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Water allocations for the farming of freshwater fish in rural parts of Madhepura, in the state of Bihar

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Abstract- The use of water in freshwater fish production in semi-intensive fish culture is the topic of this research, which focuses on rural areas of Madhepura, Bihar, India. The usage of water in the fish pond takes into account both the loss of water due to evaporation and the requirements for water exchanges. According to the findings of the present study, the amount of water necessary for fish farming is estimated to be 10.45 m3/Kg of fish production when semi-intensive culture is used and additional feed is provided. There is a mechanism linked with the production of feed that accounts for approximately 7.6 m3/Kg of fish production. Seepage loss each year comes to roughly 118.26 cm on average, whereas evaporation loss per year comes in at 149.83 cm on average.

Key words: Water budgets, freshwater fish productivity, seepage, pond evaporation.

INTRODUCTION

Freshwater fish production in India accounts for more than 95 per cent of the country's overall fish production and has contributed to the six-and-a-half fold growth that Indian aquaculture has experienced over the past few decades. Bihar's primary economic activity is carp's culture in freshwater environments. The Indian major carps, including the catla (*Catla catla*), the rohu (*Labeo rohita*), and the mrigal (*Cirrhinus mrigala*), are responsible for the majority of the production in this part of Bihar.

Fish farming is a water-intensive industry that demands more water than traditional agricultural practices.[1] In addition, the unpredictability of rain, the fear of drought, and the restricted quantity of freshwater resources have pushed a reassessment of how the aquaculture industry can prudently manage freshwater to boost water production. Because of an increase in population and the demand for water in agricultural production, industrial production, and home use, India's freshwater supply and reserve are currently in danger. The unplanned use of water in aquaculture is one factor preventing further growth in this industry. As a result, additional research is required because only a small number of researchers have calculated water budgets based on pond measurements for various types of fish culture systems that are maintained in a variety of climatic circumstances.

It is essential to create a water budget to accurately estimate the total water the Pond will need for fish production.

To determine how much water is necessary for a freshwater fish pond, the work that is being presented here was carried out in rural parts of the Madhepura district.

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Research has been done on ponds' hydrology, considering local variables, soil types, building techniques, seepage, evaporation, rainfall, and other biological considerations. However, the information learned or protocols developed as a result of this study might be utilized in the same agroclimatic zone of the country to predict water use for pond aquaculture.

MATERIALS & METHODS

Hydrological Evaluations

The research was carried out over the course of a single year in three fish ponds located in the Madhepura area of Bihar (2019-2020). These ponds were supplied with rohu, catla, and mrigal fingerlings with a stocking density of 7,000 per hectare. The fingerlings ranged in size from 15-20 g. The ponds were supplied with commercial food twice daily at a rate equal to 2% of the fish's body weight. The ponds measure 0.10 hectares in area and have a depth of 1.5 m.

In the Pond, a water level recorder in the form of a standpipe was installed.

The Pond's dyke was fitted with an evaporation pan to calculate the amount of water lost to evaporation. Using a hook made it easier to estimate the pan's fluctuating water level. To accurately record the amount of precipitation that fell throughout the study, a conventional rain gauge was installed in the vicinity of the Pond. The catch of the rain gauge made it possible to make corrections for fluctuations in the water level in the evaporation pan. As a result, accurate evaporation measurements could be obtained by deducting the amount of water contained in the rain gauge catch.

In order to accurately measure the regulated inflow and outflow from the ponds, pipes made of PVC measuring 15 cm in diameter were installed at both the input and outlet points.

RESULTS

Evaporation Losses

Water will inevitably be lost due to evaporation. The amount of sunshine, the temperature of the air around the water, the relative humidity of the air, and the speed with which the wind is blowing are the primary factors that influence the pace at which water evaporates. The amount of water lost to evaporation from the Pond daily ranged from 0.20 to 5.96 millimetres on average. The Pond lost an average of 35.65 millimetres (mm) of water each week due to evaporation. The amount of water that is lost from the Pond due to evaporation per year is 1498.3 millimetres. The low relative humidity, high wind speed, and increased amount of sunshine contributed to the high evapotranspiration rates seen during the dry months. However, because there was increased moisture in the atmosphere after it rained, the Pond required a more extended amount of time to dry out.

Seepage Losses

Not only does the seepage rate result in water loss, but it also affects the fertility of the Pond. How porous the soil is, how the Pond was constructed, how the structure shifts with time, and how the Pond is maintained are the primary factors that determine whether a pond loses water through seepage or gains water as a result of seepage. The average daily seepage rate was 1.50 millimetres, with the seepage rate typically ranging from 1.1 millimetres to 14.26 millimetres daily. The standard deviation for the quantity of water that leaked out each week was 2.15 millimetres, whereas the mean amount of water that leaked out was between 8.28 and 84.41 millimetres. About 1182.60 millimetres, of water, leaks out annually on average. Compared to the months with less precipitation, the amount of seepage decreased by approximately 20-25 percentage points. When it rains, seepage losses are typically reduced to a greater extent. This could be because rainwater can pass through pond dykes, reducing the amount of water lost to seepage overall.

Water gain

The Pond gains most of its water through precipitation, making it the most important source of water gain. Because of the region's high temperature and relative humidity, rainfall began at the beginning of June and is forecast to continue at least through the end of October. Because of the increased precipitation during the wetter months, the Pond's total volume of water increased.

