IDENTIFYING THE DIMENSIONS OF PERCEIVED CONSTRAINTS IN THE ADOPTION OF THE INTEGRATED FISH FARMING SYSTEM

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ABSTRACT

Regardless of the Integrated Fish Farming System (IFFS) being more economical and sustainable, its adoption has not been commendable, especially in developing countries like India. In light of these concerns, the current study attempts to understand the barriers to the adoption of IFFS. In addition to the variables of constraints identified through previous literature, other variables were identified and selected by conducting FGDs with experts from the College of Fisheries, Raha, Assam. A total of 504 farmers were chosen for the study using multi-stage sampling approaches in twelve districts that included all six of Assam's Agro-Climatic Zones. Analyzing the data with SPSS, both descriptive and inferential statistics were employed in comprehending the data. To reduce the dimensions of restrictions, Principal Component Analysis (PCA) was used in conjunction with Exploratory Factor Analysis (EFA). Using varimax rotation, the Factor Analysis Model resulted in seven factors of constraints. The model has been found to have a good fit with an acceptable non-residual value. The assessment of such constraints does not only provide a helping hand in disseminating such sustainable agricultural practices but also ensures the sustainable usage of farm waste by making ecological considerations.

Keywords: Perceived Constraints in Adoption, Agro-Climatic Zones of Assam, Integrated Farming System, Integrated Fish Farming System, Sustainability.

I. INTRODUCTION:

According to the agriculture census, India has 2.4 percent of the world's land area to support more than 17 percent of the world population (G.O.I., 2019a). Due to the increase in population, the per capita landholdings are going down. Also, more than 86% of farmers in the country are small and marginal farmers, and they share only 46.94% of the total operated holdings (G.O.I., 2016). There are fewer opportunities for farming to expand horizontally as a result of this declining per capita land (Gill et al., 2009; G.O.I., 2019b). Hence, there is a need for alternatives that would yield more economic benefits to the farmers without horizontal expansion. From the onset of the green revolution, Indian farmers have been adopting single intensive-based farming systems to meet market demand (Kumar et al., 2018). However, an intensive agricultural system like this uses many industrial inputs like pesticides, herbicides, and artificial fertilizers, which have seriously damaged the ecosystem (Landesman, 1994; Gill et al., 2015). This has caused a decrease in productivity in addition to polluting the ecology (Kumar et al., 2018). Such conditions put farmers in more vulnerable positions.

Farmers have been shown to perceive a decline in yield and income as well as an increase in the cost of production in earlier studies (Shankara et al., 2013). According to Nishara (2021), farmers fall into vulnerable situations due to a lack of income source diversification. Hence, there is a need for alternatives that would yield more economic benefits to the farmers by diversifying income sources without horizontal expansion. In response to these concerns, the Indian government launched the National Mission for Sustainable Agriculture (NMSA) in 2010, which aims to encourage farming practices like the Integrated Fish Farming System (ILFFS) by promoting resource conservation and sustainable farming practices. IFFS is a methodical and environmentally conscious way to farm since it incorporates vertical growth while taking the environment into account (Kumar et al., 2018; Gupta et al., 2020). It is a combination of several components with a fish element that work well together. By taking ecological factors into account, it not only achieves economic benefits but also diversifies the source of income. While the rate at which these sustainable farming practices are being adopted in wealthy countries is impressive, in developing countries, the adoption rate has not been particularly noteworthy (Burg et al., 2021). According to an integrated study conducted in Assam by the Department of Biotechnology, the Ministry of Science and Technology, and the Assam Agricultural University, only 29 percent of the trained farmers in Jorhat adopted the Integrated Fish Farming System (Sarma et al., 2011). In this light, the current study was carried out to identify the constraints in the adoption of IFFS.

II. Literature Review:

Although IFS is economically feasible and advantageous, its adoption rate has been limited and uneven. Besides the economic advantages, farmers often face certain constraints in the adoption of IFS. The constraints are diversified in nature. These are based on regions, agro-climatic situations, and societal, political, and economic scenarios. For a broader aspect, the dimensions forwarded by Pandey et al. (2019) could be used in comprehending the constraints. These dimensions were forwarded in regard to the adoption of improved aquaculture systems. The dimensions are financial constraints, marketing constraints, situational constraints, production constraints, and extension constraints. All the constraints identified in the previous literature revolved around these dimensions.

Financial, extension, and situation constraints were predominant in the literature on constraints in the adoption of IFS. This might be because the economic conditions of the farmers are poor and they are located in diverse rural counterparts. Constraints like high implementation costs, lack of labor, and lack of technical know-how were found to be predominant in practicing the integrated crop-livestock-forestry system (Gil et al., 2015). According to Desai et al. (2018), farmers perceived a lack of technical know-how and lack of training as major constraints in Integrated Nutrient Management on the farm (INM). Other constraints—unavailability of farmyard manure, high costs of fertilizer, unavailability of fertilizer, high prices of farmyard manure, lack of finance, unavailability of literature, lack of skilled labor, lack of subsidy, lack of water, and poor quality of fertilizer—were faced by the farmers. According to Pushpa (2010), the major constraints faced by IFS farmers are a lack of coordinated extension service and a lack of onsite demonstration of IFS. On the other hand, erratic power supply, high medication costs, unfavorable agro-climatic conditions, infant mortality, disease outbreaks, and scarcity of human labor were found to be major constraints in the adoption of Integrated Crop Management (ICM) in Chilli Crop (Sowjanya and Kumari, 2017). According to Akshita and Dolli (2020), IFS farmers in Karnataka, India, faced the following constraints: non-availability of inputs in time, high wage rates, lack of technical knowledge, high costs of inputs, and insufficient power supply. The heavy investment in the initial years, lack of expected returns, and non-availability of labor were observed as the major constraints in adopting the integrated farming system by Ponnusamy and Devi (2017). Viswanathan and Shivakoti (2007) found that the labor institutional support system was a major constraint in the practice of the Rubber Integrated Farm-Livelihood System (RIFLS). They believed that most institutions encourage intensive rubber farming, and they found that farmers who were availing of institutional support mainly practiced rubber monoculture. Lack of technical know-how was found to be the most severe constraint by Sabharwal and Sharma (2024). According to Islam et al. (2015), constraints related to landholdings and availability of credit were faced by farmers in Bangladesh in the adoption of the Integrated Rice Fish Farming System (IRFFS). Lack of public awareness has been found to be a significant constraint in practicing IRFFS in Nepal (Gautam et al., 2002). The predominant constraints perceived by IRFFS farmers in Ebonyi State of Nigeria were technical constraints such as inadequate water supply and scarcity of inputs (Onoh et al., 2020).

