraq. They observed a feature of unsustainable groundwater withdrawals. This observation might be accurate for the northern part of Iraq as well. Al-Taee et al. (2017) concluded the presence of a particular pathogen such as *Vibrio* in various fish farms in Basrah. They expected the presence of such pathogens in other farms in Iraq warning all farm owners to combat this threat to ensure the quality and productivity of fish which subsequently impacts the profitability of farms.

At the moment, there are only two main active official fishery research centers in Iraq including The Fish Research Center in Zaafaraniyah, closer to capital city Baghdad and The Marine Science Center in Basra, both centers are under the Ministry of Agriculture (Grafton, 2010). Although there is no similar center in the southern region of Iraq, governmental administrations of fish management in all governorates provide fish farmers with fingerling and feeds.

Fish farming occupies an essential position as a source of fish meat with excellent nutritional values in the human diet. In recent years, fish production has been evolved in Northern Iraq and particularly in Erbil governorate. It is becoming dependent on science and technology for higher economic return in a shorter time and at the lowest possible cost.

However, the performance of the fisheries sector in Iraq and particularly in the Northern Region of Iraq is below expectation with low supply. In the Northern Region of Iraq, demands for fish as a healthy source of diet has been dramatically increased. These demands are in line with the lack of national production capacity to meet such demands for this important product. Moreover, despite the provision of the necessary components to increase and develop fish production, there is no enough governmental support in the current time to protect the national product for the advancement of reality agricultural production.

To achieve a valuable economic development, fish farming is valued in terms of giving work opportunities to unemployed members of the community and providing necessary raw materials for other sectors of the national economy. This sector also contributes to agricultural development by increasing foreign exchange. Fish production is one of the key aspects of the sources of income in animal production. The main purpose of this studywas to analyze the structure and economics of fish production in the Northern Region of Iraq. The objectives of this study are;

- ✓ To analyze socio-demographic characteristics of farmers effect fish production,
- ✓ To analyze average cost of fingerlings per pond, weight, fish mortality, fish production, price and total income based on periods of fish production,
- ✓ To analyze production costs, income and profit,
- ✓ To analyse effects of socio demographic characteristic of farmers on the total fish production value,
- ✓ To estimate effects of fish production periods, pond capacity and number of fingerling, mortality rate, and price and weights of fish sold on the fish production,
- ✓ To estimate the fish production function to obtain the relationship between inputs and output.

MATERIALS AND METHODS

Materials

The present study was conducted in Erbil governorate, located in the Northern Region of Iraq. Numbers of permanent populations were approximately 1.5 million by 2015. Erbil is bordered with Turkey to the North and Iran to the East (Anonym, 2017). According to the Ministry of Agriculture and Water Resources, numbers of fish farms in Erbil governorate were 145 in 2015 (Anonym, 2017). Since it is almost impossible to collect information from the whole farms, based on purposive and clustered sampling technique, data were collected from 60 farms during May - July 2016. These farmers were selected randomly regardless of either these farms are public or private, legal or illegal, gets fingerling and feeds from the government or not. According to the method used in this study, questionnaires were distributed randomly. Through a questionnaire form, farmers were asked several questions at different disciplines such as demography, project information, types of used fingerling and ponds, cost and productivity, and harvesting and marketing time.

Methods

Data were analysed by using descriptive statistics, variance analysis and multiple regression. Multiple regression analysis is regarded to be more amenable for causal (ceteris paribus) analysis, due to its allowance to explicitly control many other effective factors that subsequently have roles on the dependent variable. This pattern can be important to test economic theories as well as to evaluate policy effects in case of relying on non-experimental data. Due to its accommodation with many explanatory variables, multiple regression models can be valuable to infer causality with any misleading in the use of simple regression analysis. Double logarithmic production function is fitted with the regression coefficients; these coefficients also show the production elasticity of variables (Osawe et al., 2008).

