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Economic viability of fish farming compared to crop cultivation

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Abstract
The low consumption of fish in Pakistan prompted an economic analysis of fish farming, which was conducted in two districts with the highest number of fish farms: Muzaffargarh and Khanewal. A random selection of 50 fish farms from each district was made to estimate the profitability of fish farming. To compare with crop cultivation, data from 50 farmers in the crop sector were also collected, and an economic analysis was performed. The study found that fish farming was more profitable than crop farming in the study area, with net income per acre estimated at Rs. 252,426 for fish farming, compared to Rs. 58,612 for wheat-cotton, Rs. 72,662 for cotton-rice, and Rs. 53,290 for sugarcane cultivation. The benefit-cost ratio (BCR) of fish farming was calculated at 1:1.52 and 1:1.74 with and without land rent, respectively, indicating that the enterprise yields 1.52 rupees and 1.74 rupees for every rupee invested. These results suggest that promoting fish farming, especially in areas with saline soils, could enhance food security and improve the socioeconomic conditions of small farmers.

Keywords: economic, fish, farming, crop, cultivation

Introduction

Fish farming plays a crucial role in improving the socioeconomic conditions of rural communities. This is because it creates various income opportunities, particularly for individuals who live below the poverty line (Ahmed et al., 2005). Furthermore, research has shown that pond fish farming is more profitable than rice cultivation, prompting many farmers in rural areas to switch to fish farming instead (Islam et al., 2002). Olawumi et al. (2010) also found that fish farming is a profitable enterprise, with factors such as fish seed stocked, labor, pond size, and waste feed of poultry having a significant impact on income and small holding production in Nigeria.

Additionally, Olaoye et al. (2013) conducted a socioeconomic analysis of pond farming in Nigeria and discovered that the total cost, total revenue, and gross margins were N 2, 883515, N 4873521, and N 2,376,616.36, respectively. The estimated benefit-cost ratio was 1:1.69, which suggests that fish farming has the potential to alleviate poverty among farmers. Similarly, Okpeke and Akarue (2015) assessed profitability by calculating total cost, total revenue, and net revenue. They found that the net farm income per farmer per annum was estimated at N 384, 306, indicating that fish farming is a profitable venture. Adewuyi et al. (2010) estimated the average total cost of N 394,380 per annum and gross revenue of N 715030, resulting in an estimated profit of 320650

Nigerian Naira and a rate of return of 0.55 Nigerian Naira. Furthermore, regression analysis demonstrated that variables such as pond size, labor, cost of lime, cost of feeds, and fingerlings have a significant impact on output. The elasticity of pond size, labor, feeds, fertilizer, lime, fixed input, and fingerlings was found to be 0.029%, 0.057%, 0.005%, 0.534%, 0.007%, 0.79%, and 0.001%, respectively.

According to a study by Namonje-Kapembwa and Samboko (2020), fish production was found to be a profitable business activity in the study area of Zambia. The study employed primary data collected through individual interviews and focus group discussions and found that investing in aquaculture was profitable over a 10-year period, with a benefit-cost ratio greater than one. The net present value and internal rate of return were also estimated, with positive results indicating that aquaculture was a profitable business in Zambia. In the Philippines, Irz and McKenzie (2003) evaluated the profitability and technical efficiency of aquaculture by comparing two production systems: intensive monoculture of tilapia in freshwater ponds and an extensive polyculture of shrimps in brackish water ponds. Both systems were found to be very profitable, with higher profitability achieved in brackish water ponds. Technical efficiency was higher in freshwater aquaculture compared to brackish water aquaculture. Olagunju et al. (2007) estimated the gross margin and profitability ratio of catfish in Ibadan metropolis, Oyo State, Nigeria. The study found that the average total cost per kg of fish was N 204 and the average total revenue per kg of fish was N 308. The estimated gross margin was N 194.60 per kg of fish produced. There was also a significant relationship found between total revenue and cost of feed, years of farming experience, size of pond and labor.

In Pakistan, where the majority of the population takes maximum calories from staple foods such as wheat and rice, fish has been identified as an outstanding source of animal protein (Brown, 2017; Wasim, 2007). The coastline of Pakistan spans approximately 990 km, comprising 270 km and 720 km of the Sindh and Makran coasts, respectively. The Exclusive Economic Zone (EEZ) of Pakistan covers an area of about 240,000 sq. km. The fisheries sector is vital to Pakistan's economy in terms of livelihood for the population, especially those in the coastal areas. Pakistan has diverse sources of water where fish can be produced, including the sea, rivers, dams, lakes, and ponds.