Literatures on constraints in adoption of improved aquaculture practices were also explored. Bhuyan et al. (2017) recognized seven factors of constraints in adoption of improved aquaculture practices. The factors of constraints were identified as extension, knowledge, financial, infrastructural, physiological, and situational constraints. Pandey and Hijam (2014) explored perceived constraints on the transfer of aquaculture technology in six major dimensions. The study forwarded the sequence of intensity of the dimensions as extensions constraints, administrative constraints, economic constraints, technological constraints, infrastructural constraints, and social constraints. The constraints identified in past studies tend to be bounded by these factors of constraints. Financial constraints were found to be predominant in the literature. The lack of affordable fish feed and the high upfront costs associated with excavating new ponds were identified as the main barriers to the adoption of mixed carp culture in Nagaon, Assam (Bhuyan et al., 2017). The findings complement the study by Miyata and Manatunge (2007) in Java Province, Indonesia, where the farmers faced high initial costs that restrained them from adopting Floating Net Aquaculture (FNA). They also reported the prevalence of high feed costs and high mortality among the mid adopters. Bhuyan et al. (2017) further elaborated that constraints such as high rental costs, lack of expected results, occurrence of floods, low water retention capacity, acidic soil, and lack of adequate agro-climatic situations were predominant among the farmers. In a study by Agbamu and Orhorhoro (2007) in the delta region of the River Niger in Nigeria, it was found that the major constraints were mostly extension-related and financial in nature. The farmers faced inadequate extension service as a major constraint in adopting Aquaculture Management Techniques (AMTs). The study also revealed that farmers faced high costs of new pond construction, hardships in obtaining micro-credit, and high costs of fish feed as major constraints. Other constraints found in the study were high costs of fingerlings, lack of proper water supply, unavailability of quality fish seed, inadequate land space, poaching/theft, inadequate credit facilities, high medication costs, cultural restrictions, unavailability of labor, threats from fish parasites/predators, and fingerling mortality. The farmers also faced inadequate fishery extension services. Another study in Obio, Nigeria, by Ogunremi and Olatunji (2019), found that although the farmers were aware of improved technologies in aquaculture, they did not adopt the practice due to high costs, inadequate capital, erratic power supply, and inaccessibility to credit services. The farmers were also found to face poor market structure and scarcity of labor as constraints to a certain extent in the study area. Farmers in Hafizabad, Pakistan, faced uncertainty in the market and poor extension services by the personnel in the adoption of recommended fish farming practices (Muddasir et al., 2016). The following constraints were also found to be faced by the farmers: lack of information, inadequate soil and water quality, feed adulteration, limited credit facilities, high construction costs, and non-availability of irrigation facilities. According to Pandey and Hijam (2014), fish farmers in Bishnupur district of Manipur perceived poor extension services as constraints in the adoption of advanced technology in fish farming. The farmers perceived that there was a lack of farm visits by the extension personnel and support from the administration. Therefore, from the literature, it could be drawn that financial and extension constraints are predominant in the adoption of improved aquaculture practices.

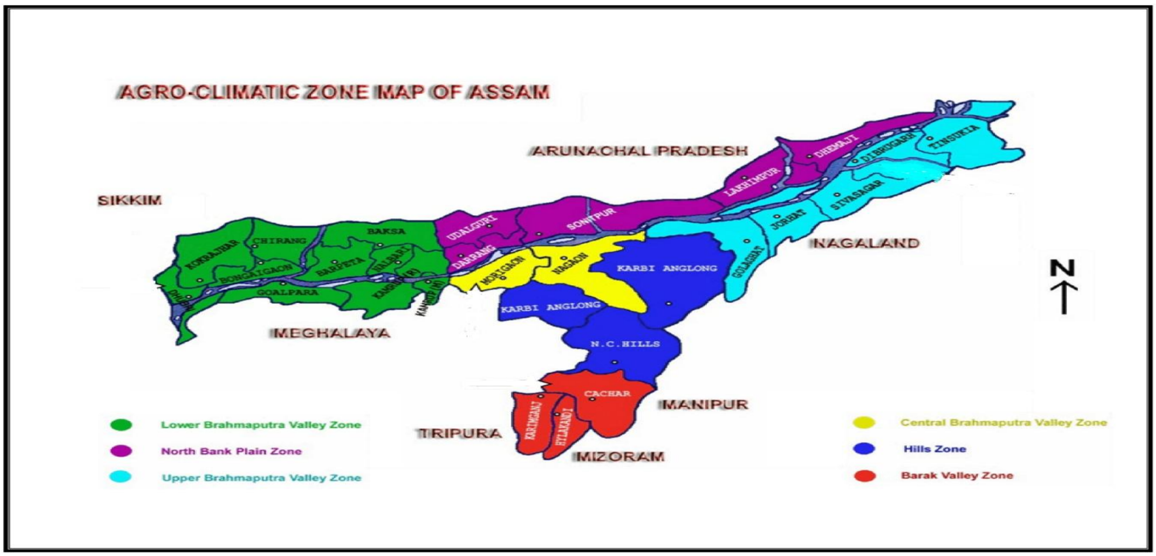
However, most of the studies did not take the potential adopters into consideration. Their perceived constraints and their reasons for not adopting improved technologies are found to be limited in the existing literature. As the literature makes apparent, knowledge and other psychological elements have a role in the adoption of new farming systems in addition to biophysical and economic effectiveness (Flett et al. 2004; Ajayi, 2007). Studies on farmers' perceived constraints in the adoption of IFFS are found to be limited. However, high ILFFS adoption is not only a key economic objective for the government, but it is also a prerequisite for the preservation of ecosystems by empowering farmers to become sustainable. In light of this, the study's goal was to determine the perceived obstacles to the adoption of the Integrated Livestock-Fish Farming System among farmers in Assam's diverse agro-climatic zones (ILFFS).

