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Disposal and Impact of Fish Pond Water Effluents in Benin City, Edo State, Nigeria.

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Abstract

Fish pond effluent commonly discharged to soil surface is one of the environmental concerns in fish farming and it is important to note the impact it has in our environment. Pond effluents are high in organic particles and inorganic nutrients and may pollute the environment if not properly disposed or utilized. This study was carried out to investigate the means of disposal and impacts of catfish pond effluents by fish farmers in Benin city, Edo State, Nigeria. Four local Governments Areas were purposively selected for the study based on their high Aquaculture activities. The study investigated the Socio-economic characteristics of the farmers, production capacity/systems of fish farming, how effluents are discharge and/or utilized by fish farmers and knowledge of effluent content by farmers. A well-structured questionnaire was used to collect data. Data was analyzed using SPSS statistical package (version 2015) and descriptive statistics was used to present results. The results showed that majority of the respondents (fish farmers) had small scale farms (47%), of which 72.2% of the respondents were males and 76% had between 1-10 years farming experience. Also majority (88%) of respondents practiced semi-intensive culture system. Most of the fish farmers had between 5-10 culture facilities (50%). Majority of the fish farmers carry out partial drainage of pond water (74%) during culture and most of the respondents discharge their pond effluents at intervals of 2-3days (51%) and majority discharge their effluent unto bare land or soil surface (33.33%). Substantial number of the fish farmers do not know what pond effluents contained (59%). All the respondents do not treat pond effluents before discharging to land surface (100%). All the fish farmers agreed that pond effluents have impacts on the environment (100%). A significant percentage (78%) of the farmers stated that pond effluents leads to pollution. Most of the farmers (38.6%) suggested the use of pond effluent for irrigation for crops as a better way of disposing/utilizing pond effluents. It was concluded that the fish farmers in the study area do not treat pond effluents before disposal due to lack of facilities and cost of treatment of pond effluents. The study recommended the practice of integrated aquaculture (fish-cum-crop production) for proper utilization of pond effluents and to reduce cost of treatment facilities.

Introduction: Aquaculture is the rearing of fish and other aquatic organism in an enclosed environment such as ponds, tanks etc. under controlled condition which include water quality management, feeding, species manipulation (FAO, 2020). Fish culture water is usually associated with higher concentrations organic matter(suspended) and inorganic substances such as nitrogen, phosphorus and potassium with high biochemical oxygen demand than natural surface water (Enaboifo M.A., Okonji V.A and Taiwo J., 2012) ; Enaboifo and Okonji, 2012). Akolisa and Okonji (2005); Nyong, and Nweze, (2012) reported some negative impacts of pond water effluents on the environment and also some strategies to minimize environmental impacts of pond effluents. Omofunmi, O. E., Adewumi, J. K., Adisa, F. A and Alegbeleye, O.A. (2016) reported that catfish effluent affect both physical and chemical properties of the soil; it contains higher concentration of macro and micro nutrient. The quality of soils at the immediate discharge site appears to be favourable in respect of soil enhancement Nyong, *et al*.,2023); (Omofunmi, *et al*., 2016). Characterization of fish ponds effluents and quantification of their environmental impacts provide required information for effective waste management systems which include pond effluents storage, treatment and disposal**.** The quality of fish pond effluents varies with

location, seasons, farm management practice, amount of overflows after rains and amount and frequency of draining water during culture and harvest. Effluents discharge during culture and harvest has a high potential for causing pollution. This is as a result of the high concentration of pollutants due to stirring of sediments during management such as feeding (Boyd, 2003; Nyong,**.** and Nweze,2012); Schwartz and Boyd, 1994).

Characterization of fish ponds effluents and quantification of their environmental impacts provide required information for effective waste management systems which include pond effluents storage, treatment and disposal.In view of the obvious effect of the effluents on the environment, it is important to monitor how fish farms discharge their effluents and ensure that it is properly carried out. Hence this study is to assess the different means of disposal and impact of pond effluents by fish farmers in Benin City, Edo State, Nigeria as a means of monitoring and minimizing environmental pollution, Nyong, *et al*.,2023).

The Aim of the study is to assess the different means of disposal and utilization of pond effluents by fish farmers in Benin City, Edo State, Nigeria. The specific objectives of the study are to: identify the various means of disposal of pond effluents in Benin City; Identify any possible form of treatment of pond effluents ;and investigate fish farmer's knowledge of the content and handling of pond effluents.

Materials and Methods: Description of Study Area

Edo state lies roughly between longitude $06^0\,04^{'}$ E and $06^0\,43^{'}$ E, and latitude $05^0\,44^{'}$ N and $07^0\,04^{'}$ N and at elevations between 500 feet (150 m) in the south and more than 1,800 feet (550 m) in the north. It is bounded in the North by Kogi state, in the south by Delta state, in the West by Ondo state and in the East by Kogi and Anambra states. Edo state covers a land area of about 17,802km^2 with a population of 3,218,332 people. Tropical rain forest covers most of the area. The highest mean monthly temperature of 29.1°C is recorded in March and the lowest of 24.4°C in June (NCEE, 2012).

