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INTEGRATED WASTEWATER AQUACULTURE

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ABSTRACT

Utilization of wastewater in fish culture is based on nutrient recycling, which enhances primary productivity, planktonic biomass , macrophytes and benthic organisms which determine fish production. Production of fishes could be enhanced to 10 ton/ha through wastewater recycling by judicial stock manipulation and management. The fallow lands around a sewage fish farm could be utilized for agrihorticultural production by recycling both sludge and sewage water, resulting in a total agro production of about 110 ton/ha through rotational vegetable cropping. The potential for additional production of vegetables not only enhances revenue but also creates employment.

INTRODUCTION

Wastewater aquafarm comprises of water area along with land around its periphery. In general, the water area is used for pisciculture activities while huge land area remain unutilized or under utilized; these could be brought under integrated farming system, from where both fishes and agri horitcultural products could be obtained. Wastewater based integrated aquafarming, being a low cost technology, would prove to be a better means of resource mobilization through reclamation of wasted nutrients and create employment generation also. The present communication deals with the proposition adopted in wastewater aquafarming at Wastewater Aquaculture Division, Rahara.

CULTURE OF FISH IN WASTE-WATER COMPOSITION OF SEW-AGE

Composition of sewage :

Arther (1986) described domestic sewage mainly consisting of faeces, urine, sullage and 99.9 % water. Out of solids about 70% is organic in nature (mainly proteins, carbohydrates and fats) and 30% inorganic (grit, salts and metals). Domestic sewage has been reported to contain about 250 to 400 ppm of organic carbon and 80 to 120 ppm of total nitrogen, thus giving a C : N ratio around 3 : 1 (Klein, 1962). Sewage may vary in composition and in strength from place to place owing to marked differences in the dietary habits of the people, composition of trade wastes and water consumption.

Effeciency of sewage :

Dehadrai and Ghosh (1979) observed sewage effluent to contain a high amount of nutritive substances which may be utilized for productive purposes in the form of organic fertilizers. Liberated nitrogen, phosphorus and trace elements of wastewater stimulate primary productivity of ponds and primary producers (phytoplankton) start blooming within 3-5 days of application followed by zooplankters, insects etc. (Ghosh *et al.*, 1988). Mann (1972) recorded that smaller particles of wastes acted as a direct source of food to zooplankters and benthos while larger particles were directly used by fishes. Allen and Heper (1979) reported that soluble organic material are used by phyto and zooplankton. Rate of production of plankton bears a direct relationship to the nutrient supplied.

Planktonic biomass :

Varieties of planktonic forms like blue green algae *Microcystis, Anabaena, Spirulina, Merismopedia, Coelospherium, Aphanocapsa, Oscilla-toria;* Green algae like *Scenedesmus, Pediastrum, Selenastrum, Trachylo-monus, Cosmarium, Staurastrum* diatoms *Navicula, Diatoma* etc. and a large quantity of filamentous algae; zooplankters comprising of Protozoa, Rotifera-*Brachionus, Keratella, Polyar-tha, Asplanchna* and *Filinia;* Crustacea- *Cyclops, Diaptomus* and *Moina* occur throughout the year. Tubificids, limnodriles and chironomids are common benthos Microbenthos will be dominated by ciliated protozoans which bear direct relationship between ciliate diversity and duration of wastewater loading (Kaufmann, 1958).

Wastewater may be recycled as a culture media for *Wolffia, Spirodela, Lemna,* used as feed for fishes and animals, with a high potentiality.

PRODUCTION OF FISH

Fishes may be grown singly (monoculture) or in combination (polyculture). Polyculture is a better means for exploitation of all the available ecological niches of pond ecosystem. Five different species of carps, Catla *(Catla catla),* rohu *(Labeo rohita),* mrigal *(Cirrhinus mrigala),* silver carp *(Hypophthalmichthys molitrix)* and common carp *(Cyprinus carpio)* are generally cultivated in sewage water. In addition Tilapia *(Oreochromis mosambicus),* grass carp *(Ctenopharyngodon idellus),* freshwater prawn *(Macrobrachium rosenbergii),* bata *(Labeo bata), (Cirrhinus reba),* carp minnow *(Amblypharyngodon mola),* and varieties of catfishes are also grown in wastewater aided culture system.

Several experiments have been carried out under Wastewater Aquaculture Programme following composite fish culture using a combination of five species at different stocking densities and combination. The results obtained in a sewage-fed fish pond at Titagarh is given in Table 1.

Phytophagus silver carp was found to attain promising growth in all the three experiments. Production suffered

Table 1 : *Culture of carps in a sewage-fed fish pond at Titagarh, West Bengal.*

Expt.	Stocking density (no/ha)	Species combination (R:C:M:SC:CC) (kg/ha)	Gross production (kg/ha)	Net production
1	24,000	1.7:3.1:3.7:0.7:0.8	6452.3/ 9 months	5711.0/ 9 months
2	15,000	2.5:1.0:2.5:2.0:2.0	7000.0/ 12 months	6791.0/ 12 months
3	10,000	2.5:1.0:2.5:2.0:2.0	5402.2/ 12 months	5002.4/ 12 months

R = Rohu, C = Catla, M = Mrigal, SC = Silver Carp and

CC = Common Carp.

