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TEMPORAL CHANGE OF RELATIVE HUMIDITY AND RAIN ELEMENTS AND THEIR RELATIONSHIP TO FISH PRODUCTION IN THE CITY OF HILLA FOR THE PERIOD (1990-2023)

Dr. Marwa Mohammed Jouda AL-AMEEDI [1]

University of Babylon, Iraq

Researcher. Zinah Salih Mahdi AL-MAMOORI [2]

University of Babylon, Iraq

Researcher. Zahraa Flaih HASSAN [3]

University of Babylon, Iraq

Abstract

The research that is the subject of the study explains the temporal change of the two elements (Humidity and Rain) with an explanation of the type and nature of the relationship to fish production in the city of Hilla in light of these changes, based on the relative humidity and rain data available by the General Authority for Meteorology and Seismic Monitoring (G. A. f. M. a. S.M.) for the period of time (1990-2023) and data related to fish production provided by the Babylon Agriculture Directorate/Fish Division for the year 2023, the research reached a detailed set of conclusions that explain the effects of the temporal changes of the two elements discussed in the study on fish production in the city of Hilla and for the period studied. It was found that there was a noticeable change in production during the study period, as it began to trend toward a decline as a result of the decline in air humidity and rain rates, which This, in turn, is reflected in surface water discharges, which in turn affect cultivated areas and the productivity of agricultural crops that are used as feed for fish, as their extent also varies throughout the study area.

Key Words: *Time Change - Relative Humidity - Rain - Fish Production.*

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[1] mmj9164@gmail.com
[2] zeenasalih33@gmail.com
[3] zhrtalzynt@gmail.com

Introduction

The rates of two climatic elements—relative humidity and rainfall—fluctuate throughout the seasons of the year. This variation significantly impacts fish wealth, either directly or indirectly. Any increase or decrease in these elements can threaten fish production and reproduction if their values change drastically. Indirect effects include the spread of microbes, bacteria, and viruses in fish habitats, whether in lakes or rivers.

This study aims to explore rational and effective solutions that align with environmental and material factors, as well as climatic changes, to overcome obstacles in fish wealth development and productivity. Additionally, it seeks to forecast the future of this vital sector, given its importance in national economic stability and its role in achieving self-sufficiency for the population.

Study Problem

- Is there a temporal change in the values of relative humidity and rainfall in the city of Al-Hilla during the period 1990-2023, and what is the nature of this change?

- Is there a change in fish production in Al-Hilla during the period 1990-2023, and what is the nature of this change?

- What is the type and nature of the relationship between relative humidity, rainfall, and fish production in Al-Hilla during the period 1990-2023?

Study Hypothesis

- There is a temporal change in the values of relative humidity and rainfall in Al-Hilla during 1990-2023.

- There is a change in fish production in Al-Hilla during 1990-2023.

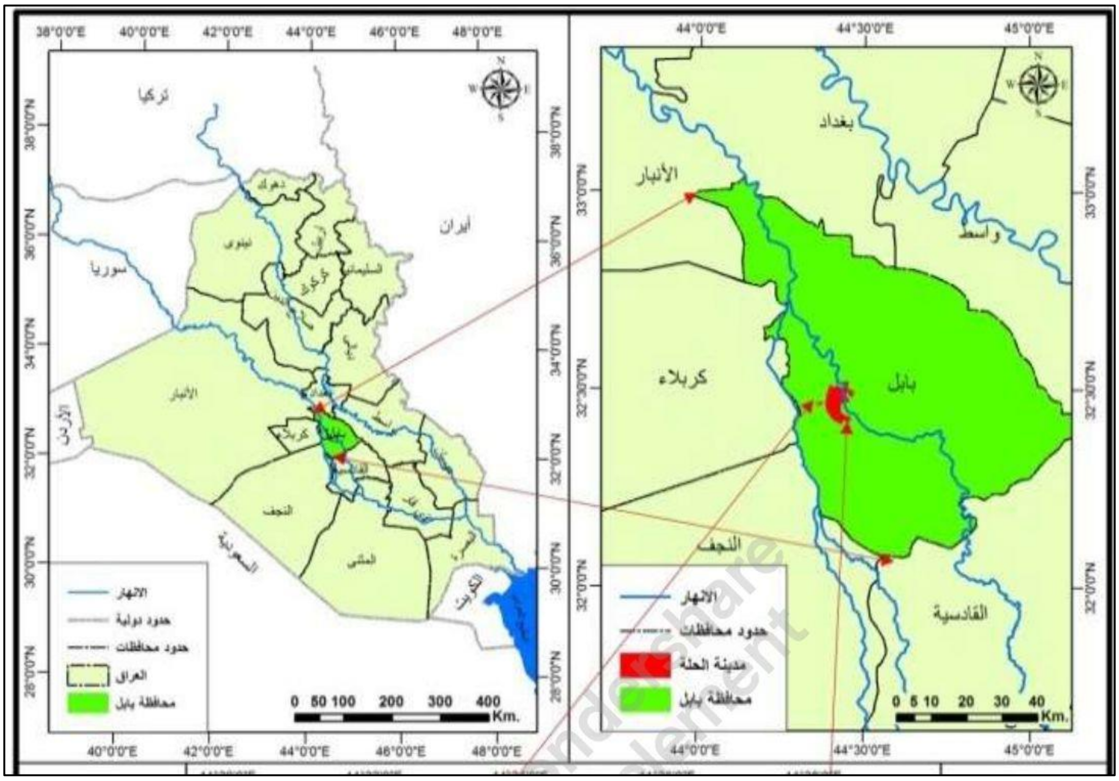
-There is a very weak positive correlation between relative humidity and fish production in Al-Hilla, while a strong positive correlation exists between rainfall and fish production in the city

