Economic analysis and farmers characterization for fish production in Dhangadhimai municipality of Siraha district, Nepal

Abstract:

The studywas done from March to June 2022. A total sample of 60 respondents was examined, 30 from Santanagar and 30 from Fulkahakatti in Dhangadhimai region selected randomly and proportionately. Utilizing a fundamental irregular examining approach essential information was assembled utilizing a pre-tested semi-structured survey, while secondary data was obtained through a review of literature relevant to the research topic MSExcel and SPSS-25 were utilized to analyze information including simple descriptive statisticalmeasurements and ordering techniques.The typical total cost of production was found to be Rs 8,98,085.7 with variable costs representing 87.2% and fixed costs representing simply 12.8%. The exploration region's typical fish yield (5340.24 kg/ha) is more prominent than the national average (4300.28 kg/ha) and district average (4800 kg/ha). Numerous production issues were accounted for by respondents, including late inputs supply, a deficiency of quality fingerlings, unreasonable input costs, irresistiblediseases and pests, and an absence of proper adequate training. Notwithstanding these issues, fish production is an effective industry with a high gross edge with Benefit-cost ratio 1.51. This suggests that although fish farming is a profitable business in the Dhangadhimai municipality, several policy implications may encourage it even more. To address these difficulties, a variety of policies need to be implemented, including control of fish markets, the supply of governmental subsidies, the provision of extension services, encouraging the engagement of women, and the provision of essential high-quality inputs.

Keywords: Aquaculture, Cost of production, Economic analysis, Benefit-cost ratio, Production issues, Study, Nepal

1 Introduction:

Aquaculture is one of the most rapidly growing industries worldwide. It is assumed that aquaculture farming contributes 47% to the total fish production in the world [1]. By 2030, it is expected that there will be additional 23 million fish food demand in the world due to the increasing population and people's concern regarding nutrition and healthy food which creates a great scope for fish farming in the world [2,3]. Aquaculture was created around 3000 BC in China in man-made lakes lodging specific fish species, for example, carp when water levels fell because of stream floods [2]. Fish was expensive and scarce in Europe before becoming widespread in monasteries throughout the Middle Ages. Aquaculture declined as a result of transportation advancements in the 19th century that made fish easily accessible and inexpensive even far from the seas[4]. After overfishing prompted prices to once again soar, the present boom started in the 1960s. Commercial aquaculture is presently done on a huge scale, which has not previously been mentioned, and it has produced controversy owing to its influence on public waterways beyond the enclosure's bounds [3]. Aquaculture is a relatively young activity that

began in Nepal in the early 1950s. It originated on a small scale in ponds with seeds from huge native Indian carp imported from India in the mid-1940s. With the introduction of the exotic carp in the 1950s, significant progress was made [5]. Following monoculture techniques, it was successful at reproducing in the 1960s and became very well-liked in the private sector. Three Chinese carp species were introduced and farmed in the 1970s: grass carp, bighead carp, and silver carp. Their ability to reproduce successfully in captivity has significantly advanced aquaculture in Nepal. Similar to this, the country successfully created three commercially significant indigenous large carps by induced breeding: rohu,mrigal, and catla[6]. This accomplishment is the result of a polyculture system in ponds that includes seven distinct kinds of fish with diverse eating patterns. This method has greatly increased yield per unit area while also providing economic benefits, and enticing more farmers. The technology truly took off in the early 1980s with the installation of the Aquaculture Development Project, which was supported by the Asian Development Bank (ADB) and the United Nations Development Program. (UNDP)[7].

Pond aquaculture has evolved to become the most practical and well-liked aquaculture production technology in Nepal and occupies more than 90%of fish production in Nepal[8].Siraha district is one of the 77 districts of Madhesh province which is situated in the terai belt of Nepal. It covers an area of 1,188 sq km having a population of 637,328 according to the census of 2011[9] (Table 1). The district is made up of 17 municipalities directly under the control of the federal government, eight of which are controlled centrally and nine of which are in rural regions [10]. Siraha district has significant potential for fish production, revenue, nutrition, and rural development in general, but productivity is poor owing to a lack of management and technical expertise in fish farming which is a challenging issue for increasing market demand and controlling trade in domestic and international fish markets [11].

This study focuses on determining the benefit-cost ratio, that might be beneficial to prospective fish farmers along with for academics and researchers. The baseline data on the present situation of fish production, its advancement, its future prospects, and the implications of upgraded production technology on the success of fish farmers are also valuable information that may be gleaned from this investigation. This assessment also reveals substantial and regular concerns with fish production in the Dhangadhimai municipality; if these issues are addressed, the region's capacity for fish production would enhance.