Water requirement for Aquaculture Ponds

The calculations for the average water budgets have been completed. The Table 1 contains the results. When looking at the table, it is easy to see that fish ponds needed additional water nearly every month of the year in order to make up for the water that was lost. During the rainy season, when ponds collected water either directly from rain or indirectly from groundwater, this was not the case. This was the only occasion this was not the case. This took place as a direct result of water being lost during the dry season. The monthly gain on average was at its peak in June and lowest in April. According to the findings of this research, the annual totals for water gain, pond evaporation, seepage, and other water addition are 1761.8, 1498.3, and 1182.60 millimetres, respectively.

Utilization of Water in the Production of Fish

Evaporation, seepage, and water exchange are the three components that make up the water management system for freshwater aquaculture. Evaporation contributes 1498.3 millimetres per year to the loss of water at the Pond, while seepage accounts for 1182.60 millimetres per year. The water demand for an aquaculture operation that aims to produce 3-4 tonnes of fish per hectare per year is 7650 litres, equivalent to 7.6 cubic metres, but this number drops as production increases. A total of 4.1 cubic metres of water is needed for fish farming if we count seepage losses as "green water".[2]

Manufacturing bone meal, fishmeal, and fish oil requires a relatively small amount of water. Animals get hydrated through their meals in a roundabout way. To produce 1 kilogramme of feed grain, the worldwide water demand is equal to 1.2 cubic metres. Fish and crustaceans are the animals that use the least quantity of water-related to their nutrition for every kilogramme of waste they produce. If the feed is used more than the 4.1 cubic metres of water that the system requires, an additional 2.4 cubic metres of water will be used to produce 1 kilogramme of fish. 1 kilogramme of fish takes a total of 6.5 cubic metres of water, which accounts for seepage losses. For this investigation, 10.3 cubic metres of water would be used to produce one kilogramme of fish.

Water consumption for freshwater aquaculture compared to that of crops, Table 2 presents a comparison between the water production of freshwater aquaculture and that of other crops.[3] We need more water if we want to produce the same amount of fish in freshwater aquaculture as we do with wheat. Rice has the lowest water productivity at 3.7 kilogrammes per hectare millimetres, whereas freshwater aquaculture has an even lower production at 1.50 kilogrammes per hectare millimetres. Alternatives for conserving water in aquaculture

In semi-intensive pond culture, the amount of water needed to produce 1 kilogramme of fish was 7.6 cubic metres. An intensive pond culture that includes additional feeding and aeration has the potential to make 10 to 15 tonnes/ha/year, effectively doubling the amount of water that may be produced. The production of aquaculture should emphasize intensive and superintensive techniques. The most significant sources of water loss in pond aquaculture come from evaporation and seepage. The results of our efforts should result in a decrease in process losses. Seepage can be reduced in pond aquaculture by the use of several management measures.[4,5] In intensive or superintensive culture systems, the treatment and reuse of effluent water should not be seen as a loss. RAS has the potential to boost water productivity and should be employed whenever it's practical to do so.

The management of water on the farm may result in less wasted water and more water available for aquaculture.

Table 1- Water budget of the experimental ponds.

Months	Water gain (mm)	Pond Evaporation (mm)	Pond seepage (mm)
April	9.10	(−)181.3	(−)237.8
May	0.90	(−)139.3	(−)160.6
June	35.4	(−)110.8	(−)169.4
July	546.2	(−)50.7	(−)42.2
August	434.2	(−)63.6	(−)38.6
September	453.1	(−)36.8	(−)35.6
October	201.1	(−)161.8	(−)53.4
November	44.2	(−)111.2	(−)38.6
December	34.2	(−)132.2	(−)85.4
January	0.61	(−)161.2	(−)93.4
February	0.46	(−)170.2	(−)102.2
March	5.01	(−)179.8	(−)125.6
Mean	147.04	115.3	90.98

Table 2- Water requirements in comparisons to major cereals

Crops	Water requirements (mm)	Yield Kg/ha	Productivity of water Kg/ha/mm
Rice	120	4500	3.7
Sorghum	50	4500	9.0
Pearl millet	50	4000	8.0
Maize	65.5	5000	8.0
Wheat	40.0	5000	12.5
Freshwater aquaculture (Carp culture)	**268**	**4000**	**1.50**

The water stored in shallow ponds can be increased by draining and deepening them. A pond should have a depth of three feet at its most external point. This water depth may inhibit the growth of aquatic plants, which may use a significant amount of pond volume, lowering the Pond's capacity to store water. To preserve water and power, you should keep the water level in the standpipe below its maximum. This causes ponds to become filled with rainwater. How far below the maximum level the Pond is filled depends on the time of year, the prevailing weather patterns, the rate of evaporation, the location, the water holding capacity of the Pond, and the size and weight of the fish.

CONCLUSION

Recent research results provide water budgets for semi-intensive ponds used in carp aquaculture and investigate different ways to reduce water consumption. The total amount of freshwater that is required for semi-intensive farming with supplemental feeding is 10.3 m^3/kg, with 7.6 m^3/kg being system-associated with this requirement. Evaporation and seepage are two of the most critical aspects of the system when it comes to fish culture. The Pond loses 1498.3 millimeters of water due to evaporation and seeps 1182.60 millimetres annually. In recent years, aquaculture has placed a greater emphasis on water conservation and recycling. Innovations in technology and management practice are driven by factors such as increased demand for groundwater, the expense of operating wells, the environmental impact of aquaculture effluent, and the desire to raise production efficiency. The amount of water required for aquaculture can be reduced by treating and recycling the water that is lost through seepage and water exchange losses. In pond aquaculture, the usage of freshwater can be cut down with the use of intensive and super intensive culture systems as well as aqua feeds.

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