Location and Boundaries of the Study Area

Spatial Boundaries

The city of Al-Hilla is located at the intersection of latitude (29–°32) North and longitude (26–°44) East. It serves as the center of Babil Governorate, giving it a strategic identity as a link between Iraqi provinces. Positioned at the crossroads of major land transport routes, Al-Hilla plays a vital role in regional connectivity.

The city is approximately 35km away from Al-Qasim District, 25km from Al-Mahawil District, 15km from Abu Gharaq Subdistrict, and 30km from Al-Kifl District. It covers a total area of 161km², representing part of Babil Governorate, and includes 97residential neighborhoods (Map 1).



Map (1) Location of the city of Hillah in Babylon Governorate and Iraq

Source: Based on the Republic of Iraq, Ministry of Water Resources, General Directorate of Survey, Map Production Department, Administrative Units Map at a scale of 1:500,000for the year 2016, using Arc GIS 10software.

As for the time limits

The temporal boundaries: The researcher relied on climate data spanning 34years (2023-1990) concerning relative humidity and rainfall, provided by the General Authority for Meteorology and Seismic Monitoring (G.A.F.M.A.S.M.). This extended period was chosen as it exceeds a full climate cycle, allowing for a clearer analysis of temporal changes in the studied climatic variables. The longer the time span, the more evident climate variations become. Additionally, fish production data for the same period (2023-1990) was utilized, sourced from the Babil Agriculture Directorate / Fish and Hatchery Division (B.A.D.F.A.H.D.).

Research objective

The research objective is to analyze the temporal change in the average values of relative humidity and rainfall and their impact on fish production in Hilla city. This is achieved by measuring the variations in their average values, identifying the nature of their relationship, and assessing the possibility of predicting future trends. The study aims to contribute valuable information to the scientific library, providing a reliable reference for future researchers.

Chapter One: Temporal Change in the Average Values of Relative Humidity and Rainfall in the Study Area(2023-1990)

First: Relative Humidity

Relative humidity represents the actual amount of water vapor present in the air under specific pressure and temperature conditions, compared to the maximum amount of vapor the air can hold under the same conditions[4].

It reflects the air's capacity and energy to lift water vapor.

There is a direct relationship between relative humidity and precipitation, where relative humidity increases as actual precipitation values rise. Several factors influence relative humidity levels, including proximity to water bodies and temperature variations. Relative humidity has a negative correlation with temperature—when temperature increases, relative humidity decreases accordingly**,** Due to the activity of the evaporation process, relative humidity levels are influenced significantly[5]. Additionally, wet winds play an active role in increasing air humidity levels, as there is a clear direct relationship between them. Since the study area is part of central Iraq, relative humidity values tend to be lower compared to the southern region, which is affected by the Arabian Gulf[6].

The general trend of relative humidity has shown a declining pattern, as indicated by Table (1) and Figure (1). The rate of change has decreased by -201.0%. The Hilla station recorded the highest relative humidity in 2004, reaching 8.52%, while the lowest relative humidity was recorded in 2010, at 7.42%.

