Utilization of Organic Sediments from an Intensive Aquaculture Pond

A report on the fieldwork of Aqua-Internship Program
Faculty of Fisheries
Bagladesh Agricultural University
Mymensingh-2202

Submitted by
Rayahana Yeasmin
M.S. in Aquaculture
ID No-10 Fish Aqua JD-06M
Reg No.-32551
Semester- July-December,2010
Session- 2010-2011

Signature of the Supervisor Professor Dr. S.M. Rahmatullah	Signature of the Field Supervisor Mr. Ritish Pondit Reliance Aqua Farms	Signature of the Intern Rayahana Yeasmin M.S. in Aquaculture

Background :

Aquaculture is a promising industry in Bangladesh. According to the Department of Fisheries(DOF),the total fisheries production is about 2.3 million metric tons comprising 850,000 tons (37%) from inland freshwater aquaculture, 95,000 tons (4%) from coastal aquaculture, 750,000 tons (33%) from inland capture fisheries and 590,000 tons(26%) from marine capture fisheries.According to Bangladesh Bureau of Statistics(BSS), the inland fisheries sector has had an annual growth exceeding 7% since 1995.Aquaculture contributes to 55% of inland fish production although it covers only 11% of the total inland water resources.

There are an estimated 1.3 million fish ponds in the country,covering an area of about 0.151 million ha; of which 55.30% is cultured, 24.52% is culturable and 16.14% is unused.

Fisheries and Aquaculture activities supports more than 7% of country's population.Aquatic resource (20persons/ha) is vast here.(Task Force,1991)

According to the FAO,Bangladesh acquired second position in inland fisheries production(2008). According to economic analysis(2010), the estimated production was 24.97 lakh metric tons in 2009-10. Fish contributes to 63%animal protein intake.Annual per capita consumption is 13.5kg against 18kg requirement.

There are about 1.4 million fulltime fishermen and 3 millions of fish and shrimp farmers.Another 12 million people are involved in part-time fisheries activities.Foreign exchang earning was TK.3000 crore(2005-06) and the share to world fish trade was 6%.

So it is important to study about aquaculture related things such as impacts,intensification,environmental problems, maximum utilization of inputs to reduce wastes and if possible recycling or reusing of farm outputs.

With the intensification of aquaculture high amount of input in the form of organic and inorganic fertilizers,liming,complete/supplementary feeding have deliberately boosted the nutrient content leading to hypernutrification and eutrophication.

Figure 1.

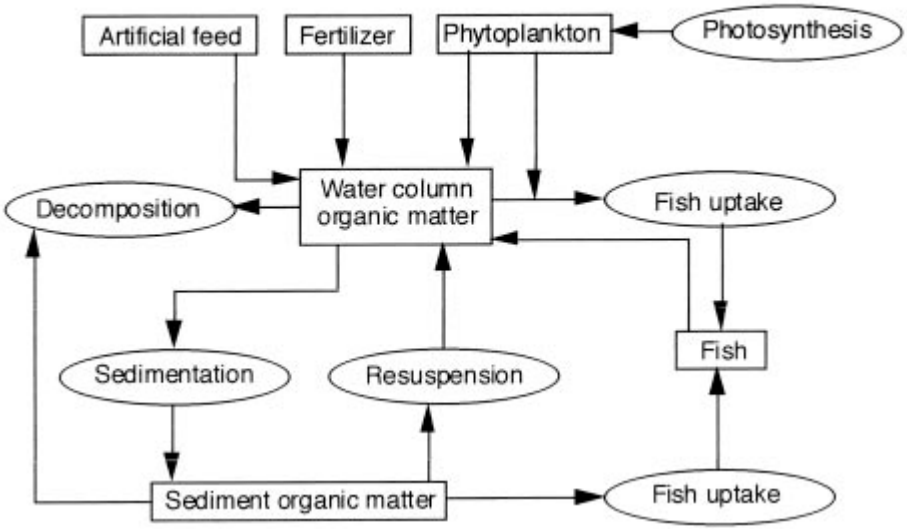

Figure 1. Schematic diagram of the sources and sinks for organic matter in the water column and in the sediment of an aquaculture pond

The feed applied is not utilized fully by fish.Uneaten/waste feed, fish faeces , metabolic wastes, dissolved nutrients from feed and faeces cause the organic nutrient accumulation in fishpond.The amount of the waste varies with the intensity of manipulation ,type of species,size, type of feed used in the farm.Solid loads(uneaten feed and faeces) may vary from 110 to 2153kg/t of fish produced.
The bottom deposits or sediment contains various forms of N,P,S and additives from feed.Bottom dwelling fishes and benthos live on sediment materials.The dissolved nutrients of most concern are the N and P.P may be insoluble and bound in the sediment as well as available to aquatic plants in dissolved form.Organic N from manures and feed is decomposed by microbes to ammonia.Ammonia is converted to nitrate-N by denitrification process.