Aquaculture is being done in almost all provinces of Pakistan, with a total area of fish ponds at about 60.47 thousand hectares. The highest potential of aquaculture exists in the provinces of Sindh and Punjab, with the total number of fish farms at approximately 13,000. Although fish has been considered an important source of protein, consumption in Pakistan is limited due to its high price and limited availability. However, the fish trade has remained a promising area for fish producers, as Pakistan is already exporting around 19 percent of its total production. One advantage of aquaculture is that it can be adopted on land that is not suitable for crop cultivation, such as saline land. This can be turned into an opportunity by turning the area into fish cultivation without opportunity cost (Bashir et al., 2018). Qasim et al. (2004) studied the economics of fish production and marketing in saline areas of central Punjab and found that per acre fish production was 1524 kgs, with a sale price of Rs. 55 per kg. The profit of fish farms in non-saline soils was

found to be Rs. 40,488 per hectare. In recent years, there has been a growing trend in fish farming (GOP, 2015). However, studies indicate that fish productivity in Pakistan is comparatively lower than that of other countries, which can be attributed to various factors, including the socioeconomic traits of fish farmers such as their level of education, land ownership, age, capital ownership, and use of outdated technologies (Meena et al., 2002).

Research Method

To analyze the economics of fish farming, 50 fish farms were randomly sampled from the top two districts for farm fish production, namely Mazaffargarh and Khanewal in Punjab. Primary data was collected from these farms. Additionally, data was also gathered from 50 non-fish farmers from the same vicinity to compare the profitability of fish farming. A well-designed questionnaire was utilized to collect detailed information on the cost of production for both fish farming and crop farming. The profitability of fish farming was assessed by calculating the benefit-cost ratio (BCR) per rupee invested. The following formulae were used to estimate cost, revenue, economic profit, business profit, gross margins, and benefit-cost ratio:

Total revenue (TR) = Total fish produced * Average price of fish.

Gross margin (GM) =TR- Total Variable cost (TVC) for producing fish

Economic profit = TR – [explicit cost + implicit cost]

Business profit = TR – [explicit cost]

Benefit-cost ratio (BCR) = Business profit/TVC (When imputed cost is not taken)

Result and Discussion

Table 1: Education Status of Fish Farmers

Schooling Years	Frequency	Percent
1-10	39	78.0
12-18	11	22.0
Total	50	100.0

Table 1 displays the education status of fish farmers, indicating that 78% of them have completed their education up to matriculation, while the remaining 22% have attained an education level ranging from intermediate to master's degree.

Table 2: Classification of Fish Farmers with Respect to Age

Age range	Frequency	Percent

18-30	15	30.0
31-40	22	44.0
Above 40	13	26.0
Total	50	100.0

The categorization of fish farmers based on age indicates that 30% of them are aged between 18 to 30 years, 44% fall within the 31-40 age bracket, and a smaller proportion of 26% are over 40 years old. This suggests that the majority of fish farmers are youthful and full of energy. Similar findings were reported in studies such as Khatun et al. (2013) and Peter and Susan (2014), which concluded that a significant proportion of fish farmers are young.

Table 3: Experience of Fish Farming

Years	Frequency	Percent
1.00-5.00	20	40.0
6.00-10.0	30	60.0
Total	50	100.0

According to Table 3, 40% of individuals had experience in fish farming for 1 to 5 years, while 60% had been doing it for the past 6 to 10 years. Although this enterprise was not popular among farmers, the profitability demonstrated through its success attracted other farmers, particularly small farmers, to adopt the practice.

Table 4: Loan Taken by Fish Farmers

Farmers	Frequency	Percentage
Loan taken	2	4
Loan not taken	48	96
Total	50	100

According to Table 4, the percentage of farmers who had taken a loan for fish farming was only 4%, while the remaining 96% had not taken any loans. One of the reasons for this low percentage was the difficulty involved in the loan application process. Research conducted by Bashir and Azeem (2008) has highlighted several issues faced by farmers in obtaining formal loans.

Table 5: Sale of Fish with Respect to Market

Sale of Fish	Frequency	Percent
Local	15	30.0
Big City	20	40.0
Both	15	30.0
Total	50	100.0

Marketing a product is a crucial aspect of any enterprise. According to Table 5, a significant proportion of farmers (40%) sold their produce in big cities, while 30% sold it at local markets, and another 30% sold it in both local and big cities markets. The primary motivation behind selling in big markets was to earn higher income from the sale of their produce.

Table 6: Distance from the market where they sell their produce

Distance	Frequency	Percentage
9 to 20 km	15	30
35 to 100 km	15	30
300 to 400 km	20	40
Total	50	100

Table 6 illustrates that in terms of the distance between the market and their farm, the maximum distance to big markets was 300 to 400 km, while the minimum distance ranged from 9 to 20 km.