The production function is very important to estimate future production of fish farming. A relevant study in Southern Ghana analyzed the production function of pond aquaculture by Asamoah et al. (2012), by using the double logarithmic production function to determine the effective inputs on productivity. Moreover, Toma et al. (2015) studied economic characteristics of small-scale farming of tilapia fish in Bangladesh and observed that the feed, human labor and irrigation costs significantly affected economic returns. They demonstrated that costs of feed, human labor and fish protection chemicals had underused patterns. They also determined that the increase in the use of these resources might elevate profit in tilapia fish production. In addition, Osawe et al. (2008) used a production function to study the technical efficiency of small scale farmers in Nigeria. Their results showed that the coefficients of education, pond type and years of experience levels were found to be negatively related to the level of productivity. Moreover, Oyakhilomen et al. (2016) showed positive but not significant estimated coefficients for pond size with male and female genders of catfish farmers. However, these researchers observed that the effect of labor was positive and significant, indicating that an increase in labor might follow an increase in the final output.

In case of using double logarithmic production function written as follow;

$$lnY = \beta_0 + \beta_1 ln X_1 + \beta_2 lnX_2 \ldots \beta_n lnX_n + e$$

where Y is the total farm income from fish production, Xi are the independent variables, β_i are regression coefficients interpreted as elasticities and e is the error term. For this study, four different production function models are estimated. Description of all these variables are given in Table 4.

Production function with socio-demographic characteristics of fish farmers:

$$LnY = \beta_0 + \beta_1 LnAge + \beta_2 LnExperience + \beta_3 Education + e$$

Production function with the variables of the capacity of ponds:

$$LnY = \beta_0 + \beta_1 LnSize + \beta_2 LnNponds + \beta_3 LnFingerlings + \beta_4 LnPage + e$$

Production function with the time of fish production variables:

$$LnY = \beta_0 + \beta_1 LnTime + \beta_2 LnWeight + \beta_3 LnMortality + \beta_4 LnPrice + e$$

Production function with the variable costs:

$$LnY = \beta_0 + \beta_1 LnFeedCost + \beta_2 LnFingerlingsCost + \beta_3 LnDrugCost + \beta_4 LnElectricCost + \beta_5 LnGasCost + \beta_6 LnTranspCost + \beta_7 LnRepearCost + e$$

RESULTS AND DISCUSSION

Socio-demographic characteristic of farmers

The present study was carried out to analyse fish productions and advancements in its development in the Northern Region of Iraq. According to results, all farmers in the research area were male and also married. This result is approximately in line with observations by Kareem et al. (2008) and Tunde et al. (2015) that they observed about 94% of farmers are male. The average age of the farmers was 42.05 years old, and 53.33% of them were less than 40 years old. Educational status of respective farmers illustrated that 16.67% was illiterate, 40% completed primary school, 25% secondary educational level and 18.33% of farmers graduated from university (Table 1). These results are agreed with findings by Ngozi and Chinonso (2013) and Akbay and Azeez (2016).

The average household size was 7, and 23.33% of the farmers had less than four family members. Interestingly household size with more than 8 individuals demonstrated higher shares (28.33%) in comparison with other groups. However, 78% of farmers do not hire workers, and they only concentrated on themselves and their family member in managing farms. These results are similar to Bene et al. (2009) and Agboola (2011), where they demonstrated that farmers use hired labor alone constituted 23%.

Results indicated that the average experience of farmers was 4.6 years. The farmers with 3-4 years of experience occupied the highest shares (40%), only 8% of farmers have experienced over than ten years. Moreover, results reveal that 68% of the fish farmers were owners of the land used for fish farming. However, only 32% of the respondents were working in partnership with stakeholders in the study area. Similarly, results from Asmah (2008) demonstrated that 67% of fish farmers had owned their lands for fish production.

To overcome the limitations of traditional fish production, modifications, in order to get semi-intensive pond management, were remarkably developed. Such developments were based on the local knowledge of the fish farmers (Pucher et al., 2014). In the present study, only 17% of respondents participated in courses aiming to manage fish production and increase the final productivity. However, 40% of them participate in such courses for only one time, and 60% of respondents attended several courses dealing with increasing productivity.