Table 1: Distribution of fish production in different provinces in Nepal

Province	**Water surface Area (ha)**	**Yield/production (kg/ha)**
1Koshi	1,819	4693
Madhesh Pradesh	7345	5122
Bagmati	687	4640
Gandaki	313	4030

Lumbini	2865	5043
Karnali	33	2274
Sudurpaschim	414	4300

Source: [12]

2 Statement of problem:

The Siraha district's fish farmers still rely on subsistence methods of production, which puts a limit on their overall output and forces them to buy from other nations. The suppliers in the area purchase goods at a discount from the farmers and sell them for a premium price. Farmers seem unable to consistently and affordably get fry and fingerlings from either private or public hatcheries [13]. The main issues affecting the production of fish in the Siraha district are a lack of high-quality fingerlings, a lack of fingerlings in time, a lack of suitable and high-quality water, a lack of labor in time, a high cost of labor and inputs, insufficient market efficiency, and a problem with pond seepage [14].

3 Production trends of fish in Siraha district:

According, to the statistical information on Nepalese agriculture 2076/77 (2019/20) Siraha district has 2219 ponds covering 882 ha of the area by water. Total fish yield (kg/ha) in the Siraha district was found to be 4800 kg/ha[15].

Table 2: Production trend of fish in Siraha district

Fiscal year	**water surface area (ha)**	**Yield/production (kg/hec)**
2015/16	695.66	4839
2016/17	807	4839
2017/18	807	4839
2018/19	837.44	4839
2019/20	882	4800

Source: [12]

The above table shows that there was only 695.66 ha of land under fish production with a total production of 4839 kg/ha in fiscal year (2015/16). The area under fish cultivation was found constant from the year 2016-18 and the yield was the same. It was found that in the year 2019/20 the yield was reduced to 4800 kg/ha.

4 Literature review

There is a dearth of the academic and empirical literature on fish farming in Nepal. 54,237 households are involved in fish farming, according to [17] and [18], and 143,241 individuals are employed in this business as a whole. Carp polyculture is the most popular, dominant, and

economically feasible aquaculture production method.A study on the economics of fish farming in Osun State, Nigeria, conducted by [19], has revealed crucial details on the financial sustainability of fish farmers. In the age range of 31 to 50, 58.3% were male, 91.7% were married, 95.8% had a formal education, 86.1% were landowners, either by inheritance or purchase, 8.3% were operating on leased property, and 5.6% were renting the land they used for their business. Only 5.6% of respondents had access to bank loans, while 75.5% obtained their capital from personal savings, 11.1% through cooperatives, and other sources. Extension agents visited around 52.8% of the population often. 30.5% were seldom visited, compared to 16.7% who were sometimes visited. Only 27.8% of people identified as farmers. 81% of the change in total production was predicted by the model. Fish farming was shown to be generally profitable, with a profit-cost ratio of 0.65 and a benefit-cost ratio of 1.65. Additionally, [20] assessed the state of fish production in the fish zone of Mahotarri, Nepal, and found that the typical household produced 70.47 qts of table fish on average, with a total output of 4158.09 qts. The B/C ratio was determined to be 1.43, which was incredibly profitable in the farming sector and indicated that the farmers were financially feasible to continue operating the business. [18] claimed that the majority of farmers' primary profession was fish farming, which was successful with an average productivity of 5.53 Mt/ha/year and a B/C ratio of 1.37. Additionally, [18] reported that traders were active in the fish marketing system, with 59.65% of the total sales going to wholesalers, 30.49% to retailers, and 9.87% going straight to consumers.

5 Methods and Methodology:

5.1 Site Selection:

A Terai district in Madhesh Pradesh called Siraha is where the survey was carried out. Its neighboring districts are Dhanusha to the west, India to the south, Siraha to the east, and Udayapur to the north. Administratively, the district is divided into nine communes and eight rural communes. The district's elevation ranges from 76 to 885 meters above sea level. The monsoon season lasts from June to mid-September, with minimal rain in the winter. The district comprises 122,797 hectares of land, 73,914 of which are arable while the remainder is forests, watersheds, and grasslands[21]. It has a population of approximately 7,00,000 people and an area of 1188 km^2[9].The research was conducted in Dhangadhimai, Siraha district, Fish Zone, Siraha PIU. This location was carefully chosen since it is home to the bulk of fish farmers, who contribute significantly to the district's overall fish production.

Fig 1: Map of studying area portraying research site

5.2 Preliminary study

The preliminary study was carried out and different information regarding the feasibility of the research was collected. The features of the research location were assessed by direct observation and in-depth discussion with farmers and dealers. It provided an overview of the fish zone from different aspects which was very much helpful in the preparation of the questionnaire as well as rapport building with farmers and traders.