This study was carried out in Edo South Agro – ecological zone, located in Edo state. Edo south agro – ecological zone is one of the three agricultural zones in Edo state namely, Edo north, Edo south and Edo central. Edo south is further divided into seven (7) Local government areas but the area under the study focused on purposely selected four local government areas which included Oredo, Ovia North East, Ikpoba-Okha and Egor.

Sampling technique/ Sample size: Four local government areas were purposively selected from Edo South Senatorial district because of their high aquaculture activities. Simple random sampling was used to select a total of 100 respondents from the four local government area with 25 respondents selected from each LGA.

Data Collection: Data were collected from both primary and secondary sources. A well-structured questionnaire and personal interview was used to generate the primary data. While secondary data was sourced from text books, journals, publications, internet and Edo State Agricultural Development Programme (ADP). Data collected included;

a) Socio-economic characteristics of respondents (such as age, gender, farming experience and level of fish farming).
b) Systems of fish production such as culture facility used, management options, disposal of pond effluents, stocking capacity and total output.
c) Effluent discharge by fish farmers such as volume of discharge, time and frequency of discharge,time and frequency of discharge, knowledge of content of effluent and treatment of effluents .

Data Analysis : Data obtained from the field survey was analyzed using the Statistical Package for Social Sciences (SPSS) version 15. Data was presented using descriptive statistics such as frequency distribution table, percentages and pie-charts.

Results and Discussion: Social-economic Characteristics and System/Production Capacity of Fish Farms : The survey (Table1) showed that 47% of respondents stated that they had small scale farms, 42% medium scale and 11% have large scale farms. This is an

indication that farming in the study area is dominated by small and medium scale farmers. The small and medium size farms may be attributed to inadequate capital for investment or low capital outlay.

The result on type of farm showed that majority of farmers practice fish farming for commercial purpose which is an indication that fish farming is a source of employment that generates income to households though at a small and medium scale.

The result on gender shows that majority of farmers in the study area were males (72%) while (28%) were females. This may be attributed to the tedious nature involved in fish farming.

The result on years of experience showed that 76% had between 1-10years farming experience, 20% had 11-15 years farming experience while only 4% had >15 years farming experience. This result indicates that Fish farming is relatively young in the study area. This agrees with the findings of Olasunkanmi and Yusuf (2014) who reported that 73% of farmers had between 0-5 years' experience while 27% had above 5 years farming experience.

Production Capacity/Systems of Fish Culture: The result on number of culture facilities shows that 50% had between 5-10 culture facilities, 40% had between 10-15 culture facilities while 10 % had > 15 culture facilities. This is an indication that the study area is characterized by low production input. The survey carried out on management options (Table 1) showed that 88.0 % of fish farmers practiced semi-intensive aquaculture. This may be due to unavailability of capital, lack of skilled manpower and unstable power supply for intensive culture system. Semi-intensive aquaculture maybe practiced due to the relatively moderate inputs required. This agrees with the study of Okonji and Osayi (2016) who reported that majority of fish farmers in Edo state practiced Semi-intensive system The dominance of semi-intensive system may be due to the fact that it is less technical and requires less energy and inputs by partially depending on natural source of food. Intensive system requires good energy supply which is unreliable, expensive and insufficient. Thus a less technical option with moderate input and output is adopted by the farmers. The survey showed that (88%) stocked 1-10 fish/m^2, while (8%) stocked 10-100 fish/m^2. The result is an indication that fish farmers in the study area are based on small scale farming which may be attributed to some limitations such as lack of capital, poor technical know-how, high cost of feed, poor power supply.

Table 1: Socio-Economic Characteristics and Systems/Production capacity of fish farms

Parameter	Frequency (No)	Percentage %
Size of farm		
Small scale	47	47.0
Medium scale	42	42.0
Large scale	11	11.0
Type of Fish Farm		
Subsistence	27	27.0
Commercial	73	73.0
Gender		
Male	72	72.0
Female	28	28.0
Fish farming Experience		
1-3yrs	12	12.0
4-7yrs	64	64.0
8-11yrs	20	20.0
12 yrs and above	4	4.0
Number of culture facility		

5-10	50	50.0
10-15	40	40.0
>15	10	10.0
Management options		
Extensive	6	6.0
Semi-intensive	88	88.0
Intensive	6	6.0
Frequency of flushing		
No flushing	0.0	0.0
Occasional flushing	90	90.0
Regular flushing	10	10.0
Stocking density		
1-10fish/m^2	88	91.7
10-100fish/m^2	8	8.3