III. RESEARCH METHODS:

The nature of the current study is descriptive and exploratory. It aims to identify and understand the perceived constraints of the farmers. A multi-stage sampling method has been employed in the study. The population under study consisted of all fish and livestock producers in Assam's six agro-climatic zones (Figure 1). From each agro-climatic zone, the top two fish-producing districts were chosen. The list of farmers enlisted by District Fishery Development Offices and District Animal Husbandry and Veterinary offices constituted the sampling frame. Figure 2 illustrates the methodical selection of 21 fish farmers and 21 livestock farmers from each district, resulting in a total of 504 [{(21+21) x 2} x 6 = 504].

Figure 1

Agro-Climatic Zones of Assam

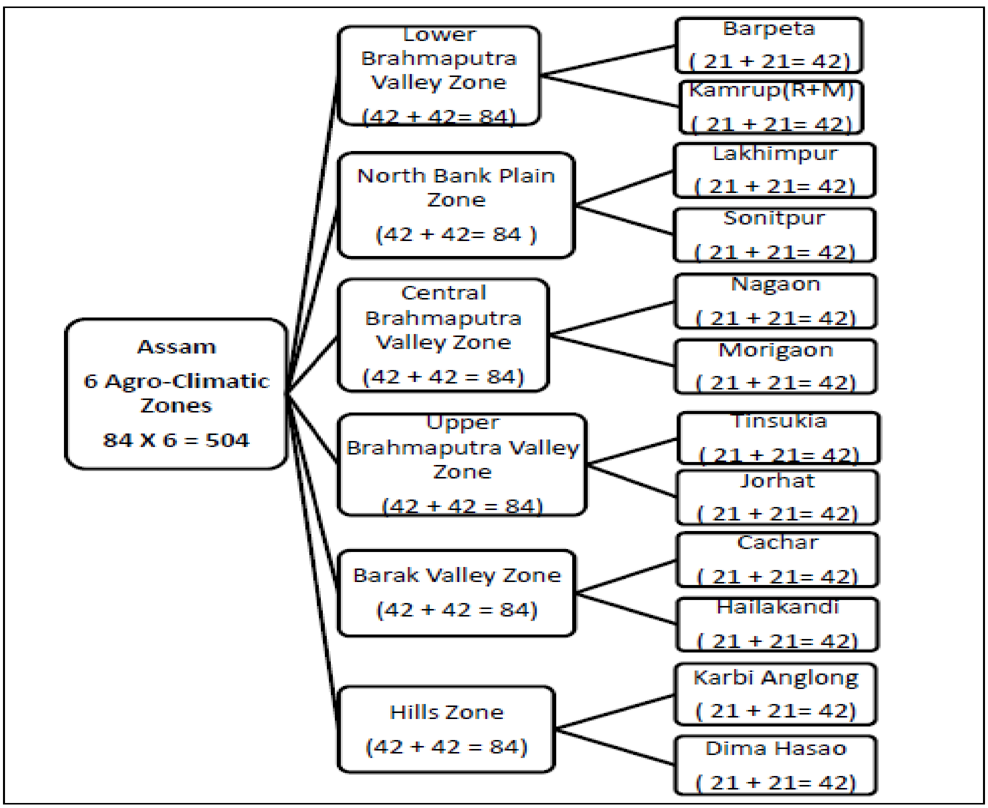


Mandal, 2014

The variables of constraints were recognized from earlier similar studies. For further identification of variables, a Focus Group Discussion (FGD) was also held among the experts of the College of Fisheries (Raha), Assam Agricultural University, Jorhat, India. Another two FGDs were held among fish and livestock farmers in identifying the variables of constraints in the adoption of IFFS. After the FGDs, a total of 47 variables of constraints were selected for further study. The data were collected through an interview schedule and tested for reliability using 60 respondents. For a scale of 1 to 7, where 7 is the greatest, the respondents were asked to rate the intensity of the variables that were a constraint for adoption. The reliability was assessed using Cronbach's Alpha (α) and was found to be 87%. The data collected have been analyzed using the Statistical Package for Social Sciences (SPSS) version 22. Factor analysis was conducted to reduce the dimensions and identify the factors of constraints in the adoption of Integrated Fish Farming System. Principal component analysis in SPSS was used to identify the elements of restrictions through Exploratory Factor Analysis (EFA). The variables (constraints) were retained if the Eigenvalues were larger than 1. Factor loading greater than 0.5 was used to identify and retain factors.