(Source : Ghosh *et al.*, 1988)

in first experiment due to higher stocking density of catla. When stocking density of catla was reduced to 10 % in the successive experiments performance of both catla and silver carp was improved.

Omnivorous Tilapia *(Oreochromis mosambicus)* has a faster growth rate and profuse breeding rate was observed in sewage fed culture system of 0.076 ha pond adjacent to the Titagarh sewage treatment plant. The sewage effluent with a BOD of 120-360 mg/l was diluted with freshwater at sewage : water ratios of 1:2 and 1:3 depending on BOD of effluent and fish were introduced at three stocking densities of 17,000; 55,000 and 20,000/ha. Harvesting was carried out at fortnightly or monthly intervals depending on density and size of fishes. (Table 2)

Further experiments showed that the performance of silver carp was better as compared with other species. In a recent experiment (1992-93) with monoculture of silver carp, within 150 days fishes attained 1 kg weight and multiple stocking and harvesting was found to be a better means to obtain maximum production.

In a sewage-fed fish farm at Mudiali Fishermen Co-operative near Calcutta where five species of carps were grown along with Tilapia adopting multiple stocking and harvesting process, over 10 ton continuous production of fishes has been recorded. This farm has a continuous flow through system (Personal communication).

At Rahara, Naskar *et al.* (1986) recorded a production of 100.5 ton/ha/yr

Table 2 : *Culture of Tilapia in a sewage-fed pond at Titagarh.*

Experiment	Amount of effluent used (m^3)			Stocking density	Sewage: water ratio	Total production (kg/ha)
	Pre-stocking	Post-stocking	Total			
1	2,200	35,800	38,000	17,000	1:2	9,350/ 12 months
2	3,000	18,900	21,900	55,000	1:2	4,850/ 7 months
3	18,900	23,800	42,700	20,000	1:2	9,534/ 14 months

(Source : Jhingran And Ghosh, 1988)

of *Wolffia arrhiza* (L) with wastewater and could obtain 10358 kg/ha/yr production of carp fed exclusively with *W.arrhiza* with a feed conversion ratio of 6 kg dry *W.arriza* to 1 kg fish flesh.

Fallow land area of the Wastewater Aquaculture Farm comprising of embankments and adjoining areas usually remain unproductive. These areas could be brought under productive schemes with integrated approach. Low lying wet lands of the farm area could be converted into paddy-cum-fish culture area.

PADDY-CUM-FISH CULTURE

Two crops of paddy i.e. Boro and Kharif could be harvested selecting and planting proper high yeilding variety & 5-7.5 ton/ha of Boro and 1.8 to 3.0 ton/ ha kharif paddy with an average of 9 ton/ha/yr could be produced with recycling of wastewater. Short term rearing of carp seed in such paddy field was found to be congenial, but it has been recently observed that culture of carp minnow *Amblypharyngodon mola* or bata i.e. *Labeo bata* and *Cirrhinus reba* are better suited for short term rearing giving 50 to 75 kg/ha/yr in the former and 1.5 ton/ha/yr for the latter species. Both the species give better profitability since they are sold at a higher rate as compared to major carp fry.

HORTICULTURE

Farm dykes and extra land available in the Wastewater Aquaculture Farm could be brought under horticulture. Seasonal vegetables like cauliflower, cabbage, radish, onions, potato, tomatoes, brinjals, etc. along with different types of leafy vegetable were planted and grown in these areas. Wastewater was

irrigated and sludge was used as manure. About 110ton/ha/yr vegetables could be produced from the system. It has been found that leafy vegetables contributed more as compared to others. Other important items grown in the area were spices, turmeric and ginger. Recent introduction of *Amorphophillium* have shown promising results. Obnoxious growth of wild grasses could be controlled successfully by growing black gram as a method of biological weed control.

On the peripheral embankments plantation of banana and papaya was done which acted as a good revenue source. Coconut plantation around the peripheral embankment took 6-8 years time to come to fruiting stage. About 300 coconut trees were planted in the farm and on average each plant produced about 50 coconuts a year, the production of which would gradually increase.

Bringing the dykes and other land areas of wastewater aquafarm under integrated aqua farming system would not only increase revenue earnings of the farm but growth of weeds could also be checked and control of snakes would be possible.

FUTURE APPROACH

We have seen that with integrated farming system resource mobilization production has been increased. The approach may be further intensified by taking fodder growing programme, Spirulina culture, apiculture, sericulture, and duckery and poultry as well as cattle rearing. If all the programmes are brought under one umbrella, resource mobilization and recovery would find a meaningful way; employment generation would be possible and an idealistic model aquafarm could be set up.

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