Source: Field

Effluents Discharge by Fish Farmers: The survey showed that 84.1% of the fish farmers carried out partial drainage of the pond while 15.9% totally drained their pond. This result corroborated the study of Nyong, *et al*.,2023); Enaboifo and Okonji., (2012) who stated that during harvest ponds are mainly drained to levels where fish can be recovered via net, because as the level of pond water decreases, the level of nutrient decreases overtime. Water released from ponds that are partially drained has greater concentrations of nutrients, organic matter and suspended solids than overflow from pond following storms (Cripps and Kelly, 1996). The result on Time of discharge of pond water (table 2) shows that 58.3% discharge their effluents in the evenings, 33.3% in the morning while 8.3 in the afternoon. This result indicates that pond water is best discharged at the cool hours of the day (i.e. morning and evening hours), to reduce stress on the fish.

The study revealed that 53.7% discharge their pond water between 2-3days intervals, 33.7% weekly, while 12.6% discharge pond effluents daily. The survey showed that 62.8% of respondents had no knowledge of the contents of pond effluents while 37.2% stated that pond effluents contain ammonia, unconsumed feed and fish waste. This result agreed with the study of Cripps and Bergheim, 2000, which stated that Aquaculture waste can be classified into solid and dissolved waste, particularly carbon, nitrogen and phosphorus. Solid wastes mainly originate from unconsumed feed by the fish and the excretory products of the fish. Dissolved waste is generated mostly from metabolites excreted by the fish (through gills and urine). The result on treatment of pond effluent showed that 100% of farmers do not treat their pond effluents. This finding compared favorably with that Nyong, *et al*.,2023) of Boyd and Hulcher (2001) who reported that the farmers are often reluctant to invest in treatments to prevent or mitigate effects unless they benefit from it directly. Pond Aquaculture internalizes much of the waste treatment cost, approximately 27-28% of the cost of producing fish in ponds is related to the waste treatment processes, (Engle and Valderrama 2003). The main reason for farmers not treating their pond effluent is cost.

The survey on methods of discharge of pond effluents (fig.2) showed that 33.3% discharged their effluents to bare lands, 29.2% used return to earth system/method, 27.1% channel their effluents to burrow pits ,6.3% use pond effluents for irrigation while 4.2 % channel their pond effluents to streams/rivers. Thus discharge of the effluents to soil surface and underground injection back to soil is commonly used in the study area. This may likely result in pollution of the environment due to the high organic and inorganic content of the raw pond water effluent that is untreated. This finding is in consonance with the works of Engle and Kouka (1996), who reported that some potential methods of disposing effluents included land application of effluents discharge to irrigate crops, constructed wetlands, use of

filter- feeding fish, intermittent sand filters and settling basins.

Table 2: Information of Effluents Discharge by Farmers

Parameter	Frequency (No)	Percentage %
Type of discharge		
Partial drainage	74	84.1
Total drainage	14	15.9
Time of effluent discharge		
Morning	32	33.3
Afternoon	8	8.3
Evening	56	58.3
Frequency of discharge		
Daily	12	12.6
Weekly	32	33.7
2-3 days	51	53.7
Knowledge of effluents content		
Yes	35	37.2
No	59	62.8
Perceived knowledge of effluent content		
Ammonia	12	34.3
Unconsumed feed	9	25.7
Fish waste	6	17.1
Combination of ammonia, feed and fish waste	8	22.9
Any form of Treatment of effluents		
Yes	0.0	0.0
No	100	100.0