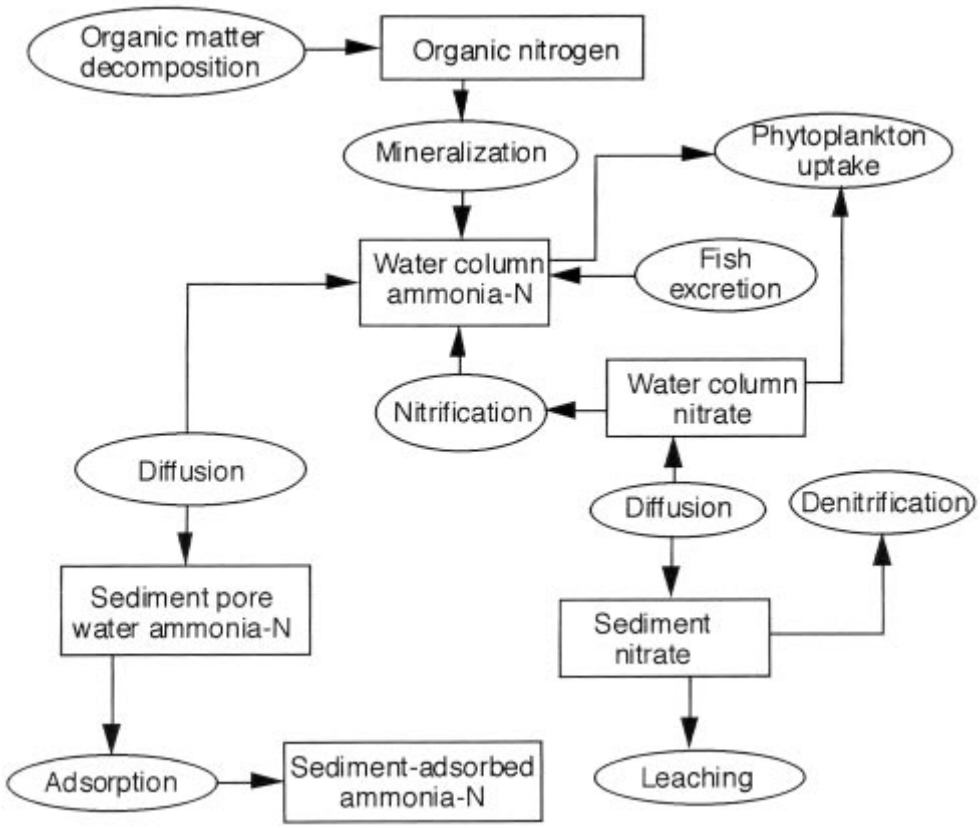

Figure 2. Schematic diagram of the sources and sinks for nitrogen in the water column and in the sediment of an aquaculture pond.

Chemical formes of N are NH_4^+, NH_3(unionized toxic form),nitrate and nitrite.
Chemical forms of orthophosphate are $H_2PO_4^-$,HPO_4^{2-},PO_4^{3-} and there are bound P with Fe^{3+} ,Al^{3+},Ca^{2+} or soil colloids.
The organic loading lead to oxygen depletion and bottom is overloaded with undecomposed plus daily addition of nutrients.

Nutrient pollution in natural waterbody is characterized by;

- Excessive concentration of N,P and organic substances.
- High phytoplankton biomass.
- Long-term presence of small zooplankton and absence of larger species.
- Low transparency of water.Proliferation of plants but later followed by lack of emergent and submerged vegetation.
- Low species diversity and reduction of waterfowls.

To minimize the negative impacts and for maintaining ecological balance the sludge/sediments are to be removed after draining or by using suction dredger.
The organic content in reservoir sediment is much lower than in fishpond sediment.(Panzonka,1966).