Moreover, 78% of respondents were used drugs aiming to grow healthy fish and to increase the final productivity. 72% of these farmers using drugs demonstrated beneficial effects of using such drugs (Table 1). As concluded by Phu et al. (2015), educated farmers who attended management courses and workshops can substantially manage their farms by reducing negative impacts of drugs and chemicals, decreasing both amounts and costs and subsequently increasing health and production.

Selected farms were using groundwater to supply their ponds with required water. However, some of the respective farmers were bred their ponds with waterfall. Only 38% of farmers were used waterfall as a secondary source of water supply in their ponds. In contrast, 62% of farmers used only underground water to supply their ponds with required water in their farms or ponds. This result is in contrast to data observed by Asamoah et al. (2012). They found that 59% of farmers used the integration of groundwater and rain-fed in their farms as sources of water.

One of the most impressive aspects of fish farming is to integrate agricultural crops such as vegetables with fish farms. However, most respective farmers which represented 68% of all respondents were not beneficially pleased with the presence of vegetables in the water of their ponds (Table 1). This result can be effective in increasing productivity. This type of farming was already used practiced by Vietnamese farmers, and they made huge profits through the use of vegetables in their farms (Bosma and Verdegem, 2011). In contrast, the use of vegetables in ponds might be a great source of heavy metals, fish will consume such chemicals, and then it will be a hazard to human health as the fish consumer (Wang et al., 2005). According to survey results, all targeted farmers were not paying taxes of their farms, the source of water in all farms were from deep well, types of ponds were earthen all respective farmers had only one rotation/year.

Table 1. Socio-demographic characteristics of farmers
Çizelge 1. Üreticilerin sosyo-demografik özellikleri

Demographic features (*Demografik değişkenler*)	Frequency (*Frekans*)	%	Demographic features (*Demografik değişkenler*)	Frequency (*Frekans*)	%
Age of farmers (mean = 42.05) *(Üreticilerin yaşı)*			**Education level of farmers** *(Üreticilerin eğitimi)*		
< 30	13	21.67	Illiterate (okuryazar değil)	10	16.67
30-40	19	31.66	Primary (İlkokul)	24	40.00
41-50	15	25.00	Secondary *(Ortaokul-lise)*	15	25.00
>50	13	21.67	Bachelor *(Üniversite)*	11	18.33
Total *(Toplam)*	60	100.00	Total *(Toplam)*	60	100.00
Household size (Mean=6.8) *(Hane halkı genişliği)*			**Hiring workers in the respective farms** *(Çiftliklerde yabancı işgücü bulundurma durumu)*		
< 4	14	23.33	No *(Hayır)*	47	78.33
4 – 6	14	23.33	Yes *(Evet)*	13	21.67
6-8	15	25.00	Total *(Toplam)*	60	100.00
>8	17	28.33	**Types of ownership patterns of farms** *(Çiftliğin mülkiyet durumu)*		
Total *(Toplam)*	60	100.00	Owner (*Mülk*)	41	68.33
Experiences of farmers on fish production (years) (mean=4.61) *(Üreticilerin balıkçılıktaki deneyimleri)*			Partnership (*Ortak*)	19	31.67
≤2	11	18.33	Total *(Toplam)*	60	100.00
3-4	24	40.00	**Attending fish management courses** *(Balıkçılıkla ilgili kursa katılma durumu)*		
5-6	16	26.67	Not participate *(Hayır)*	10	16.67
≥7	9	15.00	Participate (*Katılan*)	50	83.33
Total *(Toplam)*	60	100.00	Total *(Toplam)*	60	100.00
Using drugs in farms *(işletmede ilaç kullanımı)*			**Getting benefit from using drugs** *(İlaç kullanımının faydalı olma durumu)*		
Not using *(Kullanmayan)*	13	21.67	No *(Hayır)*	43	71.67
Using *(Kullanan)*	47	78.33	Yes *(Evet)*	17	28.33
Total *(Toplam)*	60	100.00	Total *(Toplam)*	60	100.00
Source of water supply in ponds *(Havuzda kullanılan suyun kaynağı)*			**Get benefit from using vegetables in ponds** *(Havuzlarda sebze kullanımından faydalanma)*		
Underground *(yeraltı suyu)*	37	61.67	No *(Hayır)*	41	68.33
Waterfall	23	38.33	Yes *(Evet)*	19	31.67
Total *(Toplam)*	60	100.00	Total *(Toplam)*	60	100.00