This decline may be attributed to several factors, including the influence of atmospheric depressions, the activity of ascending air currents, air movement disturbances, rising temperature levels, and reduced precipitation. The actual values of precipitation have decreased, leading to a further drop in relative humidity levels.

Table (1) Annual rates of relative humidity and rainfall values in the city of Hillah for the period(2023-1990)

Rainfall \MM	Relative Humidity (%)	year
47.4	6,43	1990
50.1	5,49	1991
131.1	50	1992
114.7	4,50	1993
123.5	8,51	1994
97.6	4,52	1995

1) Youssef Abdel Majeed Fayed, Geography of Climate and Plants, st ed., Dar Al Nahda Al Arabiya, Beirut, 2002, p. .72

1) Salam Hatem Ahmed Al-Jabouri, Applied Climatology, 1st edition, Baghdad University Library, Baghdad, 2014 AD, p. 169.

2) Abbas Fadhel Al-Saadi, Geography of Iraq - Its Natural Framework - Its Economic Activity - Its Human Aspect, 1st ed., Dar Al-Jamiah for Printing, Baghdad, 2008, p. 61.

120.1	1,51	1996
98.7	54	1997
95.8	3,52	1998
65.3	2,50	1999
85.3	2,50	2000
81.3	49	2001
102.8	47	2002
144.5	8,50	2003
71.1	8,52	2004
73.2	52	2005
70.3	6,52	2006
41	6,50	2007
51.8	7,47	2008
52.4	7,47	2009
87.3	7,42	2010
80.3	8,44	2011
62.56	3,43	2012
82.9	5,45	2013
125	2,45	2014
88.4	1,43	2015
89.4	2,45	2016
69.8	4,43	2017
80.1	5,48	2018
89	48	2019
87.2	5,49	2020
60.6	44	2021
60.3	4,44	2022
60.1	3,44	2023
99.6	**2,48**	المعدل

Source: Republic of Iraq, Ministry of Transport and Communications, General Authority of Meteorology and Seismic Monitoring, Climate Department, unpublished data for .2023

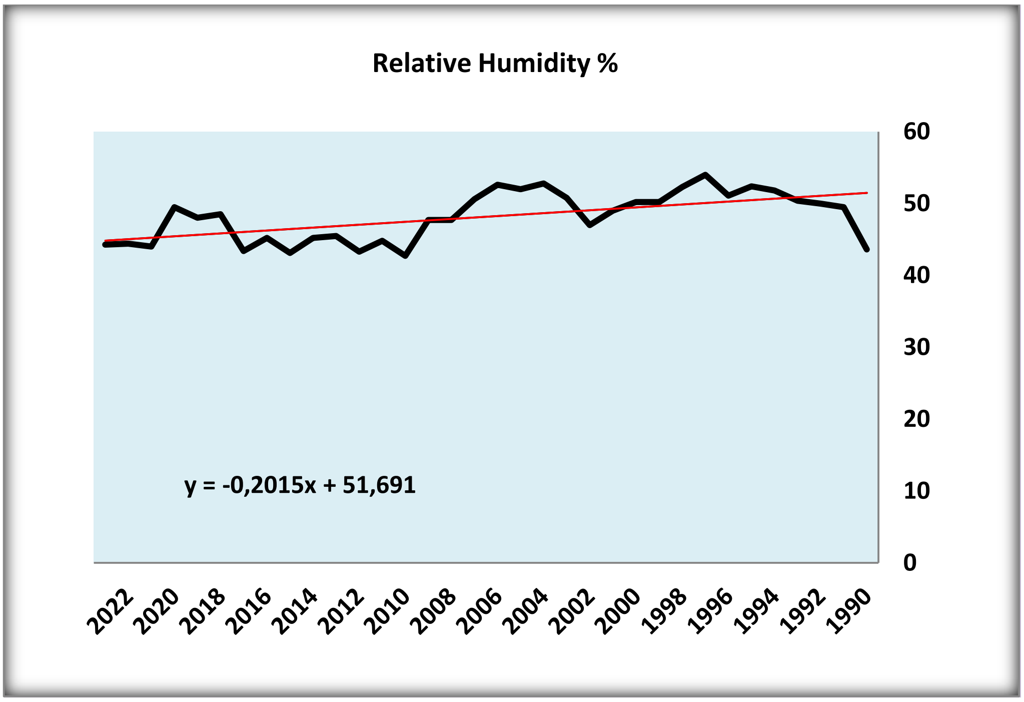


Figure (1) The general annual trend of relative humidity rates(%)