It is estimated that 25%of the ingested N is assimilated into fish body and another 75%is loaded into the environmentin the Japanese fish culture system(Ogata,1995).

Only less than 30% of feed or fertilizer N and P added to ponds are recovered in the harvest of fish.

Most of the feed used in aquaculture are eaten directly by fish and shrimp,but usually only 10 to 30% of P applied in feed is retained by culture animal.

So the rest amount of unutilized N and P are found in water column and bottom sediments.

So sediments can be used as fertilizer in agricultural land.
It is indispensable to apply N into agricultural land in order to maintain soil fertility & continue crop production. P is also to be supplemented for plant growth. Pond sediment can be used as fertilizer in agricultural activities.
Rahman et al.(2002) reported that the fertilizer value of sediment of one hectane tilapia fingerling production pond at AIT(Asian Institute of Technology) was equivalent to 6.26t urea & 1.96t TSP.
Rahman et al.(2004) stated that the high content of organic matter content of fishpond sediment could play a major role in soil aggregate formation , thus improving soil,physical & chemical conditions,& facilitating crop production.
Shamsul et al.(2007) stated that pond sediments were a valuable fertilizer for red amaranth production, & pond management had a large impact on the quality of pond sediments for crop production. This study was conducted to observe the performance of maize plants by using fishpond sediments.

Objectives:

The study was done with a view to fulfill the following objectives:

- To observe if fishpond sediment is useful as fertilizer in maize cropping..
- To assess the potential nutrient content of the sediment.
- To determine the rate of sedimentation.

Methodology:

Study area:

The study was carried out in the Reliance Aquafirms,Boilor ,Trishal, Mymensingh.The duration was from late August to late November.

Sediment Collection:

The farm was a hatchery.Sediment was collected from a pond used for brood rearing.Loading of input in this pond was not so as in grow-out pond.Mainly broods of Magur (C. batrachus) are reared here.Wet bottom clay was collected in buckets at 21th of August,2020. It was spread on floor to dry under a ceiling fan in a room. The sediment was not sun –dried as it may alter the original quality..

Details of pond husbandry practice:

Pond size- - -15 decimal.
Depth - 1m.
Pond preparation – By drying, liming and fertilization.
Rearing Period--- --For about 6 months.
Stocking-----2000 seeds.
Feeding-- 'Quality Feed' at 2% of the body weight and 2 times daily.
Final weight of the fish-- -150 to 200g and mature enough to respond to induced breeding.
Water colour---- --Slight greenish.
Disease --- No disease.Liming is done at regular interval to prevent disease and pollution.

Preparation of the pots:

6 pots were for 3 treatments designated as T_1, T_2 and T_3. Normal soil from the front part of the farm was collected. T_1 needed 2 pots filled with dried bottom sediments. T_2 included 2 pots filled with normal soil and bottom sediments at 1:1 ratio. T_3 included 2 pots filled with normal soil.

Planting:

Maize seeds were previously collected and planted on the pots on 24.09.10.
The seeds were planted 1.5 inches deep in soil to avoid being withdrawn by rain. The pots were kept in open space .

Observation:

Observation was made on germination percentage and growth performance. 5 seeds were planted in each pots to avoid overstocking. Thinning was done to reduce the nutrient exhaustion and two plants were kept in each pot for healthy growth.

Determination of sedimentation rate:

Preparation of sediment collection device:

For this bamboo pole, net, bottle, threads were used. Plastic bottle of 2L capacity was cut to make 1L capacity . Height of the cylindrical shape was 6 inches and the weight was 20g. Then it was stuck in one side of the bamboo pole and a netting enclosure was made around the cylindrical device to avoid disturbance by fishes, aquatic organisms or human activities.

Setting the device in water:

5 such devices were placed in different parts of Magur (C. batrachus) brood pond and kept for one month to allow the settling of materials from water.

Determining the extent of sedimentation:

The bottle devices were lifted from pond and formalin was applied in the water of each bottle.5%formalin was used to finish settling here. After siphoning out the water content, bottom materials were sun-dried and weight was taken. Finally, an overall estimation was done on the sedimentation rate of the whole pond.

Results:

Germination (%) of maize seeds:

The seeds germinated after 5 days of sowing. There were differences in average rate of germination in 3 different treatments.