Figure 2

Distribution of Samples



IV. RESULTS:

IV.1 Descriptives:

Upon analyzing the data, it was discovered that farmers lacked understanding regarding the uses of inputs, as evidenced by their mean score of 6.08 and standard deviation of 1.072 (Table 1). Other constraints, like unawareness of government schemes and grants, lack of knowledge in water and waste management, and lack of dissemination of the system, were found to be perceived among the farmers. As it could be observed that such a system is not practiced by fellow farmers, the knowledge level of the farmers might be low, and this makes them skeptical about the particular system of farming. The farmers also perceived a lack of capital, high seed and feed costs, and other prevalent constraints as barriers to adopting ILFFS, as reported in earlier studies of the adoption of sustainable practices. The intensity of constraints such as high rental cost, inadequate farm location, threats from external predators, and unavailability of labor were perceived to be least by the farmers.

Table 1

Constraints in adoption of IFFS

Serial No.	Constraints	Mean	Std. Deviation
1	Lack of Capital	6.00	.535
2	High Cost of Fish Seed	5.59	.718
3	High Cost of Lives1\O651tock Seed	5.61	.717
4	Rare visit of extension personnel	4.93	.782
5	High medication cost	5.02	.535
6	Poor implementation of schemes	3.94	.807
7	High rental cost	1.14	.638
8	Unavailability of veterinary experts	3.95	.818
9	Difficulty in obtaining credit	6.01	.529
10	High initiation cost	5.14	.711
11	High cost of fish feed	5.58	.739
12	High cost of livestock feed	5.61	.729
13	High cost of other inputs	5.04	.568
14	Intensity of unavailability of technical experts	5.92	.790
15	Lack of proper communication and transportation	3.22	.820
16	High wages and labor cost	5.02	.536
17	Inadequate training programs	5.93	.781

18	Lack of follow action by extension personnel	4.97	.829
19	Lack of technical know how	4.60	.736
20	Lack of knowledge in soil, waste and water management	6.06	1.096
21	Lack of knowledge in application of inputs	6.08	1.072
22	Unawareness of govt. schemes	6.06	1.071
23	Low expected return	4.12	1.101
24	Higher risk	5.09	1.085
25	Unavailability of time	4.38	.728
26	Low selling price at farm gate	3.23	.843
27	Unavailability of quality fish seed	5.22	.819
28	Unavailability of quality livestock seed	4.20	.813
29	Lack of adequate physiological condition	3.24	.937
30	Erratic power supply	4.26	.926
31	Lack of dissemination of the system	6.06	1.074
32	Unavailability of other inputs	4.18	.827
33	Frequent disease outbreak	5.26	.924
34	Lack of proper selling platforms	3.22	.814
35	Lack of proper marketing channel	3.21	.812
36	Uncertainty in demand	3.21	.823
37	Low quality retail outlets	4.21	.817
38	Inadequate land space	3.10	.892
39	Unavailability of cold Storage	4.11	.895
40	Threats from external predators	3.24	.932
41	Unavailability of irrigation facilities	4.12	.919
42	Inadequate farm location	3.11	.894
43	Occurrence of flood	5.29	.954
44	Occurrence of drought	3.25	.929
45	Unavailability of labor	3.24	.941
46	Poaching and theft	3.26	.925
47	High mortality rates	5.28	.941

Source: Field Survey

IV.2 Factor Analysis

Factor analysis is a statistical method used to identify underlying relationships between variables (Malhotra and Dash, 2018). It reduces a large number of observed variables into fewer unobserved variables called factors. These factors explain the patterns of correlations within the observed data. Factor analysis is widely used in the fields of social management sciences to identify latent constructs. In the current study, factor analysis was carried out to identify the underlying constructs of constraints in the adoption of IFFS.

IV.2.1: Kaiser-Meyer-Olkin Value (KMO) and Bartlett's Test of Sphericity

Before performing Exploratory Factor Analysis (EFA), the data's suitability was evaluated using the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity. The KMO statistic measures the extent of common variance among the variables. It ranges from 0 to 1, with higher values suggesting that the data is more appropriate for factor analysis. As per Kaiser (1958), a KMO value between 0.00 and 0.49 is deemed unacceptable, 0.50 to 0.59 is considered miserable, 0.60 to 0.69 is mediocre, 0.70 to 0.79 is middling, 0.80 to 0.89 is meritorious, and 0.90 to 1.00 is marvelous. Ideally, ten times the number of variables is desirable in conducting a factor analysis (Worthington & Whittaker, 2006). In the current study, the total sample size was 504, which was more than ten times the total number of variables considered (47 x 10 = 470). Bartlett's test of Sphericity is a test statistic to examine the hypothesis that the variables are uncorrelated in the population. In other words, the population matrix is an identity matrix; each variable correlates perfectly with itself (r=1) but has no correlation with other variables (r=0). The KMO statistic is found to be 0.932 (Table 14), and Bartlett's test is found to be significant ($p< 0.005$) implying that the matrix is not an identical one.

< 0.005), implying that the matrix is not an identical one.

Table 14

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.932
Bartlett's Test of Sphericity	Approx. Chi-Square	55415.221
	dfp	1081
	Sig.	.000

IV.2.2: Communalities

Communality is the amount of variance a variable shares with all the other variables being considered (Malhotra and Dash, 2018). This is also the proportion of variance explained by the common factors. Small values indicate that the variable does not fit well with the factor solution and should be dropped from further analysis. Normally, values less than 0.50 are removed, with an ideal score being 0.7 and above (Child, 2006). In the current study, a variable (High Rental Cost) had a value of 0.020; therefore, it was removed from further analysis. Communality values ranged from 0.615 to 0.992 (Table 15), showing that the variables were well represented. The communalities of the other variables are presented in Table 2.