Source: The researchers' work based on Table.(1)

Second: Rainfall

Rain consists of water droplets of varying sizes[7], and its occurrence is influenced by physical factors such as temperature decrease, increased water vapor levels in the air, and the presence of condensation nuclei—tiny particles of dust, organic matter, or minerals suspended in the atmosphere, around which water droplets accumulate.

Rainfall in Iraq follows the Mediterranean system, meaning its occurrence is linked to low-pressure systems originating from the Mediterranean Sea, which are further influenced by low-pressure zones over the Arabian Gulf[8]. Consequently, the rainfall characteristics in Hilla city are similar to those across Iraq, marked by seasonal precipitation and fluctuations during winter and transitional seasons Rainfall rates vary from year to year, in addition to the presence of a dry, stable, and consistent system represented by the summer season.

As shown in Table (1) and Figure (2), rainfall levels (mm) have declined, with a negative rate of change (-734.0 mm) recorded at Hilla station during the study period. The highest annual rainfall was recorded in 2003, reaching 5,144 mm, while the lowest annual rainfall was recorded in 2007, at 41 mm.

[7]) Qusay Abdul Majeed Al-Samarra'i, Principles of Weather and Climate, 1st ed., Al-Yazouri Printing and Publishing House, Amman, 2008, p. 147.
[8]) Abdullah Salem, Abdul Imam Nassar Dery, "Estimating the Climate Water Balance in Iraq (A Study in Applied Climatology)", University of Basra, Basra Journal of Arts, Issue 38, p. 177, 2005.

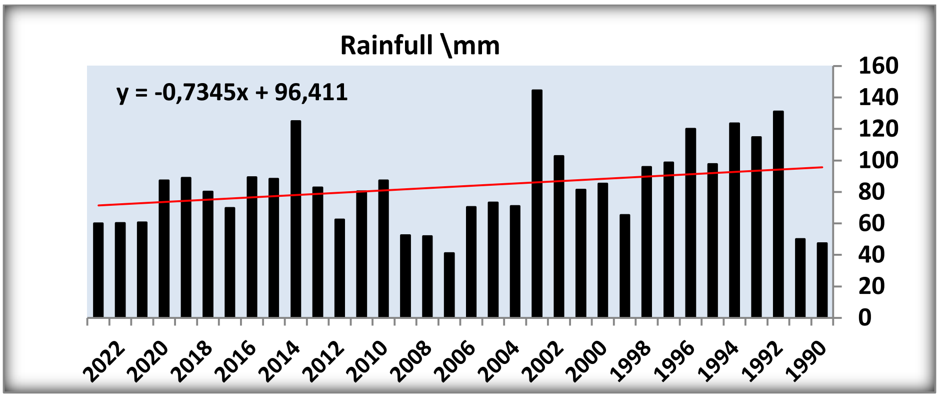


Figure (2) The general annual trend of rainfall rates (mm)

Source: The researchers' work based on Table.(1)

Chapter Two: Fish Production in Hilla City (2023-1990)

First: Fish

Fish are among the most important sources of nutrition, rich in animal protein, which itself contains large amounts of essential amino acids that humans require in their diet[9].

To achieve high growth rates, fish need high-quality feed sources. They also require larger amounts of protein compared to other aquatic organisms while needing less dietary energy to maximize protein and amino acid availability for human consumption (Image 1). Fish require between 25-56% protein in their diet, depending on fish farming systems, including stocking density, water exchange rates in ponds, water temperature, and fish species[10].

Image (1) Fish production in Hillah city

Source: Field visit/ Hilla Grand Market/ dated.(2024/20/11)

[1]) Kamel Al-Shakhrit, Fish Farming, 1st ed., Ma'an Development Center, Gaza, 2009, p. 1.
[10]) Mohamed Fathy Mohamed Othman, Mohamed Abdel Baqi Amer, Fish Production, 1st ed., Open Education Center, Egypt, 2008, p. 43.