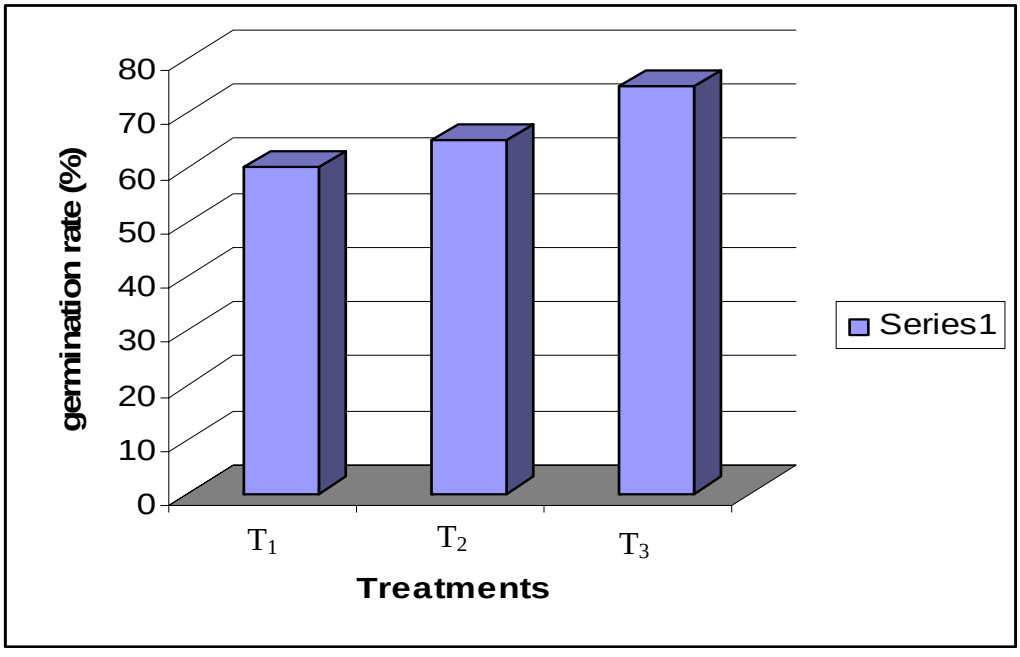

Figure: Comparison of germination rate (%) of maize using different amounts of bottom sediments & normal soil.

Growth performances of maize:

Initially the plants in bottom sediments (T_1) showed less growth but their appearances were dark greenish all the time. As the nutrients in the normal soil was more available to plants so they showed better growth. After 42 days of seeding,T_2 plants showed largest plant height and T_3 plants showed yellowish leafs. After about 57 days of seeding , T_1 plants showed the largest plant height with dark greenish leaf colour.

Table :- Growth performance after 42days of planting

Treatments	Plant height(cm)	Leaf blade	
		Length(cm)	Breadth(cm)
T_1	54.92	53.0225	3.365
T_2	57.15	56.896	4.657
T_3	57.4675	53.2765	4.254

Table :- Growth performance after 57 days of seeding

Treatments	Plant height(cm)	Leaf blade	
		Length(cm)	Breadth(cm)
T_1	72.136	68.643	5.6515
T_2	68.0085	60	5.1435
T_3	59.848	49.022	4.233

Growth of maize plants in practical field:

Measuring plant height from the ground level to the tip of the panicle.

Watering the plants

Plants in bottom sediments(T_1)

Plants in bottom sediments & normal soil at 1:1 ratio(T_2)

Plants in normal soil (T_3)

The sedimentation rate :

It was found in this study to be 5.5451g/$cm^{2.}$

Constraints in conducting the study :

There were no remarkable inconveniences except for the lack of adequate time .Harvesting of grains to observe grains per panicle ,nutrient content analysis, comparison of grains were not possible in Maize due to the time frame limitation.

Socio-economic benefits:

Aquaculture is flourishing in Mymensingh region.Maize is a common crop here planted in the chars of Brahmaputra river.Use of pond sediments would be helpful for rural small-scale farmers.

Stickney (1994) stated that excessieve accumulation of organic matter in pond sediments reduces the pond depth and space available for fish.Edwards(1993)recommended the use of semi-intensive system over intensive system, since the later is 26-44 times more polluting than the former in terms of N and 12-15 times in terms of P.

