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RESEARCH ARTICLE

ADOPTION STATUS OF IMPROVED FISH PRODUCTION TECHNOLOGY IN BADHAIYATAAL RURAL MUNICIPALITY

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ABSTRACT

The study was conducted in the PMAMP Fish Zone, Bardiya (Badhaiyataal rural municipality) to study the adoption status of improved fish technology. A purposive sampling technique was employed to select a representative sample of fish growers from various fish farming sites within the rural municipality. During the study period, 50 randomly selected fish farmer households were surveyed using structured questionnaires. The study found that the age group of 40-60 years showed the highest participation in fish farming (48%), with the majority of males. The dominant populations in the region were Brahmin and Janajati, each constituting 44%. Hinduism was a major religion (94%), and the majority of the respondents were found to be literate. Most of the respondents (92%) were engaged in agriculture, and all of them practiced commercial fish farming. They had an average farming experience of 14 years on their own land. The technology adopted by most of the respondents were liming practices, inlet devices, aerated containers for transporting fingerlings, fertilization, improved breeds of fingerlings, and pond maintenance. High feed costs followed by the absence of commercial hatcheries, lack of technicians, and high electricity bills were the main challenges. Controlling the illegal import of Indian fish and focusing on proper management of feed, fingerlings, medicine, and the market, along with the establishment of a nearby lab, and availability of skilled technicians might help to increase the number of farmers adopting improved fish production technologies.

KEYWORDS

Adoption, fish farmers, improved fish technology and problem.

1. INTRODUCTION

Aquaculture, which is growing quickly, is the breeding and raising of fish, shellfish, or plants in ponds or any other enclosure for the direct harvest of the product (FAO, 2004). The FAO estimated in 2006 that more than one billion people depend on fish as their primary source of animal protein because it is an affordable and nutrient-dense form of animal protein. Omega-3 fatty acids, and vitamins D and B are found in fish that help in reducing blood pressure and the risk of a heart attack or stroke (Philibert et al., 2013). Over 60% of the protein consumed globally, and 30% of the protein ingested each year in developing countries, comes from fish (Abisoye et al., 2011).

Aquaculture in Nepal is in the developing stage, and the amount of fish production is too low compared to the world aquaculture production (Mishra, 2015); however, it is spreading to 55 districts and producing about 584,839 employment to people (Kuwar and Adhikari, 2020). Fish production throughout the year in Nepal reaches 77,000 tonnes (t), among which 28% are derived from capture fisheries and 72% from the aquaculture sector (Kunwar and Adhikari, 2020), and contributed 1.13% to the country's gross domestic product and 4.18% to Agriculture Gross Development Product (AGDP) for the fiscal year 2077/78 (MoALD, 2020). Nowadays, the least developed country has 11 kg of fish available, while Nepal only has 3.43 kg (MoALD, 2020). This indicates that demand for fish and fisheries have risen, symbolizing the need for change in the sector, and according to the report by FAO, aquaculture will have 62% of all fish food production by 2030. So, Nepal has to boost its economy by leveraging this rising demand for fish (Dhakal et al., 2022).

The term "improved" technology in freshwater fish farming denotes the adoption of innovative methods and procedures that can boost farm productivity and efficiency, which may include the use of hatchery methods, successful strategies for disease management, and efficient water management systems, among others (Vejlgaard, 2018). The farmer's choice to adopt or reject a method depends more on the level of risk involved compared to current practices (Singas and Manus, 2014). Improved technology results not only uplift living standard of fish farmers through fish growth, survival, and quality rates but also mitigate environmental issues by lowering the damage that fish farming does to freshwater ecosystems. To maintain ideal water temperature, pH, dissolved oxygen, and ammonia levels, advanced water circulation systems, such as aerators, water pumps, and filters, are put in place, while farmers are encouraged to use organic inputs, such as compost and manure, to enhance soil and water quality as natural substitutes (Shukla et al., 2019). To protect fish populations from disease outbreaks and restrict the spread of illnesses, biosecurity measures are put in place. These include regular health monitoring, cleaning of tanks and equipment, vaccinations, and proper handling and disposal of dead fish (Hoque et al., 2018).