5.3 Data collection and sampling procedure

The study was conducted from January-July, 2022 and the primary data collection was conducted from February-March, 2022.The list of fish farmers of the command area of fish zone

Dhangadhimai, Siraha was obtained through zone profile. Out of the total farmers residing in the command area of the fish zone, 30 farmers were selected randomly, each from Santa Nagar and Fulkahakatti, and were surveyed. Thus, the sample comprises 60 respondents selected randomly and proportionately from the two villages. Simple random sampling was done in various stages to obtain the required sample

5.4 Research instruments

5.4.1 Interview schedule

Pretesting of the interview schedule was done to test the validity and effectiveness of the interview schedule with 10 respondents near the study area. The interview schedule was a bit modified as per the result of pretesting before actually applying to the actual respondent.The interview was scheduled in English, while the questions were in Nepali. The questions were developed fromfollowing the aforesaid objectives of the research.

5.4.2 Household survey

A household survey was employed to collect data using a pre-tested schedule of closed and open interviews. 60 household including 30 each from Santa Nagar and Fulkahakatti Ward under Dhangadhimai municipality was surveyed.

5.4.3 Key informant interview (KII)

Key informant including progressive farmers, Agriculture Knowledge Center (AKC), and traders, were interviewed with a series of questions related to the economics of production and marketing of fish atthe study site.

5.4.4 Focus group discussion (FGD)

As a part of the preliminary study for the assessment of economic analysis of fish production in the study site, FGD comprising 5-8 participants was conducted. To debate the matter, progressive farmers from the area, traders, and focal points from the fishing area were employed. A checklist of questions was used for discussing the topic. A checklist of questions was used to guide and facilitate the discussion and a meaningful conclusion was written in the notebook.

5.5 Sources of data

5.5.1 Primary data

Direct connection with farmers was used to obtain primary data via questionnaire survey, focus group discussion, and Key informant interview (KII).

5.5.2 Secondary data

Secondary data was obtained through a review of literature relevant to the research topic. It has included the annual Department of Agriculture Development Office (DADO) report, research articles, National Agriculture Research Council(NARC) publications, Ministry of Agriculture and Livestock Development (MOALD) publications, Prime Minister Agriculture Modernization Project (PMAMP) reports, Agriculture Knowledge Centers (AKC) publications, and relevant works.

5.6 Method of Data analysis

The survey's quantitative and qualitative results were analyzed and interpreted using SPSS version 25 and MS Excel. To examine socioeconomic and agricultural variables such as ethnicity, education, land ownership, and so on, simple descriptive statistics such as mean, frequency, and percentage are utilized. To examine data obtained from multiple sources, descriptive approaches are utilized. Simple statistics like mean, frequency, and percentage were calculated and analyzed with SPSS and MS-EXCEL. Mainly tables, charts, diagrams, figures, etc. were used to give a bird's eye view of the research findings.

5.6.1 Cost and Return Analysis

5.6.1.1 Fixed Cost

Fixed costs are expenses that a fish farmer must incur whether ~~it~~the farmer produces one item or a million. He must pay the same amount regardless of productivity. In other words, it is a cost that remains constant even at increased levels of output. Rent, for example, is an example of a fixed expenditure. This fee must be paid regardless the quantity of the quantity produced and sold. The total fixed cost was estimated by using the following formula:

$$\textbf{Total Fixed Cost (TFC) = C(PC)+ C(D) + C(EMP) + C(WP) + C(LR) +C(I) +C(B)}$$

Where,
C(PC) - Cost for pond construction (NRs/ha)
C(D) - Cost of depreciation (NRs/ha)
C(EMP) - Cost of the electric motor pump (NRs/ha)
C(WP) - Cost of waterpipe (NRs/ha)
C(LR) - Cost of land rent (NRs/ha)
C(I) - Cost of interest (NRs/ha)
C(B) - Cost of boring/well (NRs/ha)

5.6.1.2 Variable Cost

On the other hand, the polar opposite of variable cost, which changes according to industrial activity i.e., variable costs are costs that fluctuate when a company's output of goods or services

changes. The total marginal cost of all units produced is referred to as variable cost. All variable inputs encountered during fish production, including feed, fingerlings/seedlings, medications, labor, chemical fertilizers, organic fertilizer costs, electricity/fuels, lime expenses, and other expenditures, have been considered and assessed at current market rates to project thetotal costs.The total variable cost was estimated by using the following formula:

Variable Cost (VC) = C(Fe) + C(Fi) + C(Me) + C(L) + C(F) + C(E) + C(Li) + C(O)

Where,
C(Fe) - Cost of feed (Rupee per hectare)
C(Fi) - Cost of fingerlings (Rs/ha)
C(Me) - Cost of medicine (Rs/ha)
C(L) - Cost of labor (Rs/ha)
C(F) - Cost of fertilizer and manure (Rs/ha)
C(E) - Cost of electricity and fuels (Rs/ha)
C(Li) - Cost of Lime (Rs/ha)
C(O) - Other costs (Rs/ha)

5.6.1.3 Total Cost

The two basic categories of expenses in a fish farm are variable costs and fixed costs, which combine to form total costs. Pipes, motors, pumps, generators, wells, aerators gas, farm works, and other equipment and gear used in fish farms depreciate at a rate of 10% each year on average. Total production was estimated by multiplying the number of fish produced (kg) by the average harvest price (NRs/kg). Total cost is computed by combining total variable and total fixed costs.