Table.7: Source of Fish Feed

Source of Fish Feed	Frequency	Percent
Formulated	22	44.0
Self-Prepared	12	24.0
Both	16	32.0
Total	50	100.0

The utilization of feed is a crucial component in enhancing production. According to the data presented in Table 7, a majority of farmers opted for formulated fish feed, while 24% chose to prepare their own feed. Additionally, 32% of farmers utilized both types of feed. Although the

popularity of formulated feed among fish farmers is high, there is still potential for an increase in fish feed production. It is also important to monitor quality standards for optimal results.

Table 8: Number of Fingerlings Per Acre

No. of fingerlings per acre	Frequency	Percent
600-800	45	90.0
800-900	5	10.0
Total	50	100.0

Table 8 reveals information about the number of fingerlings stocked in a fish farm that is one acre in size. The data indicates that 90% of farmers stock their one-acre farm with 600 to 800 fingerlings, while only 10% of farmers release 800 to 900 fingerlings in a one-acre pond.

Table 9: Land Ownership Status

Ownership status	Frequency	Percentage
Owners	23	46
Tenants	21	42
Owner cum Tenants	6	12
Total	50	100

Table 9 shows that 46% of fish farmers were classified as owners, 42% as tenants, and 12% as owner-tenants. This suggests that the majority of farmers owned their own farms.

Table 10: Classification of Farmers Categories

Farm type	Frequency	Percentage
Samll Farms (1-7 acres)	18	36.0
Medium Farms (8-25 acres)	17	34.0
Large Farmers (> 25 acres)	15	30.0
Total	50	100

Table 10 further categorizes the farmers, revealing that 36% were considered small, 34% medium, and 30% owner-tenants.

Table 11: Types of Fish Cultured

Type of fish	Frequency
Rahu	50
Thaila	48
Grass Carp	15
Mori	5
Malli	4
Singhari	4
Tilapia	1
Gulfam	1
Silver Carp	1

Table 12: Analysis of Non-Fish Farmers

	N	Minimum	Maximum	Mean	Std.
Education	50	0	16	4.90	5.148
Age	50	17	75	42.60	16.284
Experience	50	2	50	21.72	14.995
Farm distance from main road (Km)	50	1	7	3.01	2.057
Family Size	50	2	26	8.42	4.682
D_Market	50	1.00	300.00	15.2600	41.84986
Valid N (listwise)	50				

According to Table 13, non-fish farmers have varying levels of experience, ranging from one year to over 40 years. The majority of farmers (34%) had experienced between 1 to 10 years, while 30% had experience between 11 to 20 years. The remaining 36% of farmers had experience ranging from 21 to more than 40 years.

Table 13: Farming Experience

Years	Frequency	Percentage
1_10	17.0	34
11_20	15.0	30
21_30	6.0	12
31_40	6.0	12
>40	6.0	12
Total	50.0	

Table 14: Age Distribution of Crop Farmers

Age	Frequency	Percentage
18_30	16	32
31-40	11	22
41-50	10	20
>50	13	26
Total	50	

Table 15: Educational Status of non-Fish Farmers

S.No.	Education	Frequency (n=50)	Percentage
1	Illiterate	20	40
2	Primary	14	28
3	Matriculation	10	20
4	Bachelor	3	6
5	Master	3	6
	Total:	50	

Table 15 indicates that among non-fish farmers, the majority were either illiterate (40%) or had only primary education. The second largest group consisted of farmers who had education up to Matriculation (20%). Additionally, 6% of farmers had a Bachelor's degree, and another 6% held a Master's degree.

Table 16: Per Acre Cost of Production of Pond Fish

S.No.	Income and Cost items	Rupees.
1	Average fertilizer cost/ Acre	2656
2	Average feed cost per acre	158760
1	Average disease cure cost per acre	678
2	Average electricity and fuel cost per acre	21298
3	Average labour cost per acre	17340
4	Average cost of fingerling per acre	449
5	Average rent of farm per acre	27828
6	Average gross cost per acre	229009
7	Average gross Income per acre	349050
	Average Net income	120041
	BCR	1.52