In Nepal, the level of adoption and awareness regarding fish improved technologies in Rupandehi district was high, where fertilization and liming, provision of inlet and outlet, soil testing before site selection, an aerated container for transporting fingerlings to reduce stress and mortality, improved techniques in pond construction and maintenance, improved breeds for fingerlings, prevention and control of disease, optimum stocking rate were the major improved technologies prevalent in that district; however, there were some constraints in adoption of these aforementioned improved technologies, such as high cost of fish feed, high cost of fingerlings, inadequate capitals, and genetic erosion (Neupane and Gharti, 2018). Most of the Nepalese farmers preferred polyculture rather than monoculture, and Rohu (*Labeo rohita*), Catla (*Catla catla*), Mrigal (*Cirrhinus cirrhosus*), Rainbow trout (Oncorhynchus mykiss), Common carp (*Cyprinus Carpio*), Grass carp (*Ctenopharyngodon idella*), Silver carp

(*Hypophthalmichthys molitrix*), Bighead carp (*Hypophthalmichthys nobilis*) are the fish species used in polyculture system in Nepal (Pandit and Rizal, 2022).

Fish farming holds significant potential for improving livelihoods in rural Nepal, but local farmers, particularly in regions like Badhaiyataal, face challenges such as low awareness of modern techniques, high costs, and inadequate infrastructure. These issues hinder productivity and profitability. Thus, research is needed to explore the adoption status of various improved technologies in the research site. The objectives of the study are to analyze the socio-demographic characteristics of fish farmers and identify the types of technology and the problems faced by farmers in using improved fish production technology in Badhaiyataal rural municipality.

2. METHODOLOGY

The study was conducted in the Bardiya district of the rural municipality (Badhaiyataal), Nepal (Figure 1). Bardiya is renowned for huge fish production and ranked at second position after Rupandehi district. Badhaiyataal rural municipality is located in the Bardiya district of the Lumbini Province of Nepal. Geographically, it is located between 81º23'17" to 81º33'49" east longitudes and 28º4'11" to 28º13'58" north latitude. The municipality ranges in altitude from 143 to 157 meters above sea level and has an area of 115.19 square kilometers (IALDO, 2021).

Figure 1: Map of Nepal showing the research site

2.1 Sample and sampling method

A list of fish farmers was obtained from PMAMP, PIU, Bardiya, Fish Zone. Only the listed fish farmers from the PMAMP Profile book of Badhaiyataal were selected as the population (i.e. 55). About 50 farmers were chosen for the study with the help of the Taro Yamane (Yamane, 1973) formula with a 95% confidence level. The formula for calculating sample size using Taro Yamane is:

$$n = \frac{N}{1+Ne^2}$$

Where,

n= sample size

e= allowable error

N= No. of population

After estimating sample size, they were selected randomly from listed farmers in PMAMP, Fish Zone of Badhaiyataal rural municipality.

2.2 Research process

2.2.1 Preliminary field visit

Before initiating main survey research, preliminary field visit was done for acquiring crucial background information about the study location such as demographics, socio-cultural aspects, topography, and farming practices of research area. The data gathered during the field trip was then utilized to create a schedule, and develop a questionnaire for the main research study.

2.2.2 Preparation and testing of questionnaire

After conducting a preliminary field visit, the data gathered from the visit were used to prepare a questionnaire for the survey. The prepared questionnaire was subjected to a pre-test with five households of non-sampled farmers to evaluate its effectiveness and identify any necessary adjustments or improvements, and structured questionnaire was developed.

2.2.3 Data collection

Primary and Secondary data were gathered for the study. Having adjusted questionnaire, primary data was collected through face-to-face interviews with a carefully selected group of fish producers in the research area from April to May 2023. On the other hand, secondary data was collected through various articles, reports, journals, websites, and institutions/organizations such as the Central Bureau of Statistics (CBS), Nepal Agriculture Research Council (NARC), Department of Agriculture, Ministry of Agriculture Development, Agriculture Knowledge Centres (AKC), and the Ministry of Agriculture.