Total cost (TC) = Total Variable Cost (TVC) + Total Fixed Cost (TFC)

5.6.1.4 Benefit-cost ratio (BCR)

Benefit-cost ratio seeks to ensure that an investment in resources generates a reasonable return on those resources. The benefit-cost ratio is often cited as one of the easiest and fastest ways to assess the economic performance of a farm. It is a monetary or qualitative indication of the connection between the relative costs and benefits of a proposed project. If a project's BCR exceeds 1.0, it must generate a positive net present value to the firm and its investors. The formula provided by was used to compute the BCR:

Benefit-cost ratio (BCR) = Gross return (GR) / Total Cost (TC)

5.6.1.5 Net profit

Net profit illustrates the total amount of profit obtained after subtracting all expenses from the gross revenue. Therefore, Net profit was calculated by deducting the total cost (TC) of production from total return i.e.,

Net profit (Rs.) = Total return (Rs.) - Total cost (Rs.)

5.7 Indexing of problem

Focus group talks, key informant interviews, and field visits were used to identify five significant difficulties in fish production. Farmers were asked to rank these issues in order of severity. The relative severity of these production issues was measured using a five-point scale (1, 0.8, 0.6, 0.4, and 0.2).

The indexing of the problem is calculated by using the given formula.

$$\mathbf{Iprob = \Sigma \{(Sifi)/N\}}$$

Where,

Iprob = Index value for intensity
Σ = Summation
Si = Scale value of ith intensity
fi = Frequency of ith response
N = Total number of respondents

6 Results and Discussion:

6.1 Socioeconomic and demographic characterization of fish farmers

Population and gender distribution, ethnicity, family size, economically active population, education level, employment, ownership size of land, and fish farming experience were among the respondents' sociodemographic characteristics.

6.1.1 Sex of the fish farmer

According to the findings of the survey, the majority of fish farmers are 95% male, with only 5% females in Dhangadhimai, Siraha (Table 3).

6.1.2 Age of the farmers

Farmers' ages were profiled to learn about the engagement of young people in fish farming. However, the data below shows (Table 3) that the majority of fish farming in Dhangadhimai is done by people aged 40-50, farmers of a certain age group. In the age range of 50-60 years, ~~the~~this age group accounted for 38.3% of the total number of respondents, and similarly, 25% of fish farming was conductedof the age group, and 18.3% are within the age range of 30-40 years old. Within this age group, 10% are in the range 60-70 years old. While 8.3% of the farmers are in the age range of 20-30 years(Table 3). This table shows that the youths of Siraha have been contributing to fish farming in a decent amount, and hope this number will increase gradually.

6.1.3 Level of Education

This study shows that most of the farmers (43.3%) had attained only the primary level of education, followed by 21.7% lower secondary level, 15%seconday education, and only 6.7% had attained college study whereas 13.3% of the farmer had not attained any formal school and are categorized as illiterate (Table 3).

6.1.4 Religion of the farmers

Out of 60 respondents of fish farmers in Dhangadhimai municipality, 56 are Hindu and the remaining 4 are Muslim (Table 3). According to the table, there are relatively few Muslim respondents in the site area. After investigation, it was discovered that there weren't many Muslim families living in this area. As a result, there are few respondents belonging to this religion in this community. Thus, no evidence of a religious influence on fish farming can be detected.

6.1.5 Ethnicity of farmers

The bulk of fish farmers in Dhangadhimai city, Siraha, are Madhesi, with 53 farmers, followed by four ~~janajati~~Janajatifarmers and three Chhetri farmers (Table 3). In general, several ethnic groups, such as the Tharu, Majhi, Mukhiya, Malaha, Dunuwar, Kuwait, Jalari, Kumal, Bote, Musahar, Danger, etc., have historically participated in fisheries. In Nepal, almost 24 ethnic groups rely heavily on fisheries for their subsistence. The majority of Nepal's ethnic groups involved in fish farming belong to the Madhesi class, which is why the Madeshi respondents in the table are higher.

6.1.6 Main Occupation

From the above study, it was found that 48 farmers are solely doing fish farming practices as their main occupation whereas 6 farmers are engaged in other agriculture as their main occupation and other 6 farmers have trade business as their main occupation (Table 3).