Fish production, income and costs

Table 2 shows that total numbers of ponds were 215, only 203 of them were in use, the average size of each pond was 1750 m^2 and the average age of ponds was 4.3 years in the present study. The average pond size was higher than pond sizes (1125m^2) observed by Kareem et al. (2008). Sizes of ponds in meter square with 15000m^2 and over were recorded the highest numbers regarding the number of ponds in use (69), size of ponds (682500 m^2 acre) and the average age of ponds (5.6 years). However, ponds with less than 5000 m^2 observed lowest values in regards to the number of ponds in use (39) and the average age of ponds (3.3 years). In general, as the sizes of ponds increased, the number of ponds in use, the average size of ponds and age of ponds increased.

The period of fish production is mostly linked to total income. Table 3 demonstrates the different periods in producing fish and their effects on the total income considering weight, fish mortality, and price of fish at harvesting time. Although the cost of fingerlings of less than six months in age was observed the lowest cost per pond, the highest income was recorded when fish ages were more than eight months. In comparison to other groups, the latter group was demonstrated the highest numbers in regards to the weight of fish (2.4 kg) during sell time, the mortality rate (21.5%) and total fish and prices. In addition, fish groups aged 6-7 and 7-8 months were given moderate numbers considering those parameters. They relatively observed similar weight per fish 2.16 and 2.02, the price of one Kg fish 5028 IQD/ Kg and 4958 IQD/ Kg, and income 46.73 million IQD and 45.63 million IQD respectively. Interestingly, the total incomes steadily increase in parallel with the elongation of periods of fish production. The use of smaller fingerlings in longer periods of production might lead to increase mortality rates, however, increasing weight and price of fish also increased farm income.

Table 2. Numbers of ponds, average size and age of ponds by size of ponds
Çizelge 2. Havuz sayıları, havuz sayılarına göre havuzların ortalama büyüklüğü ve yaşı

Sizes of ponds(m^2) (*Havuz boyutları(m^2)*)		Numbers of ponds (*Havuz sayısı*)	Numbers of ponds in use *(Kullanımdaki havuz sayısı)*	Total sizes of ponds (m^2) (*Havuz boyutları(m^2)*)	Average age of ponds (year) *(Havuzların ortalama yaşı (yıl))*
Group *(Grup)*	Frequency *(Frekans)*				
< 5000	18	40	39	520000	3.3
5000- 10000	16	54	53	432500	3.7
10000- 15000	13	44	42	342500	4.7
>15000	13	77	69	682500	5.6
Total / Average *(Toplam/Ortalama)*	60	215	203	1977500	4.3

Source: Analysis from field data.

Table 3. Average of cost of fingerlings per pond, weight, fish mortality, fish production, price and total income based on periods of fish production
Çizelge 3. Balık üretim dönemlerine göre, havuz başına balıkçılığın ortalama maliyeti, ağırlık, balık ölüm oranı, balık üretimi, fiyat ve toplam gelir

Periods of fish production (*Balık üretim periyodu*)		Cost of fingerlings (Yavru balık maliyeti) (1000 IQD/ pond)	Weight of fish sell *(Satılan balık ağırlığı)* (Kg)	Fish mortality rate *(Balık ölüm oranı)* (%)	Total production of fish(Number) *(Toplam balık üretimi (adet))*	Price (*Fiyat*) (IQD/ Kg)	Income (*Gelir*) (Million IQD)
Age group (Months) (*Yaş grupları (Ay)*)	Frequency (*Frekans*)						
< 6	6	1168	2.10	12.1	2988	4938	32.56
6 – 7	25	1197	2.16	14.1	4303	5028	46.73
7 – 8	12	1420	2.02	14.7	4504	4958	45.63
> 8	17	1798	2.40	21.5	5156	5180	60.41
Average *(Ortalama)*		1396	2.17	16.4	4238	5026	46.33