2.2.4 Data analysis

The gathered data was entered in MS- Excel, and analysed with the help of Statistical Package for Social Science (SPSS) software.

2.2.4.1 Data Entry and Cleaning

The collected data was entered and cleaned in the Excel file for analysis. Data cleaning involves detecting and removing errors and inconsistencies to improve the accuracy of the data.

2.2.4.2 Data Analysis

Variables like family size, sex and age distribution, occupation, education level, ethnicity, and size of land holding were analysed descriptively and presented in frequencies, percentages, and mean.

Moreover, improved technologies and problems for the production of the fish were ranked with the help of the forced ranking technique. The index value for calculating major problems faced by producers was determined using the following formula:

$$I = \sum \frac{S_i F_i}{N} \quad \text{(Miah, 1993)}$$

Where,

I = Index value

∑ = Summation

S_i = I[th] scale value

F_i = Frequency of i[th] importance given by the respondents

N = Total number of the respondents

3. RESULTS AND DISCUSSION

3.1 Socio-demographic data

3.1.1 Age of the respondents

It reveals that 24% of the respondents were in age ranged from 40-60 years followed by 20-40 years (20%) and 60-80 years (12%). This data in the figure 1 indicates that the majority of the respondents were in middle age.

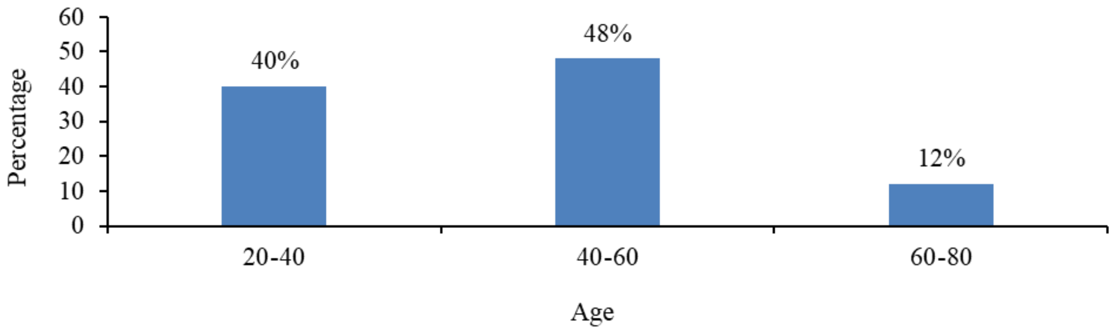

Figure 2: Age of the respondents

3.1.2 Gender and ethnicity of the respondents

In the survey area among 50 selected respondents, 80% of the respondents were male whereas 20% of the respondents were female. On the other hand, the most dominant castes among the sample respondents were Brahmin and Janajati, both accounting for 44% each, and Chhetri constituted 6% of the sample, while Dalit represented 4% and Madhesi represented 2%. Figure 3 and 4 revealed that male from Brahmin and Janajati family had more information related to fish production and fish-related activity.