In a perennial pond, sediment contains OM total N, available P, Fe, exchangeable Ca and K in ranges of 4.5 to 13.1 g/Kg, 900 to 2000 mg/Kg, 70.0 to 112.0 mg/Kg, 24.2 to 47.8 mg/Kg, and 87.8 to 130.8 mg/Kg respectively.(Wahab et al. 1984).

It has been shown that OM is less in new ponds.Dead organisms become OM and deposit in sediment.(Boyd,1990). The organic sediment constitutes about 35-40 % of the total P. (Rath, 2000) . Avnimelech (1998) stated that , only 25.5% organic carbon and 26.8% N were harvested in Catfish(C. macrocephalus) ponds. When benthivores create turbulence in bottom , it provides oxygen to the sediment pores and thus helps in mineralization of organic P trapped in sediment.According to FAO (1977) waste is only a

misplaced resource that can become a valuable input for another product.

In successful aquaculture practice nutrient recycling , nutrient concentration , diversity of practices, stability of the established farming unit , capacity, economic efficiency etc. are important. Utilizing pond sediments for crops would reduce the cost of fertilizer. Farming system in Mekong delta indicates the use of sediments within a farm or other region. They dig up the sediment and apply it for orchard after selling fish. So, it is a good system to sediment removal from fishponds. Beneficial use of sediments date back to ancient times when clay was used in pond dikes.

Conclusion and recommendations:

Fishpond sediment can be used as a soil conditioner to improve the conditions of agricultural soils. It has not yet been clarified whether the sediments from intensive aquaculture systems are safe for application in field as it may contain harmful chemicals and drugs, additives from feed etc.Agricultural manures are organic materials rich in nutrients. Fertilizers are widely used on agricultural land but where they are applied in

large quantities, OM and the nutrients can leach into rivers and ground-water causing severe pollution. The inorganic form of nutrient in pond sediment will be immediately available to plants. The OM is mineralized first and then made available to plants. A part of the OM content provides nutrient to plant by rapid decomposition. Pond sediment include stable organic matter , moderately decomposable OM and easily decomposable OM. Partly decomposed OM is broken down over a 3 to 5 years period and old humified OM decomposes very slowly. So, the rate of decomposition determines the availability of nutrients and plant growth. As the sediment has high potential to provide N, P, K, macroelements and microelements it can be used properly in combination with inorganic fertilizers, compost etc. So, we are not to dump dirty sediments but to analyse and utilize its nutrient contents.

References:

Boyd , C.E. 1990.Water quality in ponds for aquaculture . Alabama Agriculture Experiment station, Auburn University, USA, Alabama, 482 pp.

Boyd, C. E. 1995. Bottom, sediment and pond aquculture, Chapman & Hall, New New York. 348 pp.

Lin, C.K. and Yang Yi, 2003. Minimizing environmental impacts of freshwater Aquaculture and reuse of pond effluents and mud. Aquaculture, 226, 57-68.

Rahman, M. M. and Ranamukhaarachchi, S. L., 2003. Fertility status and possible Environmental consequences of Tista Floodplain Soils in Bangladesh. Thammasat International Journal of Science and Technology, 8, 11-19.

Rahman, M. M., Yakupitiyage, A. and Ranamukhaarachchi, S. L., 2002. European Commission funded POND LIVE Project, Aquaculture and Aquatic Resource Management Field of Study, Asian Institute of Technology, Thailand.

Rath, K. R., 2000. Aquatic environment. Freshwater aquaculture, Scientific Publishers (India), Jodhpur, Pp. 34-71.

Tucker, C. S., 1998. Characterization and management of effluents from aquaculture Ponds in The Southeastern United States, Southern Regional Aquaculture Center SRAC Final Project No. 600, Stoneville, Mississippi.

Wahab M. A., Haque, Aminul, A. K. M., and Bhuiya, Z. H. 1984. Nutrient status of Bottom soils of two ponds in BAU Campus. Bangladesh Journal of Fisheries, 6, 1-10.

Avnimelech, Y., Hargreavs, J. A. and Kochva, M., 1999. Sedimentation and Resuspension in earthen ponds. Journal of World Aquaculture Society, 30, 401-409.

Avnimelech, Y., 1998. Minimal discharge from intensive fishponds. World Aquaculture, 9, 32-37.