Table 2

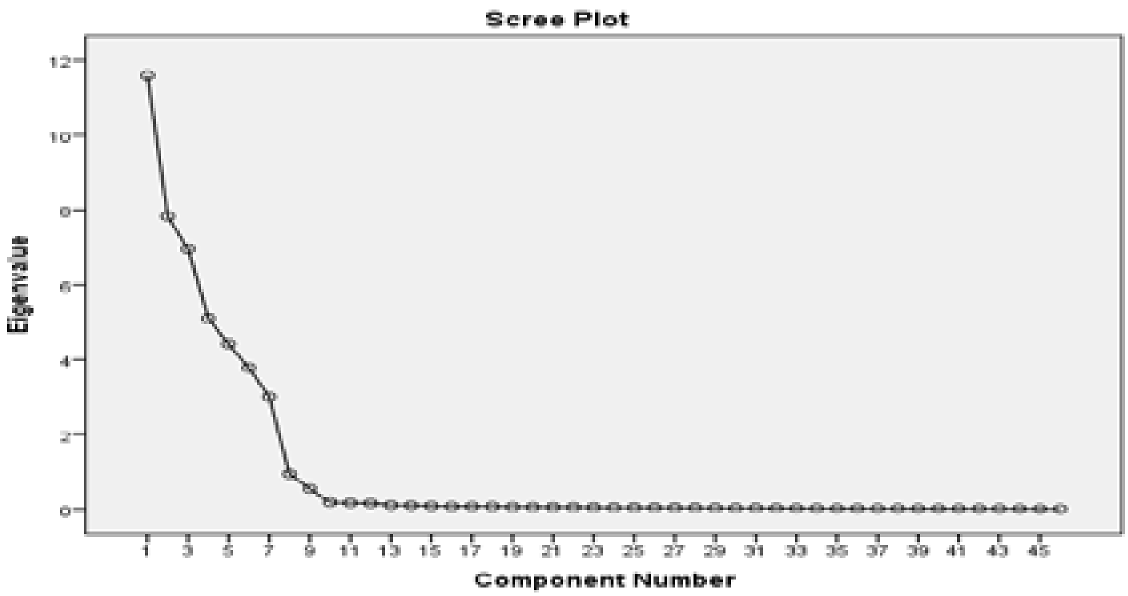
Communalities

Variables	Initial	Extraction
Inadequate capital	1.000	.709
Difficulty in obtaining credit	1.000	.910
High wages and labor cost	1.000	.846
High cost of Fish seed	1.000	.838
High cost of livestock seed	1.000	.841
High medication cost	1.000	.832
High maintenance cost	1.000	.615
High cost of fish feed	1.000	.781
High cost of livestock feed	1.000	.838
High initiation cost	1.000	.800
Unavailability of Veterinary experts	1.000	.927
Unavailability of technical experts	1.000	.964
Rare visit of extension personnel	1.000	.971
Inadequate training programs	1.000	.952
Poor implementation of schemes	1.000	.936
Lack of follow action by extension personnel	1.000	.888
Lack of technical know how	1.000	.878
Lack of soil, waste and water management	1.000	.956
Lack of knowledge about application of inputs	1.000	.986
Low expected return	1.000	.950
Higher perceived risk	1.000	.966
lack of dissemination of the technology	1.000	.988
Unawareness of govt. schemes	1.000	.984
Unavailability of time	1.000	.914
Unavailability of quality fish seed	1.000	.980
Unavailability of quality livestock seed	1.000	.992
Low selling price at farm gate	1.000	.939
Unavailability of inputs	1.000	.965

Lack of proper selling platforms	1.000	.964
Lack of proper marketing channel	1.000	.982
Lack of proper communication and transportation	1.000	.984
Uncertainty in demand	1.000	.983
Low quality retail outlets	1.000	.984
Inadequate land space	1.000	.985
Unavailability of cold Storage facilities	1.000	.983
Unavailability of irrigation facilities	1.000	.958
Inadequate farm location	1.000	.979
Erratic power supply	1.000	.979
Occurrence of flood	1.000	.938
Occurrence of drought	1.000	.983
Lack of adequate physiological condition	1.000	.976
Unavailability of labor	1.000	.962
Poaching and theft	1.000	.985
Frequent disease outbreak	1.000	.984
Threats from external predators	1.000	.977
High mortality rates	1.000	.937
Extraction Method: Principal Component Analysis.		

Figure 3

Scree Plot



IV.2.3 Extraction and Rotation Method:

As the aim of the study was to explore and reduce the dimensions of constraints and to identify the factors, extraction was done using the Principal Components Method. The factors are assumed to be not correlated, and therefore an orthogonal rotation method—varimax—was employed (Malhotra and Dash, 2018). All factor loadings were suppressed to less than 0.5. The scree plot and the eigenvalues were used to calculate the number of factors that needed to be retained. Most statistical software packages retain all factors with eigenvalues larger than 1.0 as default (Costello & Osborne, 2005). Velicer's MAP criteria, parallel analysis, and scree plots are additional methods to identify the number offactors. The number of factorsthat needed to be retainedwas ascertained using the scree plot. It is one of the simplest, most reliable, and most used methods for figuring out how many factorsto retain. The scree test uses a graphic analysis of the eigenvalue to pinpoint the data's inherent bend or break, or the point at which the curve levels off. Sevenconstraint factors were retainedin total, according to the eigenvalue and scree test analysis. These factors explained 92 percent (Table 16) of the variance, which is above the cut-off range (Streiner, 1994).