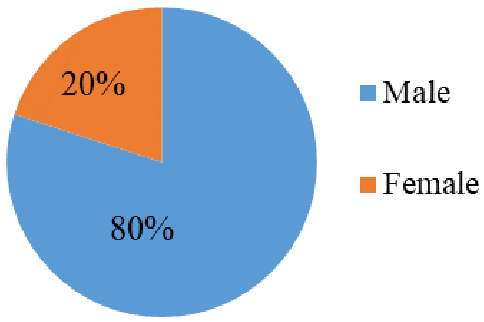

Figure 3: Gender distribution of respondents

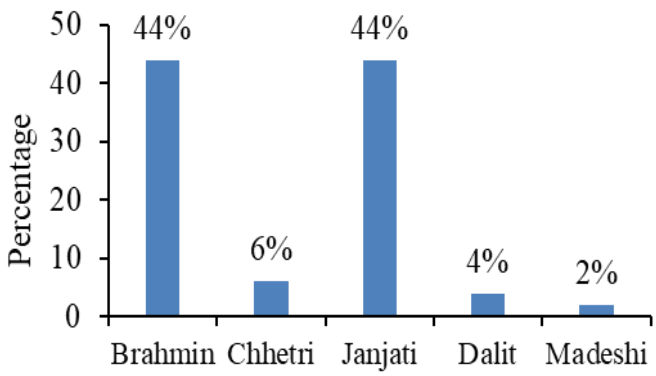

Figure 4: Ethnicity of respondents

3.1.3 Religion and Education of the Respondents

The majority of respondents (94%) identified as Hindu, followed by a smaller percentage of Muslim (4%) and Buddhist (2%) respondents. Similarly, the majority of respondents (40%) had an education level above 12, which was followed by 30% who had an education level between grades 10 to 12, 24% had an education level below grade 10, and remaining 6% were illiterate. The figure 5 and 6 indicates that there was a higher involvement of individuals with a higher level of education, and Hindu religion was the most dominant in the study area, with smaller populations of Muslim and Buddhist followers.

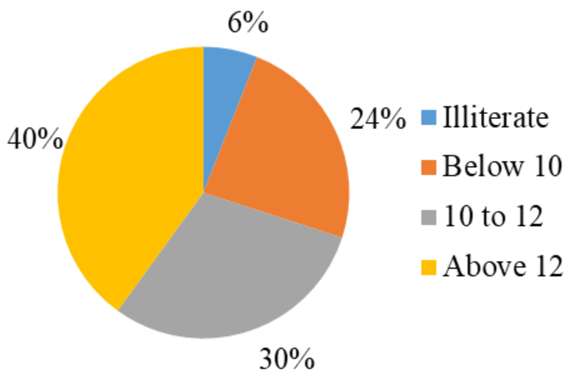

Figure 5: Education of respondents

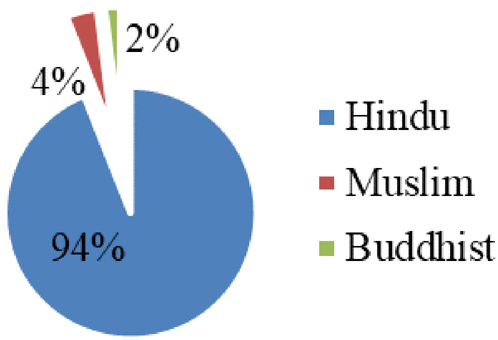

Figure 6: Religion of respondents

3.1.4 Source of Capital and occupation of the respondents

Among the respondents, the major source of capital for investment in fish ponds was bank loans, reported by 88% of the respondents, which was followed by personal savings, reported by 8% of the respondents, and smaller percentage (4%) obtained capital through cooperative loans. The distribution of source of capital is represented in the figure 7. Similarly, the figure 8 revealed that the majority of respondents (92%) were engaged in agriculture, and the remaining 8% of them engaged in agriculture and others. i.e. teachers, rice mill, and auto garage.

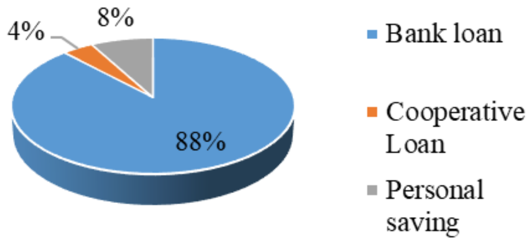

Figure 7: Source of capital

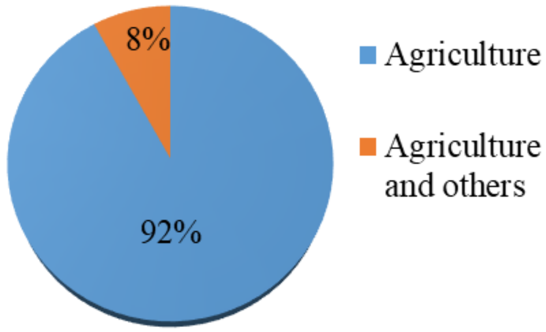

Figure 8: Occupation of the respondents

3.1.5 Modes of Fish farming and ownership of land

It can be concluded from the survey of 50 farmers that they were all involved in commercial fish farming on their own property. The figure 9 suggests that all farmers surveyed (100%) farmed fish for commercial purposes on their own property.