Table 3: Socio economic and demographic characterization of farmers

Sex profile of farmers	Frequency	Percentage
Male	57	95.0
Female	3	5.0
Total	60	100.0

Age category of farmers	Frequency	Percentage
20-30	5	8.33
30-40	11	18.33
40-50	23	38.33
50-60	15	25.0
60-70	6	10.0
Total	60	100.0

Level of Education	Frequency	Percentage
Illiterate	8	13.33
Primary level	26	43.33
Lower secondary	13	21.7
Secondary	9	15.0
College	4	6.7
Total	60	100.0

Religion of the farmers	Frequency	Percentage
Hindu	56	93.33
Muslim	4	6.67
Total	60	100.0

Ethnicity of farmers	Frequency	Percentage
Madhesi	53	88.33
Janajati	4	6.67
Chhetri	3	5
Total	60	100.0

Main occupation	Frequency	Percentage
Fish farming	48	80.0
Other agriculture	6	10.0
Trade	6	10.0
Total	60	100.0

Source: Field Survey, 2022

6.1.7 Total annual income

According to the report, 40% of farmers have an annual income of 5-7 lakh, 31.7% have 3-5 lakh, 25% have 7-10 lakh, 1.7% have between 1-3 lakh, and other 1.7% earn more than 10 lakh every year.

6.2 Cost and return of fish production

6.2.1 Fixed Cost

The average total fixed cost of the 60 fish farmers is Rs.1,15,387.81 (Table 4). Where pond construction cost was found to be the highest i.e., Rs. 50978.08, followed by land rent cost of 17648.89, the boring cost is Rs. 17210.3, interest cost on loan is 12631.96 and electric motor pump cost is Rs.11240, and water pipe cost is 5678.40 (Table 4).

6.2.2 Variable Cost

The average variable cost per hectare in the research region is NRs. 782637.92 (Table 5). The cost of feeding per hectare is NRs. 531253.39, accounting for 67.88% of total variable

expenditures followed by the labor cost is Rs 64795.89 per hectare. Whereas lime costs 9624.90 NRs per hectare on average which is the second lowest, followed by other cost NRs. 9499.94 per hectare (Table 4). As per [18], the total variable cost was found to be 11,72,000, which is higher than the result obtained from Dhangadhimai municipality.

Table 4: Average fixed cost per ha per year

Particulars	Average fixed cost per hectare (Rs.)	Total share percentage
Pond construction cost	50978.08	44.2
Electric motor pump cost	11240	9.74
Cost of water pipes	5678.40	4.86
Land rent cost	17648.89	15.3
Interest (loan) cost	12631.96	11
Boring /well cost	17210.3	14.9
Total average fixed cost	115387.81	100

Particulars	Average variable cost per hectare (Rs.)	Total share percentage
Feed cost	531253.39	67.88
Fingerling cost	64149.65	8.19
Fuel and energy cost	31737.5	4.04
Labor cost	64795.89	8.27
Lime cost	9624.90	1.22
Others cost	9499.94	1.21
Chemical fertilizer cost	44305.7	5.6
Organic manure cost	10282.87	1.31
Medicine cost	16988.05	2.2
Total average variable cost	782637.92	100
Average total cost per hectare	898025.7	100

Source: Field survey, 2022

6.2.3 Returns per hectare

The average total return per hectare of 60 fish farmers was found to be Rs 13,52,875.09.Further, the average net return per hectare of 60 fish farmers was found to be Rs. 414367.66. Additionally, the average productivity of fish per hectare of 60 fish farmers was found to be 5.26 Mt (Table 5).

Table 5: Returns per hectare

Returns (Per	Minimum	Maximum	Mean	Standard

hectare)				Deviation
Total return (Rs)	11,25,000	17,16,000	13,52,875.09	1,09,464.63
Net return (Rs)	1,68,675	8,09,400	4,14,367.66	1,30,399.42
Productivity of fish (Mt.)	4.43	6.50	5.26	0.40

Source: Field survey, 2022

6.2.4 Benefit-cost ratio analysis (BCR):

The benefit-cost ratio of fish farming was slightly over one, at 1.51, indicating that it is economically advantageous to practice fish farming in Dhangadhimai. For every rupee invested in the firm, returns of Rs 1.51 may be expected.

BCR =Total return per ha. / Total cost per ha.

= Rs.1352,875.09 / Rs. 898025.73

=1.51

Here, BCR 1.51 indicates that fish farming in Dhangadhimai is profitable.

6.3 Status of fish production in Dhangadhimai municipality

6.3.1 Fish culture

Mostly prevalent fish culture system in Nepal is pond fish culture which accounts for more than 90% of production in Nepal and also in the Siraha district but based onthe number of species grown in the pond, fish culture is of two types: a) monoculture and b) polyculture. About 23.33% of respondents were engaged in monoculture and other 76.67 % were engaged in polyculture.

6.3.2 Species grown

Most of the fish farmers in Dhangadhimai are found to be growing major carp species (76.67%) and the remaining 23.33% are growing other species of fish on their farms.

6.3.3 Source of fingerlings

It was found that the majority of the farmers use the private farm as their source of fingerlings i.e.,31 farmers out of 60, bring fingerlings from the private farm, 14 from a government farm, 9 from their production, and the remaining 6 from another place like India border.