Source: Field survey,

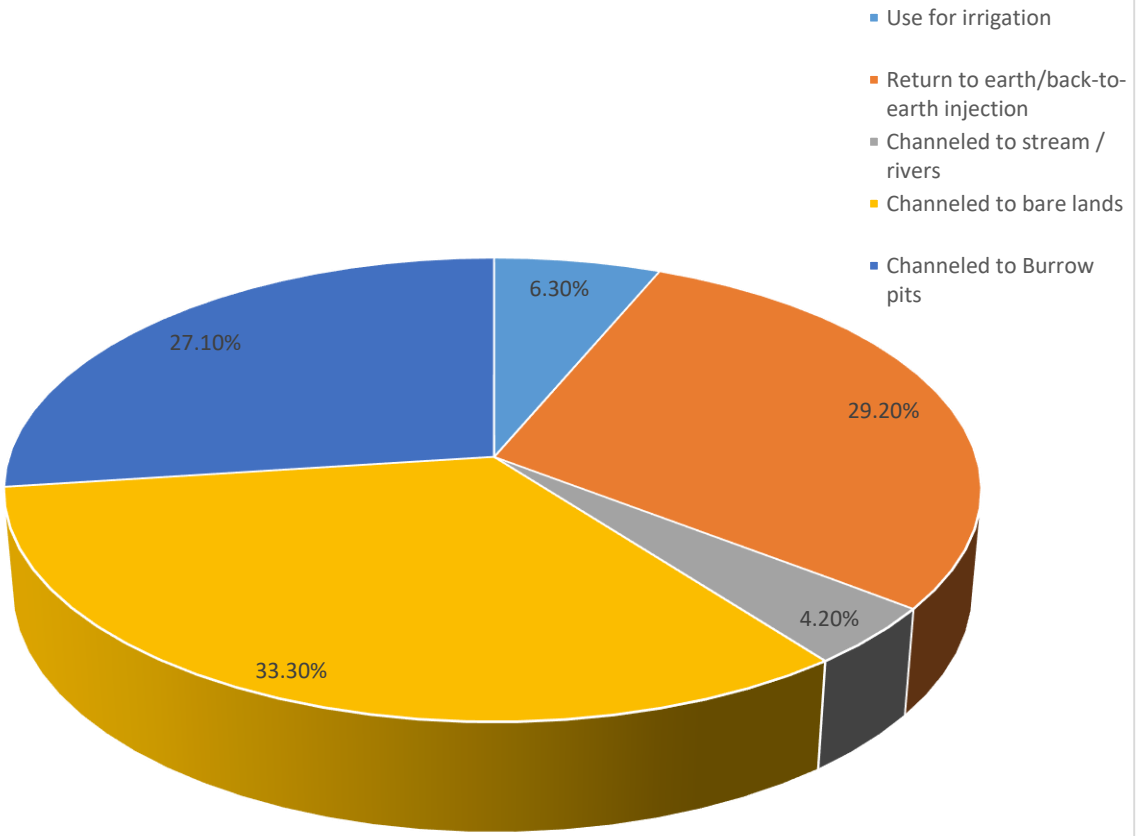

Fig. 2: Means of disposing pond water effluents

Impact of Effluents Discharge on the Environment and Suggestions on Better Ways of Disposal : The result on table 3 showed that 100% of fish farmers stated that pond effluents has impact on the environment. They stated that the impacts includes pollution (air and water) and flooding/erosion. This agrees with the study of Coldebella, A.,Gentelini, A.L, Piana, P.A.,Coldebella, P.F., Boscolo, WR., and Feiden, A (2018) who stated that pond effluents can pollute the environment . The result on table 3 also showed suggestion of farmers on better ways of discharging effluents. 38.6% stated that effluents should be used for irrigation of crops 31.6% stated that integrated aquaculture (fish cum vegetable) will help in effluents discharge as nutrients from the effluents can be used by plants while 29.8% stated that the use of water re-circulatory system (WRS) and proper treatment of effluents are better ways of managing pond effluents. This agrees with the study of Ikechukwu C C, Okolie H, and Edeh I.C, (2023) who stated that fish pond effluents can be used for irrigation and integrated fish farming

Table 3: Impact of Effluents Discharge on the Environment and Suggestions on Better ways of Disposal

Parameter	Frequency (No)	Percentage (%)
Pond Effluents have impact on the Environment		
True	100	100.0
False	0.0	0.0
Possible Impacts of Effluents on the Environment		
Pollution (air/water)	78	79.6

Flooding/Erosion	10	10.2
1 and 2	10	10.2
Better ways of Discharging / Managing Effluents		
Use of WRS and treatment of Effluents	17	29.8
Integrated Aquaculture (Fish cum Vegetable)	18	31.6
Irrigation of crops	22	38.6

Conclusion: The means of disposal and utilization of pond water effluents by fish farmers in Benin city was investigated. The result of this study indicated that catfish farmers do not treat their pond water effluent and discharge the untreated effluent mainly to soil surface or injected back into the soil. It is believed that properly treated and discharged effluent will minimize soil pollution and the negative impacts of the effluent on the environment. From this study it is concluded that the fish farmers (respondents) are mainly into small scale and medium scale farming and lack proper facilities to dispose the pond effluents. The quality of catfish pond effluents varies with location, seasons, type of culture system, farm management practices and amount of overflows after rains. To minimize environmental impacts of pond effluents, it requires effective waste management systems which include pond effluents storage, treatment and disposal. This may involve the use of the water for crop cultivation (integrated aquaculture) or use of water treatment units to reduce the organic and inorganic particles in pond water effluents.

Recommendations: Based on the findings from this study, it is recommended that:integrated aquaculture should be practiced by fish farmers, by using effluents for irrigation of crops; to minimize the negative impacts of pond effluents, best Management Practices such as (better feeds and feeding practices, treatment of effluents in sedimentation basins) can be used to improve the volume and quality of these discharges; and Pond water effluents may also be treated by passing through storage, sedimentation and filtration units before emptying into the soil surface.

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