* Source: Analysis from field data. 1 Iraqi Dinar (IQD) = 0.00084 Dollar ($)

Total cost, income and profit are shown in Table 4. The total cost including drugs, worker, transportation, electric, petrol and gas, ponds repair, fingerlings and feeds was averagely 27490065.99 IQD, the average income was 50343218.75 IQD, and the average gross profit was 22853153.76 IQD. In addition, the cost of feeds constituted the highest percentage rate in comparison with other variables. However, costs of drugs, petrol and gas and ponds repair recorded lowest cost rates respectively when compared with other variables in farms. Moreover, the cost of fingerlings is another variable that might be considered as an effective variable on total costs; this cost occupied 15.51% of total costs which subsequently play important function in gross profit. Benefit-Cost Ratio is 1.83 and seems highly feasible. This ratio indicates that fish farming in the region is economically efficient and beneficial. These results are similar to results observed by Tunde et al. (2015), Janssen (2017); Lasner et al. (2017), Karim et al. (2017) and Wambua (2018). For example Janssen (2017) found that Benefit-Cost Ratio for aquaculture production is 1.42. Sharma et al. (2018) found the benefit-cost ratio as 1.63 for fish farming in Nepal. They also reported feed cost as the largest cost item with 35.5% contribution to total variable cost of production. Tunde et al. (2015), examined economic analysis of fish farming in Nigeria and found that Benefit Cost Ratio in the fish farming was 1.9, the Rate of Return on Investment was 0.89, therefore, the fish farming considered to be profitable. Wambua (2018) estimated benefit-cost ratio for fish farming in Kenya is 1.05..

Table 4. Fish production costs and income
Çizelge 4. Fish production costs and income

	Average cost (IQD) (*Ortalama maliyet*)	**(%)**
Feeds (*Yem*)	18186314.33	66.16
Fingerlings (*Küçük balık*)	4264483.33	15.51
Transportation (*Ulaşım*)	1268666.67	4.62
Electric (*Elektrik*)	1238333.33	4.50
Worker (*İşgücü*)	795000.00	2.89
Ponds repair (*Havuz tamiri*)	715583.33	2.60
Petrol and gas (*Yakıt*)	642666.67	2.34
Drugs (*İlaç*)	379018.33	1.38
Total costs (*Toplam maliyet*) (a)	27490065.99	100.00
Total revenue(*Toplam gelir*) (b)	50343218.75	
Gross profit (*Brüt kar*)	22853153.76	
Benefit-Cost Ratio (*Gelir maliyet oranı*)(b/a)	1.83	
Return on Investment (*Yatırım geliri*) (ROI)	0.83 (83%)	

Source: Field survey cost analysis.

Production Functions

This section begins with a descriptive analysis of each variable used in the fish production functions. The analysis was mainly focused on investigating the relationship between dependent and independent variables. Each relevant dependent variable has its own table and multiple regression model. Table 5 shows the definition and description statistics of variables in production function models.

Effects of socio-demographic characteristic of farmers on fish production

In order to determine the effect of the socio-demographic characteristic of farmers on fish production, it is imperative to observe relations between personal and behavioral patterns of respective farmers on the total production value. Using multiple regressions is an amenable analysis to observe the effect of those patterns including age, educational status and farmers experience on the final production of fish farms, due to its allowance to explicitly control many other effective factors that subsequently have roles on the dependent variable.

As shown in Table 6, the coefficient of determination (R^2) is 0.55, and the F-test value is 13.14 and indicates that the overall equation is statistically significant at 1% level. The regression analysis showed that when the fish farming experience increases 10%, the production value will increase by 7.02%. Moreover, coefficients of age and educational status of farmers have positive and significant effects on total production value. In addition, the coefficient of fish farming experience was positively significant at 1% significance level, indicating that this factor led to a very significant increase in income. This result is similar to finding by Kareem et al. (2008) and Ahmed and Garnett (2011). Kareem et al. (2008) found that age of farmers have negative effects but experience and education level of farmers have positive effects on fish production. Osawe et al. (2008) indicated that educational level, years of experience, pond type and cooperative membership have positive effects on fish farmers' income. It seems that the income might increase in line with the increase in years of experience, and this factor is previously observed to positively correlate with fish production (Khan et al., 2018).