Table 3

Rotated Component Matrix

variables	components							Cronbach Alpha (α)
	1	2	3	4	5	6	7	
Unavailability of quality fish seed	.989							0.987
Unavailability of inputs	.964							
Lack of proper selling platforms	.963							
Unavailability of quality livestock seed	.955							
Low quality retail outlets	.950							
Lack of proper communication and transportation	.923							
Uncertainty in demand	.922							
Lack of proper marketing channel	.920							
Low selling price at farm gate	.897							

Erratic power supply		.977						0.972
Unavailability of labor		.976						
External predators		.923						
High mortality rates		.901						
Poaching and theft		.890						
Frequent disease outbreak		.890						
Occurrence of drought		.890						
Lack of adequate physiological condition		.885						
Occurrence of flood		.817						
Higher risk perception			.980					0.978
Lack of knowledge about application of inputs			.980					
Unawareness of govt. schemes			.979					
Lack of knowledge in soil,waste and water management			.965					
Lack of dissemination of the technology			.947					
Lack of technical know how			.912					
Unavailability of time			.878					
Low expected return			.820					
Difficulty in obtaining credit				.928				0.952
High wages and labor cost				.888				
High cost of livestock seed				.879				
High cost of Fish seed				.877				
High cost of other inputs				.869				
Inadequate capital				.832				
High maintenance cost				.778				

Rare visit of extension personnel					.931			0.946
Unavailability of Technical experts					.929			
Inadequate training prograames					.919			
Lack of follow action by extension personnel					.884			
Poor implementation of schemes					.878			
Unavailability of Veterinary experts					.765			
High medication cost						.872		0.889
High cost of livestock feed						.831		
High cost of fish feed						.798		
Inadequate land space							.989	0.966
Unavailability of cold Storage facilities							.981	
Unavailability of irrigation facilities							.974	
Inadequate farm location							.855	

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.a
a. Rotation converged in 6 iterations.

IV. 2.4. Factor Solution:

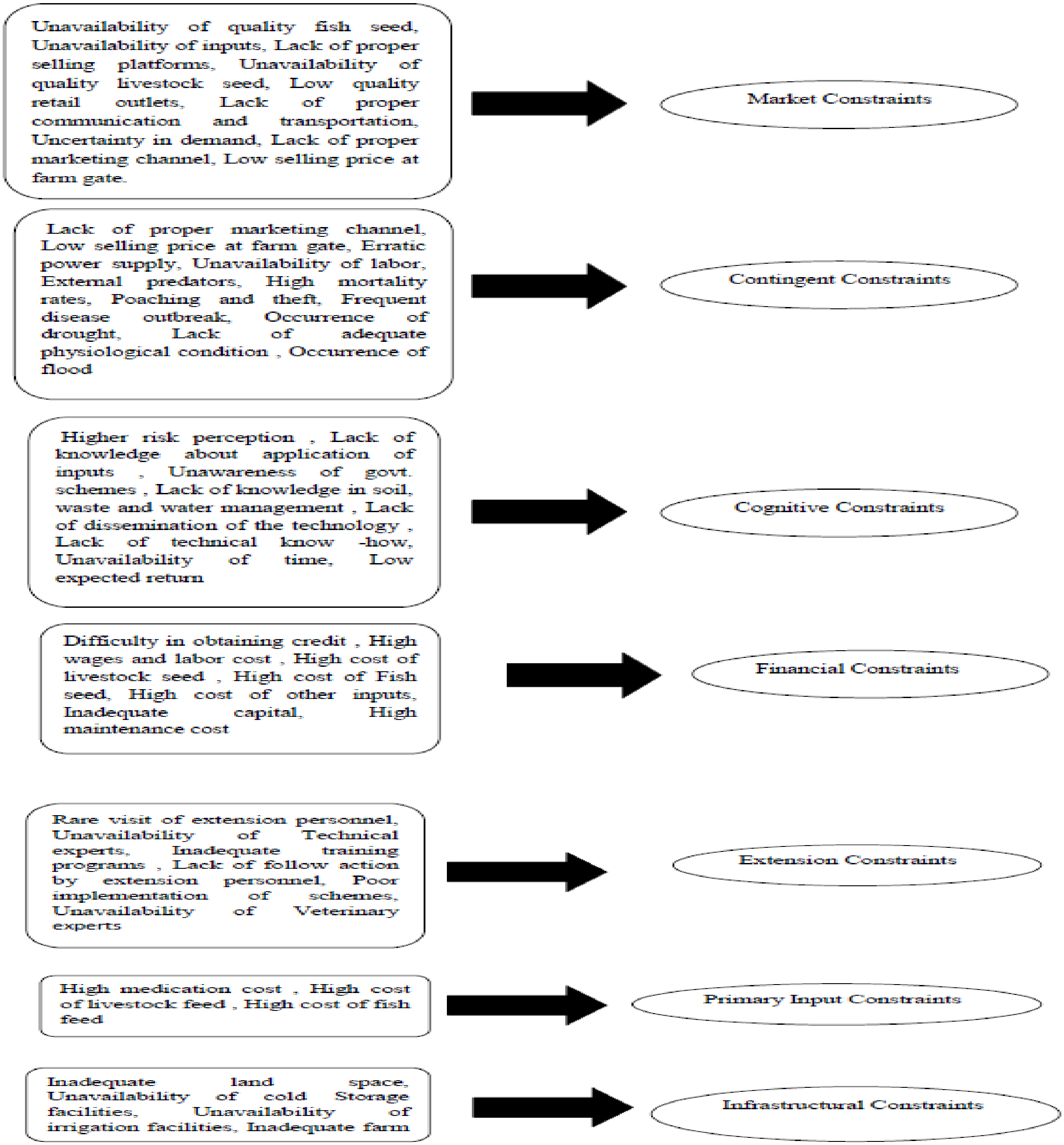
Based on the nature of the variables and their interrelations, the identified seven factors were extracted (Table 17). These are named as Market Constraints, Contingent Constraints, Cognitive Constraints, Financial Constraints, Extension Constraints, Primary Input Constraints, and Infrastructural Constraints. These are discussed in the following section.

DISCUSSIONS:

The factor analysis provided a seven-factor solution. Based on the nature of the variables and their interrelations, the identified seven factors were named as Market Constraints, Contingent Constraints, Cognitive Constraints, Financial Constraints, Extension Constraints, Primary Input Constraints, and Infrastructural Constraints. These are discussed in the following section.