The general trend of fish production in Hilla city has shown a declining pattern, with a negative rate of change (- 458.62tons). The highest production rate was recorded in 2013, reaching 45,989tons, due to favorable climatic and environmental conditions that supported fish farming and increased production. Conversely, the lowest production rate was recorded in 2007, at 37,045tons, primarily due to climate changes that led to deterioration in aquatic environmental conditions, including low water levels, increased salinity, and reduced dissolved oxygen. Additionally, water pollution has intensified, further impacting fish production.

Table (2) Annual rates of fish production in Hillah city for the period(2023–1990)

Fish production\ton	years
40834	1990
40833	1991
45878	1992
41489	1993
42009	1994
41897	1995
42778	1996
39996	1997
39954	1998
38872	1999
39662	2000
38532	2001
40321	2002
45284	2003
39261	2004
39112	2005
41507	2006
37045	2007
38281	2008
38941	2009
39944	2010
39098	2011
41132	2012

45989	2013
41677	2014
42766	2015
42201	2016
38522	2017
40672	2018
41249	2019
40868	2020
37877	2021
37699	2022
37441	2023
40577	المعدل

Source: Researchers' work based on: Republic of Iraq, Ministry of Planning, Central Statistical Organization, Directorate of Agricultural Statistics, unpublished data, Baghdad, 2023AD.

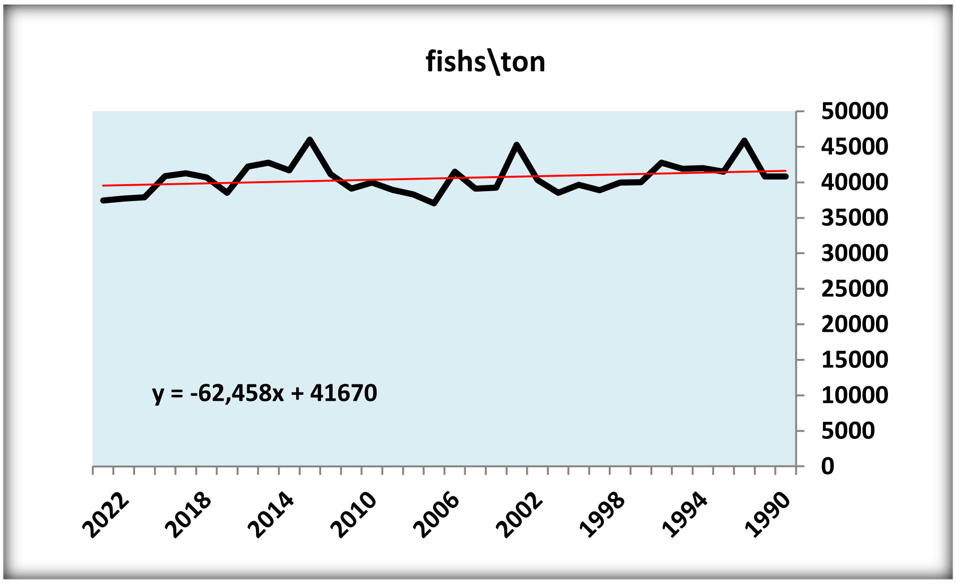


Figure (3) The general average of fish production rates (tons)

Source: The researchers' work based on Table.(2)

Chapter Three: Assessing the Relationship Between Relative Humidity, Rainfall, and Fish Production in Hilla City(2023-1990)

To determine the relationship between relative humidity and rainfall and fish production in Hilla city, the Pearson Correlation formula was applied automatically using Excel (version

2016). The analysis involved identifying independent variables (relative humidity and rainfall) and the dependent variable (fish production) to assess the nature, type, and strength of the relationship.

The study relied on available data from the Ministry of Planning (M.O.P), the Central Organization for Statistics (C.P.O.S), and the Directorate of Agricultural Statistics (D.O.A.S) in Baghdad for the period 2023-1990. Additionally, climate data on relative humidity and rainfall for the same period was obtained from the General Authority for Meteorology and Seismic Monitoring. The correlation was calculated using the following mathematical formula[(11)]

$$\mathbf{r} = \frac{\mathbf{n}\sum \mathbf{xy} - \left(\sum \mathbf{x}\right)\left(\sum \mathbf{y}\right)}{\sqrt{\left[\mathbf{n}\sum \mathbf{x}^2 - \left(\sum \mathbf{x}\right)^2\right]\left[\mathbf{n}\sum \mathbf{y}^2 - \left(\sum \mathbf{y}\right)^2\right]}}$$

Where:

-r: Pearson correlation coefficient between the variables

-x: Value of the first variable

-y: Value of the second variable

-n: Number of observations

If the correlation results are positive, it indicates a direct relationship (positive correlation). Conversely, if the correlation results are negative, it signifies an inverse relationship (negative correlation).