Effects of pond capacity and number of fingerling on production

Pond capacity plays important roles by supplying the adequate size to meet fish requirements and to limit unavoidable water losses. So, it can be of interest to consider the role of this factor on total income. Table 7 demonstrates the link between pond capacity and total income of respective fish farms. According to overall significance of regression, R^2 was 0.837, and the F-test

Table 5. Descriptive analysis of variables in production function models
Çizelge 5. Üretim fonksiyon modellerinde etkili değişkenlerin tanımlayıcı istatistikleri

Variables *(Değişkenler)*	**Definitions of variables** *(Değişkenlerin tanımı)*	**Mean** *(Ortalama)*	**Standard deviation** *(Standard sapma)*
Age	Age of farmers (Year)	42.05	11.16
Education	Educational status (Illiterate or primary:0; Secondary or bachelor:1)	0.57	0.08
Experience	Fish farming experience (Year)	4.62	2.88
Size	Size of project (Acre)	13.18	11.20
Nponds	Number of ponds/Project (Unit)	3.58	2.35
Fingerlings	Total fingerlings entering/rotation (Unit)	5694.17	4546.73
Page	Age of project (Year)	4.15	2.16
Time	Time of fish production(Month)	6.86	1.27
Weight	Weight of sold-fish (Kg)	2.21	0.41
Mortality	Number of fish mortality (Unit)	931.17	11.06
Price	Price of fish sale (IQD/Kg)	5049.16	704.86
DrugCost	Cost of drugs (IQD/Project)	379018.33	5303.81
LaborCost	Cost of Labor (IQD/Project)	795000.00	18270.49
TranspCost	Cost of transportation (IQD/Project)	1268666.67	14428.99
ElectricCost	Cost of electric (IQD/Project)	1238333.33	8741.58
GasCost	Cost of petrol and gas (IQD/Project)	642666.67	6591.17
RepairCost	Cost of ponds repair (IQD/Project)	715583.33	7947.51
FingerlingsCost	Cost of all fingerlings (IQD/Project)	4264483.33	33338.95
FeedsCost	Cost of all feeds (IQD/Project)	18186314.33	186989.73
Production Value	Income (IQD/Project)	50343218.75	368997.52

* Source: Field survey cost analysis.

Table 6. Effects of socio demographic characteristic of farmers on the total fish production value
Çizelge 6. Toplam balık üretim geliri üzerinde etkili olan sosyo-demografik faktörlerle ilgili regresyon analiz sonuçları

	Coefficient *(Katsayı)*	**Standard error** *(Standard hata)*	**t – ratio** *(t – oranı)*	***P – value*** *(p - değeri)*
Constant	14.557**	1.138	12.791	0.000
LnAge	0.560*	0.322	1.738	0.088
LnExperience	0.702**	0.161	4.352	0.000
Education	0.276*	0.162	1.711	0.093
R^2: 0.55; F-test: 13.140** ; P-value: 0.000				

Note: *and ** indicate significance levels at 10% and 1% respectively.

Table 7. Effects of pond capacity and number of fingerling on production
Çizelge 7. Havuzların kapasitesi ve küçük balık sayısı gibi faktörlerin balık üretim değeri üzerindeki etkisi

	Coefficient *(Katsayı)*	**Standard error** *(Standard hata)*	**t – ratio** *(t – oranı)*	***P – value*** *(p - değeri)*
Constant	12.465**	0.622	20.039	0.000
LnSize	0.183**	0.049	3.722	0.000
LnNponds	0.287**	0.119	2.425	0.010
LnFingerlings	0.485**	0.086	5.624	0.000
LnPage	0.197*	0.105	1.872	0.066
R^2 : 0.837; F-test : 70.674**; P-value: 0.000				

Note: *and ** indicate significance levels at 10% and 1% respectively.