6.3.4 Fish Pond area coverage of the farmers

Out of the total respondent fish farmers, 24 farmers have fish pond area coverage in 1020 Kattha. Similarly, 21 households have a fish pond size of 20-30 Kattha, 4 farmers have a fish pond area

of 30-40 Kattha, 5 farmers have a fish pond area of less than 10 Kattha, and 6 farmers have a fish pond area that exceeds 40 Kattha (Table 6).

Table 6: Fish Pond area coverage

fish pond area	Frequency	Percent
less than 10 kattha	5	8.3
10-20 kattha	24	40.0
20-30 kattha	21	35.0
30-40 kattha	4	6.7
more than 40 kattha	6	10.0
Total	60	100.0

Source: field survey

6.3.5 Fish farming experience of the farmers

25 of the 60 farmers in Dhangadhimai have been involved in fish farming for 10 to 20 years. Similarly, 20 farmers have been involved in fish farming for 5-10 years and 8 farmers are a bit new and have experience of fewer than 5 years whereas 7 farmers have the most experience among all of the farmers i.e., more than 20 years (Table 7). According to [22], in terms of aquaculture, fish productivity is greater due to the associated fact that fish farmers have more expertise with fish farming. Conclusively, this suggests that a fish farmer's ability to produce more fish might improve with experience. We can see from the table (Table 7) that a number of respondents have a long history of involvement in fisheries.

Table 7: Fish farming experience in year

fish farming experience of the respondent	Frequency	Percent
0-5 years	8	13.3
5-10 years	20	33.3
10-20 years	25	41.7
>20 years	7	11.7
Total	60	100.0

Source: field survey,2022

6.3.6 Training and service providers

Dhangadhimai is located in PMAMP's fish farming region, the majority of training programs and services are provided by PMAMP, which contributes 48.33% to the training of city suppliers,

followed by primary farmers in this area (20%) and associations. The farmer group has 18.33% while the cooperative has 13.33%.

6.3.7 Market place for selling the fish

Farmers sell the majority of the fish produced in Dhangadhimai in the local market (65%), then on the farm (18.33%), and 16.67% is sold beyond the districts.

6.3.8 Fish price settlers

In Dhangadhimai City, fish prices are mostly determined by discussion between farmers and dealers (53.33%), wholesalers (21.67%), farmers themselves (13.33%), and the government (11.67%).

6.3.9 Satisfaction level of the farmer with the price received per kg of fish

While discussing the received fish price per kg of fish in Dhangadhimai, about 43.33% of the fish farmers are found to be satisfied whereas 28.34% of the farmers are dissatisfied, and the remaining 28.33% are neutral. Following a conversation with the respondents, it was discovered that the sample's small-scale farmers made comparatively less profit than the large-scale farmers. The average market set price prevents them from requesting a higher price for the produced fish, which directly results in their dissatisfaction with the amount they receive. As a result, although some respondents are satisfied with the price received for the fish produced, others are not.

6.3.10 Types of loss or disaster

The disease is the leading cause of fish productivity and farm loss in Dhangadhimai, followed by predators, flooding, and pollution (Figure 2).