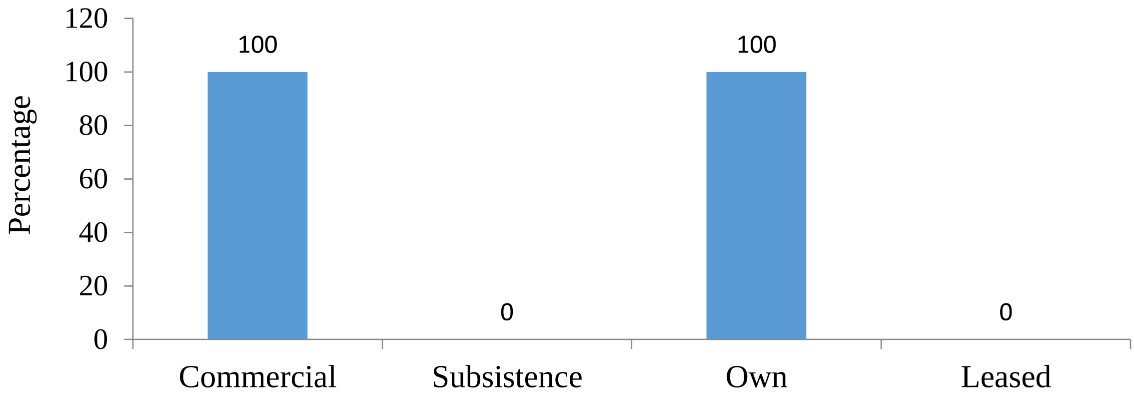

Figure 9: Modes of Fish farming and ownership of land

3.2 Pond Information

3.2.1 Type of pond and source of water for the pond

Among the fish farmers surveyed in the area, the majority (96%) reported having earthen ponds, while a smaller percentage (4%) had cemented ponds. In this type of pond, the majority of farmers (54%) used underground water while a few farmer (2%) used canal water for their pond which is represented in Table 1. This indicates that earthen pond was the most common type of pond and underground water was the main source of water for the pond in the survey area.

Table 1: Types of pond and Sources of water to the pond

Variables	Frequency	Percent
Types of Pond		
Earthen Pond	48	96
Cemented Pond	2	4
Source of water to the pond		
Canal	1	2.00
Underground boring	27	54.00
Underground boring, Canal	2	4.00
Underground boring, Submersible pump	5	10.00
Underground boring, Monsoon	9	18.00
Underground boring, Lake	2	4.00
Underground boring, Monsoon, Submersible pump	3	6.00
Underground boring, Lake, Submersible pump	1	2.00

3.2.2 Availability of water year-round in pond

The distribution of water availability year-round in pond is depicted in figure 10. During the survey, respondents were asked whether the water was available in their pond year-round or not. 68% of the respondents said that water was available throughout the year, while 32% said that water was not available throughout the year.

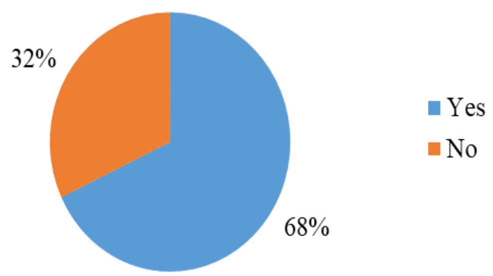

Figure 10: General distribution of availability of water year-round in pond

3.2.3 Subsidy and types of fish culture

The information on subsidies obtained and types of fish culture have been depicted in the Table 2. Out of the total 50 respondents, 44% of the respondents received subsidies from various organizations such as PMAMP, Fish Zone, District Agriculture Office, and few farmers received subsidies from Sana Kishan Sahakari, while 56% did not receive subsidies. Additionally, in the survey area, the majority of fish farmers (98%)

followed a polyculture system of fish farming, which involves cultivating seven major carp (common carp, silver carp, bighead carp, rohu, naini, grass carp, bhakur) stocking at a same time. Only a small percentage of farmers (2%) were found to practice a monoculture system of fish farming, where they focused on cultivating a single species of fish.