(70.674) was significant (P<0.01). The results show that the size of the project per acre, number of ponds per project and total fingerlings entering per rotation in respective farms will significantly increase total income by 1.83%, 2.87% and 4.85% respectively when they are increased 10%. However, by increasing the age of project (year) 10%, the total income will increase 1.97%. As discussed, coefficients of those variables were positive, which indicate that such variables might play roles in increasing productivity and income as well. This finding agrees with the works of Asamoah et al. (2012), Crentsil and Ukpong (2014) and Tunde et al. (2015), Iruo et al. (2018). Asamoah et al. (2012) and Crentsil and Ukpong (2014) reported that number of fingerlings stocked influenced positively and significantly fish production value. Ahmed et al. (1996) and Tunde et al. (2015) concluded that stocking density and pond size are the factors that significantly influenced fish production value.

Effects of fish production periods, mortality rate, and price and weights of fish sold on the fish production

Selecting a precise time of fish production is another important factor which subsequently relates to the final cost and gross profit of fish farming. Table 8 shows how the time of production and its consequences correlate with the total income of the targets farms.

By looking at Table, R^2 was 0.90 and F-test was 13.08 and significant at 1% level. The regression analysis of different reflections can be seen between independent variables with the dependent variable. The results show that the weight of sold-fish (Kg) and price of the fish sale in respective farms will significantly increase total income. Similarly, total income might increase with increasing time of fish production (month). Generally, economic objective of aquaculture and specifically fish farming in ponds is to produce a maximum weight of marketable fish as shortest as of the time (Papka, 1993; Ogundari and Ojo, 2009 and Olawumi et al., 2010). In this context, it is clear that each of the prices and weight of fish at a particular time can be effective in regards to total income. This statement typically agrees with our results, observing positive links between such variables with the final income. However, in case of increasing 1% of the number of fish mortality, the total income will increase by 0.0001%. This result agrees with Prellezo et al. (2012). They indicated that fish mortality will influence the stock size as well as stock dynamics and ultimately gross profit.

Table 8. Regression analysis of the affective factors on the total income of fish production in regards to time of fish production, weight, and mortality

Çizelge 8. Balık üretim zamanı, ağırlığı ve balık ölüm oranlarının balık üretim geliri üzerine etkisiyle ilgili regresyon analizi

	Coefficient *(Katsayı)*	**Standard error** *(Standard hata)*	**t – ratio** *(t – oranı)*	***P – value*** *(p - değeri)*
Constant	6.5160**	0.273	23.885	0.000
LnTime	0.0070	0.027	0.245	0.807
LnWeight	0.0860	0.091	0.948	0.347
LnMortality	0.0001**	0.00005	6.368	0.000
LnPrice	0.0002*	0.00003	2.584	0.012
R^2 : 0.898; F-test : 13.078**; P-value : 0.000				

Note: *and ** indicate significance levels at 5% and 1% respectively.

Production Function

It is clear that the cost of variables directly affects the total income and gross profit as well. In the present study, input elasticities of the production function are observed in Table 9. This table represents that R^2 was 0.82 and F-test was 34.58 and was significant at a level of significance at 1%. The results from the present study demonstrate that the coefficient of fish production is inelastic in response to changes in the coefficients of all inputs. Moreover, a 10% increase in the cost of fingerlings leads to a 3.1% increase in the value of fish output. Results are also shown that the cost of all feeds might increase total income by 0.37% at a level of 1% significance. The results demonstrate that the cost of drugs is very significantly increased total revenue by 0.13%. Furthermore, in the case of increasing cost of electric 1%, the total income will significantly increase by 0.21%.

In this context, all costs of drugs, electric, fingerlings and feeds significantly affect the total income positively. These results indicate that the use of drugs, providing adequate condition and the use of healthy and good quality with the proper size of fingerlings might directly increase the income. This statement is also true for using good quality and healthy feed in fish farming (Kitessa et al., 2014; Phu et al., 2015; Rahman et al., 2017). For example, a Cobb-Douglas production function analysis by Rahman et al. (2017) showed that fish fingerlings and fish feeds were positively contributed to the total income as well as farm productivity. The observations of the present study are also agreed with the previous studies by Kareem et al.