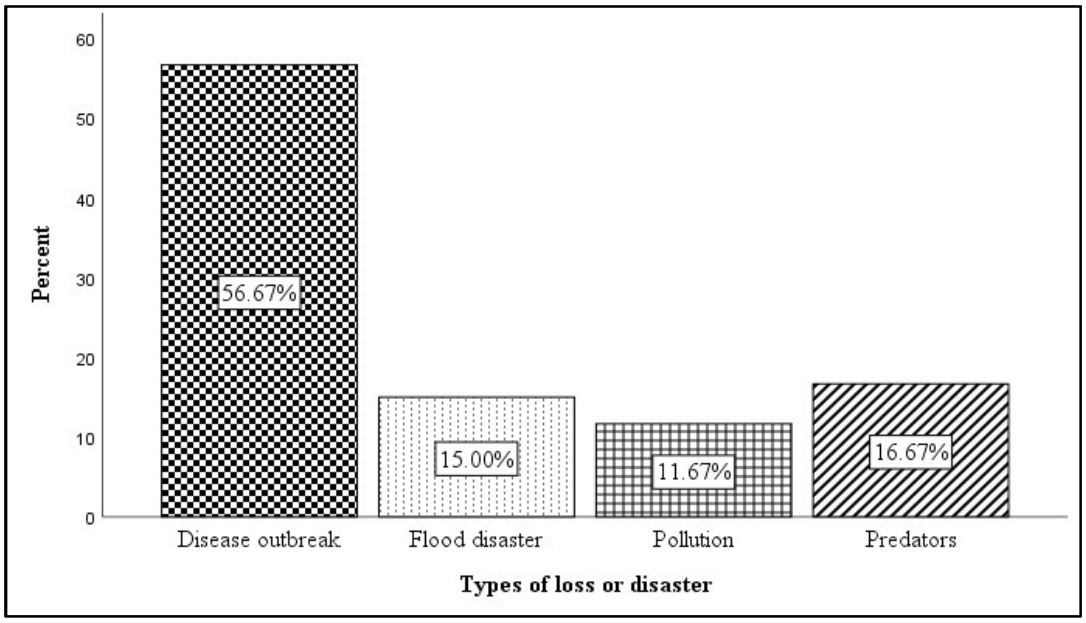

Fig 2: Types of loss or disaster in fish farm

Source: Field Survey, 2022

6.3.11 Insurance of fish farm

Out of the total respondent fish farm in Dhangadhimai municipality, three-fourth of the fish farm have insurance, and the rest one-fourth do not.

6.3.12 Source of loan or financial support

Among 60 fish farmers, 48.33% have not borrowed any loan or financial support from anyone but 33.33% of fish farmers have borrowed a loan from Bank,10% from friends and relatives followed by 8.33% from cooperatives.

6.3.13 Production problems of fish farmers

As expected, high cost of inputs for fish production is found as the major problem for fish production in commercial fish farmers also with an index value of 0.84. Farmers identified a shortage of quality fingerlings as the second most serious concern, with an index value of 074. Similarly, with an index value of 0,60, the third main issue was recognized as the presence of illnesses and pests. The most common ailment found in the research region was a bacterial infection, which included fin rot and ascites, white spot disease, and EUS (epidermal ulcer syndrome). According to farmers in the research region, the disease's presence causes major output decreases at times. With an index score of 0.53, the fourth significant issue observed was the lack of fry over time (Figure 3).Even though the region has multiple breeding centers, farmers are finding themselves without fingerlings due to the entry of new fish farmers. They are now properly trained as a result of government policy toward fish growers. As this region has been included in the fishing area, PMAMP has made significant efforts in training, technical assistance, information, and subsidies for fish producers.