Figure 4

Factors of Constraints. in the adoption of IFFS



Market Constraints: Variables revolving around market issues like the lack of proper selling platforms, the lack of proper marketing channels, uncertainty in demand, low-quality retail outlets for inputs, unavailability of inputs, l'ack of proper communication and transportation, low selling prices at the farm gate, and unavailability of quality livestock and fish seed were loaded in this factor. All the variables were found to be related to the flow of inputs and outputs of the farm. Among them, the farmers perceived 'unavailability of quality fish and livestock seed' as a constraint with the most intensity in the adoption of IFFS. This might be because of the fewer number of hatcheries near the farmlands. As the seed/fingerlings are transported through unorganized retailers in conventional methods through normal containers, the quality of the seed degrades and gets contaminated. According to certain farmers, such degradation could not be observed through the physical appearance of the seed. This further intensifies the constraints of quality seed. Similar findings were reported by Pandey et al. (2019) in the adoption of the integrated farming system. The farmers of the current study were also found to perceive the unavailability of other farm inputs such as tools and equipment as a constraint in the adoption of the technology. The intensity of the other constraints was found to be perceived moderately by the farmers of the study region.

Contingent Constraints: This factor included nine variables of conMstraints related to physiological and social issues. They are the occurrence of flood, frequent disease outbreaks, lack of adequate physiological conditions, erratic power supply, occurrence of drought, unavailability of labor, poaching and theft, high mortality rates, and threats from external predators. Considering its relevance, the variables of this factor were found to be situational or incidental in nature. Therefore, this factor was named contingent constraints. Among these, the intensity of frequent disease outbreaks and high mortality rates were found to be most prominent among the farmers. The concern for disease outbreaks was especially significant for livestock farmers. During the survey, they reported disappointments due to Foot and Mouth Disease (FMD) and African Swine Flu (ASF). This might also be due to the low quality of the seed, as reported in the earlier factor. The disease-resistant capacity of the seed might be low. Similar findings were reported by Miyata and Manatunge (2004), where "sudden deaths" were found to be a major constraint in the adoption of Floating Net Aquaculture (FNA). The intensity of the occurrence of floods and erratic power supply were also found to be of high intensity among the farmers. Since most of the agricultural lands in the study area (Assam) are situated in the floodplains of the Brahmaputra and Barak Rivers and their tributaries, it is evident that the farmers in the region encounter floods. Regarding erratic power supply, the farmers were found to be concerned during the monsoon period. This complements the findings of Ogrunemi and Olatunji (2019), where they reported erratic power supply as a major constraint in the adoption of fish farming technologies in local government areas of Rivers State, Nigeria. This also complements the findings of Sowjanya and Kumari (2017), where power cuts were identified as a major constraint in the adoption of Integrated Crop Management (ICM) in chili crops. The intensity of the other constraints of this factor was found to be moderately perceived by the farmers. However, the unavailability of labor was found to be a major constraint in the adoption of Integrated Crop-Livestock-Forestry Systems (ICLF) in Brazil (Gil et al., 2015).

Cognitive Constraints: Constraints related to the knowledge and awareness of the farmers are concentrated in this factor. It includes variables like lack of technical know-how, lack of knowledge in the application of inputs, unawareness of government schemes, low expected return, higher perceived risk, unavailability of time, and lack of dissemination of the system amongst the farmers. Considering their nature in limitations to human resources, this factor was termed as cognitive constraint. The intensity of all the variables as constraints was found to be high. The most intensely perceived by the farmers was the application of inputs. They were found to be concerned regarding the organic wastewater ration and the treatment of livestock waste. The farmers also perceived water quality management as a major constraint in the adoption of the system. This complements the findings of Gil et al. (2015), Desai et al. (2018), and Akshita and Dolli (2020). This also complements the findings of Sabharwal and Sharma (2024), where farmers were found to lack knowledge about the balanced use of pesticides and fertilizers in Integrated Farming System (IFS). Unawareness of government initiatives was also perceived to be a major constraint in the current study. During the survey, a few farmers reported that the circulation of messages on government schemes is confined to only the friends and family of certain influential individuals. Lack of awareness was also found to be the main reason for not adopting the rice-fish farming system in Nepal (Gautam et al., 2002). Similar findings were reported by Muddassir et al. (2016), where farmers faced a lack of information as a major constraint in the adoption of recommended fish farming practices. The farmers were also found to perceive higher risk and low return compared to single intensive farming. They were concerned about the additional costs associated with the new component. They were also skeptical about the increased productivity of the existing component as compared to the single intensive farming system. This complements the findings of Ponnusamy and Devi (2017), where 'lack of expected return' was found to be a major constraint in Integrated Farming System (IFS). According to Miyata and Manatunge (2004), the main reason a farmer adopts a technology is when they see others' success with the new system or technology. It was also noted during the survey that the dissemination of IFFS was not well, and farmers are well accustomed to the particular system of farming. This might be the reason why they perceive the lack of practice by fellow farmers as a constraint in the adoption of Integrated Fish Farming System (IFFS). The farmers also believed that the additional component would require more of their time and attention. Therefore, they perceived unavailability of time as a major constraint in the adoption of the system. This finding contrasts with the findings of Sabharwal and Sharma (2024), where 'lack of time' was found to be an insignificant constraint in IFS.