(2008), Agboola (2011), Aydin et al.(2014) and Tunde et al. (2015), they showed the positive effect of those variables on the gross profit. However, in contrast to expectation, all costs of transportation, petrol and gas and pond repair are negative and also non-significant. Although this result is in contrast to Toma et al. (2015), the negative effects of such factors on total income were verified by Bozoglu and Ceyhan (2009). When the output increases less than proportionately as all the inputs increase proportionately, we call it diminishing returns to scale. According to the results of all elasticities, if all inputs are increased by 1%, then output increases by only 0.92%.

Table 9. Estimation results of production function
Çizelge 9. Üretim fonksiyonu tahmin sonuçları

	Coefficient *(Katsayı)*	**Standard error** *(Standard hata)*	**t – ratio** *(t – oranı)*	***P – value*** *(p - değeri)*
LnFeedCost	0.369**	0.081	4.584	0.000
LnFingerlingsCost	0.308**	0.098	3.137	0.003
LnDrugCost	0.126**	0.045	2.782	0.008
LnElectricCost	0.206*	0.096	2.157	0.036
LnTranspCost	-0.015	0.043	-0.342	0.733
LnGasCost	-0.018	0.042	-0.427	0.671
LnRepearCost	-0.055	0.053	-1.043	0.302
Constant	3.603**	0.937	3.844	0.000
R^2 : 0.823; F-test : 34.576**; P-value: 0.000				

Note: *and ** indicate significance levels at 5% and 1% respectively.

CONCLUSIONS and RECOMMENDATIONS

Fish farming is becoming one of the main sources of animal protein as the human diet in Iraq. Fish production has been one of the most dynamic subsectors in the governorate of Erbil in particular. It's important to identify the problems and constraints of the fish sector since fish meat is the best alternative to red meat.

The purpose of the current study is to shed light on the most important economic and productivity factors affecting fish productions in Erbil under the current circumstances. The most valuable challenges facing the producers to raise the return on investment for the fish farming and increasing its productivity is to increase production to meet the demands in northern Iraq, and particularly Erbil markets as the volume of consumption become more and more.

In this study, we focused on effective variables on total production and income. Results showed that age of farmers, size of ponds, number of ponds, total fingerlings entering/ rotation, the weight of sold-fish, price to one Kg of fish sale, costs of all fingerlings and cost of all feeds had significant effects on fish production. Farmers have been using fingerlings at small ages (4-5 days) that subsequently led to increase mortality rates. Another challenge was the unavailability of enough markets to buy produced fish on time and to decrease costs.

The government should grant special facilities (such as supplying 24 hrs electricity to farms that will decrease fish mortality), marketing, canning factories and stores in order to maintain the balance between supply and demand in the market or local shops to reduce price volatility and protect both the producer and the consumer.

Farmers do not work at full capacity during the production process. Effective solution methods should be developed for farmers to participate in the production process, and it is important to motivate and encourage farmers to produce a large part of the fish demand in the region. Working on the expansion in the production of fish is a vital subject that contributes in reducing or solving the problem of food security. This requires strong government support in helping to run idle fields or carry out researches and studies related to education. In addition, policies should be implemented to optimize the production level of the producers, to help them continue and expand the production process and to reduce losses. The government should assist farmers in the supply of feed at low tax rates and affordable prices.

A department or a division of the Ministry of Agriculture should prepare monthly or annual reports on production and consumption trends, domestic and world prices on fish, poultry, red meat and all other meat products. This information will guide existing farmers and new entrepreneurial companies that want to enter the market to make better production decisions. Due to the climate fluctuations in the respective area, modern technology needs to fully adapt to these temperature changes. In future studies, researchers may conduct more studies that take care of the economic sides, in different periods and other provinces including Dohuk and Sulaimaniyah.

ACKNOWLEDGEMENT

This study is summarized from the results obtained from the first author's master thesis.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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