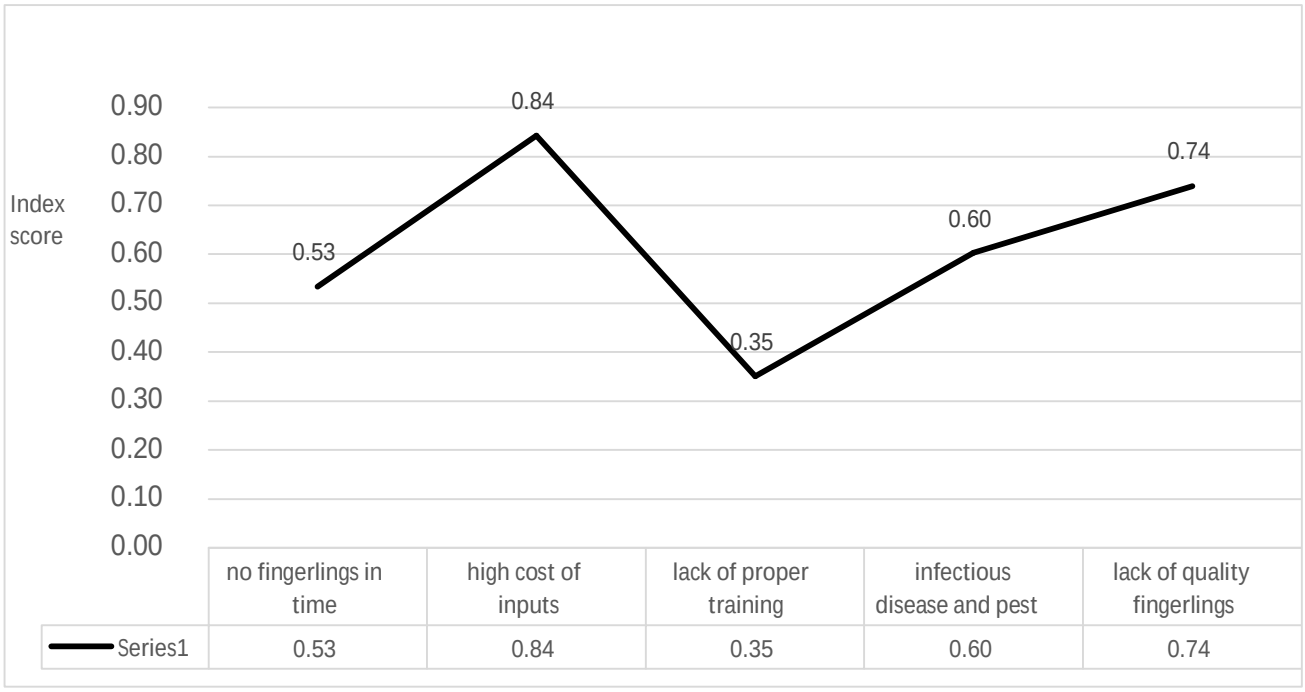

Fig 3: Ranking of problems in the fish production system

7 Discussion:

The average total cost of production in Dhangadhimai City, Siraha, was Rs 8,98,025.7, whereas [23] estimate in the Chitwan district was Rs 7,43,798. This suggests that the research area's production costs are somewhat similar than those calculated in Chitwan by [23]. In addition, research done by [18] in Dhanusha, Nepal, and [20] in Mahotarri, Nepal, revealed that the total fish production was Rs 17,35,000 and Rs 14,22,249.93, respectively. Compared to the production costs found in the Dhangadhimai municipality, these numbers are significantly higher. According to the assessment, large variable costs that vary by location were the reason for the fluctuation in production costs.

In Dhangadhimai, variable costs account for approximately 87.2% of total production costs. Feed expenses are the most expensive variable cost factor, accounting for 59% of overall production costs. Variable costs account for 79% of overall production costs, according to [23], while variable costs account for 67.55% in the Dhanusha district, according to [18]. Similarly, [19] discovered that variable costs account for around 87% of overall production costs of whichfeed costs alone account for 34% of total production costs in Nigeria. Labor expenses are the second greatest variable cost factor, followed by fingerling costs, maintenance costs, manure and fertilizer, fuel and electricity, limestone, and miscellaneous fees. As a result, producers in this research pay more for feed, labor, and fingerlings. Furthermore, according to the B/C ratio of 1.51, fish production in Dhangadhimai City looks to be a lucrative company. [23]computed a B/C ratio of 1.63. Similarly, the B/C ratio for [18]fish output is 1.37.

Furthermore, research conducted by [24] examined the economics of fish farming in the Nepalese district of Dhanusha and discovered that the BC ratio there was 1.69, which is rather higher than in our study. Therefore, using high-quality, protein-rich feed types that improved fish production was the primary factor in such high values. Additionally, Nepal's production area and output have not expanded as much as it had anticipated due to the high cost of fish farming operations.Small-scale farmers struggle to finance fish farming on a commercial basis due to the high cost of inputs. This problem has been discussed by several researchers, including [18], who studied the fish production system in Dhanusha, Nepal; [20], who evaluated the fish production status in Mahotarri, Nepal; [15], who examined the adoption of improved fish production technology in Rupandehi, Nepal; and [25], who studied fish farming in Suddhodhan rural municipality of Rupandehi district, Nepal.

8 Conclusion and policy implications:

According to ~~a~~ this study based on an economic analysis of fish production in Dhangadhimai municipality of Siraha district, Nepal, fish farming is one of the fastest growing enterprises in the area, employing a huge number of people. In recent years, Dhangadhimai has witnessed ~~seen~~ an increase in the number of fish ponds, and many young people in the city are drawn to this farming, however, the net yield in this region is slightly lower than in nearby Terai districts such as Dhanusha, Bara, and Saptari. Fish farming may be a very successful industry that contributes to food security and the economy if suitable technical and economic assistance, services, and

facilities are provided. The majority of the fish is consumed in the local district market due to high demand, with just a tiny portion sold to neighboring districts and Kathmandu. Despite the high potential of farmers and traders in Dhangadhimai, Siraha faces several production challenges, including a lack of quality fingerlings in terms of timing, poor pond water quality, high investment costs, and so on. Other challenges include high entry rates, epidemics, and a lack of effective training. As a result, many issues influencing the entire sector must be considered. This would boost the economic viability of fish production in the research region as well as the country's overall aquaculture scenario.The following policy interventions are advised to be implemented for the fish farming sub-sector in Dhangadhimai municipality of Siraha district to transition from subsistence to commercial fish farming;

1. Promoting female involvement in fish farming to assist the family in generating extra income via the introduction of Women in Aquaculture projects.
2. Boost public-private partnerships (PPPs) throughout the value chain to provide smallholder farmers access to high-quality fingerlings, feeds, medications, processing, and markets.
3. Offering low-interest loans to fish producers can help the agriculture industry expand more successfully.
4. Provision of farmers workshops aimed at enhancing their knowledge and abilities, with an emphasis on small and medium fish farmers.
5. Reduction of several social issues associated with fish farming, such as poisoning and poaching.
6. Extension services should be made available to help small farmers quickly embrace new technologies. This is crucial right now because farmers lack access to the tools, they need to maximize profits while minimizing labor and time expenditures.
7. Implement a fish farming subsidy scheme to encourage the development of ponds and contributions from internal governmental agencies.
8. Local governmental bodies should oversee fish marketing to guarantee the commitment and enthusiasm of fish farmers for the growth of market infrastructure and administration in the local areas.

Author declaration:

The authors declare no irreconcilable circumstances. All authors contributed equally in all phases of the preparation of this manuscript. Likewise, the final version of the manuscript was approved by all authors.

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