Table 2: Subsidy obtained and type of fish culture followed by respondents

Variables	Frequency	Percentage
Subsidy		
Yes	22	44
No		56
Types of fish culture		
Monoculture	1	2
Polyculture	49	98

3.3 Farm characteristics

The table 3 showed data from 50 selected respondents in the survey area, the pond counts ranged from a minimum of 1 pond to a maximum of 7 ponds, and the average number of ponds reported by the respondents was 3.22. Similarly, minimum farming experience was 1 year, while the maximum was 23 years. On average, respondents had a farming experience of 14 years. Among the 50 selected respondents, the pond areas ranged from 0.67 hectares to 7.33 hectares, with an average area of approximately 1.27 hectares. The table also shows data from 50 respondents about the number of fish farming training sessions they had attended. The range was 0 to 7 sessions, with an average of 1.88. The minimum number of nurseries was 0, indicating some respondents may not have a nursery, while the maximum number of nursery was 1, indicating some respondents had a nursery. On average, respondents had a nursery with a mean value of 0.04. The average period between pond drying events was approximately 1.52 years, with a minimum value of 0 indicates that some ponds may not be dried at all, while the maximum value of 5 suggests that the longest period recorded between pond drying events was 5 years.

Table 3: Farm characteristics

Farm characteristics	Frequency	Mean	S.D.
Total number of pond	50	3.22	1.37
Farming experience	50	14	6.84
Area (ha)	50	1.27	1.33
No. of fish farming training	50	1.88	1.89
No. of nursery	50	0.04	0.19
Pond drying (Year)	50	1.52	0.93

Note: S.D. = Standard Deviation

3.4 Adoption of improved fish production technologies

With the help of force ranking method, the most commonly adopted improved fish production technology was analyzed and presented in Table 4. The table reveals that the adoption of liming practices, inlet devices, aerated containers for transporting fingerlings, fertilization of fish ponds, improved breeds of fingerlings, and pond maintenance all have an index value of 1, and are not only considered as highly adopted but also widely implemented technologies, which is followed by regular sampling and sorting of fish, the prevention and control of fish diseases (0.99), optimum stocking rate, daily sanitation, frequent change of water (0.98) and water test (0.97). These technologies were greater than the weighted mean (0.97), so they are considered as adopted technologies by the farmers in their ponds. Technologies that have seen milder adoption were fingerling production and soil testing before site selection, both with an Index value of 0.964, which was followed by fencing and use of aerators both with an Index value of 0.95. The least adopted technologies were the record-keeping, outlet devices, and fish preservation and storage techniques all with Index values of 0.94. Finally, the technologies that were not adopted by any respondents were techniques of hatchery production and integrated fish farming, both with an Index value of 0.94.

Among the technologies, the adoption of liming practices and fertilization by all respondents coincides with the study of (Neupane and Gharti, 2018). Highly adopted technologies included regular sampling and sorting of fish which coincides with the study of (Salau et al., 2014). Techniques of hatchery production and integrated fish farming were not adopted by all, which was aligned with the study in 2016 where only 2% of the respondents had adopted these technologies (Akangbe et al., 2016)

Table 4: Adoption of improved fish production technologies

Technologies	0	1	Index Value	Rank
Adoption of liming practices	50	0	1	I
Adoption of inlet devices	50	0	1	I
Adoption of aerated containers for transporting fingerlings	50	0	1	I
Adoption of fertilization of fish pond	50	0	1	I
Adoption of improved breeds of fingerlings	50	0	1	I
Adoption of pond maintenance	50	0	1	I
Adoption of regular sampling and sorting of fish	47	3	0.99	II
Adoption of prevention and control of fish diseases	46	4	0.99	II
Adoption of optimum stocking rate	41	9	0.98	III
Adoption of daily sanitation	41	9	0.98	III
Adoption of frequent change of water	39	11	0.98	III
Adoption of water test	26	24	0.97	IV
Adoption of techniques of fingerling production	21	29	0.96	V
Adoption of soil testing before site selection	20	30	0.96	V
Adoption of use of Aerator	15	35	0.95	VI
Adoption of fencing	14	36	0.95	VI
Adoption of record Keeping	8	42	0.94	VII
Adoption of outlet devices	6	44	0.94	VII
Adoption of fish preservation and storage techniques	2	48	0.94	VII
Adoption of integrated fish farming	0	50	0.94	VII
Adoption of techniques of hatchery production	0	50	0.94	VII
Weighted mean			0.97	