To determine whether the relationship between the independent variables (relative humidity and rainfall) and the dependent variable (fish production) is genuine, the Interpretation Coefficient (R^2)—also known as the Coefficient of Determination—was calculated. This value represents the square of the Pearson correlation coefficient. Subsequently, the values were tested using degrees of freedom (N-2).

1) The Relationship Between Relative Humidity and Fish Production in Hilla City (1990-2023)

Analysis of Table (3) indicates that the relationship between relative humidity and fish production in Hilla city is very weakly positive. The Pearson correlation coefficient was 0.118, with a correlation percentage of 11% and an interpretation coefficient (R^2) of 0.013.

This relationship is statistically significant at a confidence level below 0.05, meaning that fish production increased only slightly with higher relative humidity—by just one day. This suggests that other environmental factors have played a more significant role in the decline of fish production in Hilla city.

1) Amani Musa Muhammad, Statistical Analysis of Data, 1st ed., Institute of Statistical Studies and Research, Center for the Development of Graduate Studies and Research in Engineering Sciences for Publishing, Cairo University, 2007, pp. 64-63.

Table (3) The relationship between relative humidity and fish production in Hillah city for the period(2023-1990)

Strength of Relationship	Type of Relationship	Degree of Freedom	R2	Correlation coefficient	Fish production
Very weak	positive	32	013,0	118,0	

Source: Based on Excel .2016

2) The Relationship Between Rainfall and Fish Production in Hilla City (2023-1990)

Analysis of Table (4) indicates that the relationship between rainfall levels and fish production in Hilla city is strongly positive. The Pearson correlation coefficient was 0.711, with a correlation percentage of %71and an interpretation coefficient (R^2) of .0.505

This relationship is statistically significant at a confidence level below 0.05, meaning that fish production increased considerably with higher rainfall levels. Additionally, environmental, climatic, and biological factors have also contributed to the growth in fish production in Hilla city.

Table (4) The relationship between rainfall and fish production in Hillah city for the period(2023-1990)

Strength of Relationship	Type of Relationship	Degree of Freedom	R2	Correlation coefficient	Fish production
strong	positive	32	505,0	711,0	

Source: Based on Excel .2016

Conclusions and Recommendations

Conclusions

1) The study indicates that the general trend of relative humidity has been declining, with a negative rate of change (-201.0%). The Hilla station recorded the highest relative humidity in 2004, while the lowest relative humidity was recorded in 2010.

2) The study shows that the general trend of rainfall has also been declining at Hilla station, with a negative rate of change (-734.0 mm). The highest annual rainfall was recorded in 2003, while the lowest annual rainfall was recorded in 2007.

3) The study reveals that the general trend of fish production in Hilla city has been declining, with a negative rate of change (-458.62 tons). The highest fish production was recorded in 2013, while the lowest production was recorded in 2007.

4) Statistical analysis of the relationship between relative humidity and fish production in Hilla city indicates a very weak positive correlation, with a Pearson correlation coefficient of 0.118 (11%) and an interpretation coefficient (R^2) of 0.013.

5) Statistical analysis of the relationship between rainfall and fish production in Hilla city shows a strong positive correlation, with a Pearson correlation coefficient of 0.711 (71%) and an interpretation coefficient (R^2) of 0.505.

Recommendations

1)Identify environmental, biological, and geographical obstacles that hinder fish growth and production in Hilla city, while considering the size and area of lakes and ensuring adequate nutrition for fish development.

2) Conduct periodic water inspections in lakes and fish ponds, especially during the hot and dry season, to address pollution issues that limit production.

3) Prohibit the fishing of mother fish, which are responsible for reproduction and spawning.

4) Monitor artificial reproduction processes by providing safe hatcheries with proper maintenance, cleaning campaigns, and measures to control weeds, microbes, and parasites to prevent production losses.

5) Strengthen the role of local guidelines by promoting programs focused on fishery resources, their importance, and the development of scientific research, highlighting its role in agricultural development.

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