According to the study, the cost of producing different crops per acre in the area, including land rent, was as follows: Wheat - Rs. 41,079, Rice - Rs. 50,825, Cotton - Rs. 64,158, Sugarcane - Rs. 79,513, and Fodder - Rs. 426,465. Without land rent, the cost of production per acre for the same crops was calculated to be Wheat - Rs. 22,443, Rice - Rs. 32,189, Cotton - Rs. 45,522, Sugarcane - Rs. 60,877, and Fodder - Rs. 24,010. The net income, including land rent, for these crops was estimated to be Rs. 11,756, Rs. 25,806, Rs. 9,584, Rs. 34,654, and Rs. 437, respectively. The net income without land rent for these crops was estimated to be Rs. 30,392, Rs. 44,442, Rs. 28,220, Rs. 53,290, and Rs. 19,073, respectively. The benefit-cost ratio (BCR) for all crops was found to be above 1. However, Rice had the highest BCR, followed by Sugarcane and Wheat. The BCR for Cotton was the lowest due to its high cost of production and the effect of climatic changes. Additionally, the prices for Cotton were not encouraging, which made farmers hesitant to cultivate it.

Table 17: Per Acre Cost of Production of Crops

Crops	Wheat	Rice	Cotton	S/Cane	Fodder
Land Preparation cost	2606	4814	4833	7500	2073
Seed Bed Prep. Cost	2301	2527	2000	3500	1980
Seed Cost	2125	1503	3138	9000	6400
Fertilizer cost	7835	7765	11168	7200	6500
Plant Protection cost	1222	4326	13706	3667	2100
Irrigation cost	1970	7462	6210	8135	2100
Harvesting cost	3317	2725	3400	12500	2357
Land Rent (6 months)	18636	18636	18636	18636	18636

Labor cost	1067	1067	1067	1500	500
Marketing cost	0	0	0	7875	0
Production cost (with land rent)	41079	50825	64158	79513	42646
Production cost (without land	22443	32189	45522	60877	24010
Gross income per acre	52835	76631	73742	114167	43083
Net income (with land rent)	11756	25806	9584	34654	437
Net income (without land rent)	30392	44442	28220	53290	19073
BCR	1.29	1.51	1.15	1.44	1.01

As fish farming requires a year to reach harvest, it's necessary to compare the two enterprises based on their annual net income.

Table 18: Per Year Per Acre Net Income from Different Combinations of Crop Cultivation

Net income from crop cultivation	Per Year Net income (with land rent) (Rs.)	Per Year Net income (without land rent) (Rs.)
Wheat-Cotton	21340	58612
Cotton-Rice	35390	72662
S/Cane	34654	53290

Table 18 illustrates the annual net income per acre earned from crop cultivation, with and without land rent. For the wheat-cotton combination, the net income was estimated to be Rs. 21,340 with land rent, and Rs. 58,612 without land rent. Similarly, for the cotton-rice combination, the net income was calculated to be Rs. 35,390 with land rent and Rs. 72,662 without land rent. The sugarcane farmers earned a net income of Rs. 34,654, including land rent, and Rs. 53,290, excluding land rent (Table 18).

Table 19: Per Year Per Acre Net Income from Fish Farming

Income from fish farming	Per Year Net income (with land rent) (Rs.)	Per Year Net income (without land rent) (Rs.)
Fish Farming	120041	147869

According to Table 19, the net income from fish farming is Rs. 120,041 with land rent and Rs. 147,869 without land rent. Comparing the estimates of income earned per acre from crop cultivation and fish farming, it can be concluded that fish farming is a more profitable enterprise. This is consistent with the findings of Gachucha et al. (2014), who reported that fish farming was more profitable than maize crop farming in Kenya.

Conclusion and Recommendations

The objective of this research is to analyze the economic viability of fish farming in the study area. The study focused on two districts, Muzaffargarh and Khanewal, which were selected based on their high number of fish farms. A random sample of 100 farms, consisting of 50 fish farms and 50 non-fish farms, was collected from both areas for economic analysis. To make a comparison, data from 50 crop-growing farmers were also collected. The study found that fish farming is more profitable than crop farming in the study area. The net income per acre for fish farming was estimated to be Rs. 252,426, while the net income per acre for wheat-cotton, cotton-rice, and sugarcane crops was estimated to be Rs. 58,612, Rs. 72,662, and Rs. 53,290, respectively. The benefit-cost ratio (BCR) for fish farming was calculated to be 1:3.61, indicating that for every rupee invested, the enterprise yields 3.61 rupees.

From the results of this study, it is recommended that fish farming is a profitable business and can be a viable option for small landholders to improve their socioeconomic conditions. Furthermore, it could contribute to addressing the issue of food security at the household, community, and national levels, as well as earning foreign exchange for the country. Fish farming is particularly suitable for those who face severe issues with salinity in their soil, as traditional crops struggle to grow well in such conditions. Therefore, fish farming can be viewed as an alternative to traditional agriculture, and can be seen as a means to increase agricultural profits from saline-affected land.

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