Note: 0=Adopters and 1=Non adopters

3.5 Problems in the adoption of improved fish production technology

Table 5: Problems in the adoption of improved fish production technology

Problems	0	1	2	3	Index Value	Rank
High cost of feed	50	0	0	0	1	I
Lack of Commercial hatchery	47	3	0	0	0.99	II
Lack of technician	43	7	0	0	0.98	III
High electricity bill	42	8	0	0	0.98	III
Unavailability of fertilizer on time	34	16	0	0	0.97	IV
Unavailability of feed on time	32	17	1	0	0.96	V
Lack of proper market	22	16	12	0	0.93	VI
Disease outbreak	1	30	15	4	0.88	VII
Illiteracy	1	14	31	4	0.85	VIII
Inadequate Capital	2	20	8	20	0.84	IX
Lack of managerial skill	5	15	8	22	0.84	IX
Lack of extension service	2	17	9	22	0.83	X
Inability to expand pond size	2	1	9	38	0.78	XI
Weighted Mean					0.91	

Note: 0= High, 1= Medium, 2=Low and 3= Not encountered

The problems encountered by the farmers during the implementation of improved technologies are illustrated in Table 5 after analysis by using the problem ranking method. From the table, the high cost of feed, lack of commercial hatcheries, technicians, high electricity bill, unavailability of fertilizer, feed on time, and lack of proper market were considered as major problems as its index value is greater than the weighted mean (0.91). Among them, the most critical constraint for fish farmers was the high cost of feed, ranked first with an Index Value of 1.00. Lack of access to commercial hatcheries ranked second with an Index Value of 0.99. This constraint greatly affected the profitability and growth potential of fish farming operations. The lack of skilled technicians and high electricity costs both ranked third with an Index Value of 0.98. These challenges had significant implications for farm efficiency and operational costs. Unavailability of fertilizer on time ranked fourth with an Index value of 0.97, followed by unavailability of feed on time and lack of a proper market with Index values of 0.96 and 0.93 respectively. Additionally, challenges of lower importance included disease outbreaks, which shared the seventh rank with an Index Value of 0.88, and illiteracy, ranking eighth with an Index value of 0.85. Both capital constraints and the need for improved managerial skills shared the ninth rank with an Index Value of 0.84. While capital availability impacted resource availability, enhancing managerial skills could address specific operational challenges within fish farming. The limited access to extension services ranked tenth with an Index Value of 0.83. This challenge influenced the overall support available to fish farmers. Effective extension services could provide valuable knowledge and guidance for improved farming practices. Finally, the inability to expand pond size ranked eleventh with an Index Value of 0.78 and was not encountered as a significant constraint.

The most severe challenge, the high cost of feed aligned with a few studies, significantly impacted fish farming operations (Neupane and Gharti, 2018; Salau et al., 2014; and Ogunremi and Olatunji, 2020). The lack of skilled technicians was also a high problem in the study by (Omitoyin and Adediran, 2022). Problems related to disease outbreaks, illiteracy, managerial skills, and extension services were also low problem in the study conducted by (Omitoyin and Adediran, 2022).

4. Conclusion and Recommendation

To sum up, the study reveals that the farmers follow adequate improved technology; however, there are some hindrances encountered by the farmers while implementing various improved technologies in their pond. Through this research, we should make specific plans to overcome the difficulties that stop people from adopting this technology. We can help by creating a good learning environment, providing extra help through extension services, improving management skills, and making helpful rules. In addition to this, controlling illegal fish imports, improving feed, fingerling, availability of vitamins and medicines, market management, establishing a nearby lab with skilled technicians, and promoting women's participation in training is needed to bring positive outcomes for the fisheries sector and rural communities.

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