Financial Constraints: It included variables related to cost and capital constraints in the adoption of ILFFS. A total of seven variables were found to be loaded in this factor. They are high medication cost, high initiation cost, difficulty in obtaining credit, high cost of other inputs, and high wages and high labor cost. This factor was named financial constraints. The intensity of all the variables in this factor was found to be high amongst the farmers. Among these, the intensity of difficulty in obtaining credit and inadequate capital was found to be the highest among the farmers. As most of the farmers were found to be less educated and living in vulnerable economic conditions, such constraints become evident. The farmers also perceived that the high initiation cost restrains them from adopting the particular system of farming. Similar findings were reported by most of the previous studies that farmers faced inadequate capital and difficulty in obtaining credit in the adoption of farming technology (Gil et al., 2015; Ponnusamy and Devi, 2017; Pandey et al., 2019). The cost of seed and feed was also perceived to be high and acted as major constraints in the adoption of the particular system of farming. This complements the study by Desai et al. (2018), where the farmers were found to face high costs of inputs as a major constraint in the adoption of Integrated Nutrient Management (INM). However, it was found to be a minor constraint by Ogunremi and Olatunji (2019) while exploring the constraints in the adoption of fish farming technologies. Comparing the financial constraints across all the agro-climatic regions, it was found that farmers in the Hills Zone perceived financial constraints to a greater extent compared to farmers from other zones. This might be because most of the farmers in the Hills Zone were found to be living in rural areas and have limited access to external resources and information due to the harsh terrains.

Extension Constraints: It included constraints related to extension aspects such as the rare visit of extension personnel, poor implementation of schemes, unavailability of veterinary experts, unavailability of technical experts, inadequate training programs, and lacking subsequent actions by extension personnel. Therefore, this factor was termed extension constraints. The intensity of all the constraints of this factor was found to be high. This complements the findings of Pandey and Hijam (2014) and Desai et al. (2018) in the context of the transfer/adoption of aquaculture technologies. Among the variables, inadequate training programs and unavailability of technical experts were perceived to be major constraints by the farmers. During the survey, it was noted that though the farmers received training on a single intensive farming system, they lacked training in IFSs. A similar incidence of poor extension services, lack of coordination among extension institutions, and lack of on-site demonstrations was reported by Puspa (2010). However, according to Ogunremi and Olatunji (2019), extension constraints were found to be minor in nature in the adoption of fish farming technologies. This might be because the performance of extension activities might differ by region. Similarly, in the current study, the results of the comparison analysis revealed that the constraints of the rare visit of extension personnel, unavailability of technical experts, and poor implementation of schemes were significantly lower in the Central Brahmaputra Valley Zone compared to the Hills and Barak Valley Zones. The results of the comparison analysis also revealed that the constraint of unavailability of veterinary experts was significantly higher in Barak Valley compared to the Central and Lower Brahmaputra Valley Zones.

Primary Input Constraints: A total of three variables were loaded in this factor. They include high cost of fish feed, high cost of livestock feed, and high medication cost. Examining the variables and considering their relevance to the particular farming system, it was termed primary input constraints. All three variables were found to be constraints of high intensity. The intensity of the high fish feed cost was found to be the most significant, followed by high livestock feed and high medication cost. This complements the findings of Bhuyan et al. (2017) in the context of adopting mixed carp culture in Assam, India. Similar findings were revealed in a study by Sowjanya and Kumari (2017), where farmers faced high medication costs as a major constraint in the adoption of Integrated Crop Management (ICM) in chili crops. The intensity of high fish feed cost as a constraint was perceived to be greater by livestock farmers compared to fish farmers. This might be because livestock farmers are well accustomed to the economics of fish farming.

Infrastructural Constraints: This factor included variables like inadequate land space, unavailability of irrigation facilities, and inadequate farm location. This shows that such variables revolved around farmers' assets and resources. Therefore, this factor has been termed Infrastructural Constraints. All the constraints in this factor were perceived to be of moderate intensity by the farmers in the study area. This aligns with the findings of Pandey and Hijam (2014), where the intensity of infrastructural constraints was found to be not significant in the transfer or adoption of fish farming technologies. The findings also complement the study by Desai et al. (2018), where lack of irrigation was not found to be significant in the adoption of Integrated Nutrient Management (INM). However, lack of irrigation was identified as a major constraint in the adoption of IFS by Gautam et al. (2002) and Pandey et al. (2019). This might be because most of the farmers are dwelling in the floodplains of the Brahmaputra and Barak rivers and their tributaries. Therefore, they might have perceived the lack of irrigation as a less intensive constraint. The difference in intensity among the types of farmers and agro-climatic zones was tested, and it was not found to be significant.

Thus, the constraints in the adoption of the Integrated Fish Farming System (IFFS) could be comprehended through seven factors: Marketing Constraints, Contingent Constraints, Cognitive Constraints, Financial Constraints, Extension Constraints, Primary Input Constraints, and Infrastructural Constraints. Understanding the farmers' perceived constraints through these dimensions would aid in mitigating the issues. This would enable and enhance the adoption of the particular system of farming.

V. CONCLUSION:

The study contributes to the knowledge of understanding farmers' behavior for better dissemination of sustainable farming systems. Constraints revolving around knowledge and awareness of ILFFS are found to be predominant among the fish and livestock farmers. Although they had an idea about the particular system of farming, they lacked knowledge regarding the application of inputs. They were also found to lack knowledge of waste and water management. Some of the farmers are even skeptical about the productivity of the system. Certain training campaigns need to be carried out by the concerned authority. Such programs should be designed with the dissemination of technical knowledge among the farmers in mind. Other financial constraints are also found to be prevalent among the farmers. The factor analysis resulted in seven dimensions of constraints: Market Constraints, Contingent Constraints, Human and Knowledge Constraints, Financial Constraints, Extension Constraints, Primary Input Constraints, and Infrastructural Constraints. Hence, the constraints hindering the farmers in the adoption of ILFF could be explored through these seven dimensions. The assessment of such constraints does not only provide a helping hand in disseminating sustainable agricultural practices but also ensures sustainable usage of farm wastes by making ecological considerations. Similar studies on different forms of Integrated Farming System across other climatic zones of the world could pave the way towards sustainable agriculture.

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