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Enhancing production of fish through duck droppings in village pond of Chhattisgarh

Saugata Sasmal, Ankit Thakur and Goutam Roy

Abstract
Experiments were conducted at Gunderdehi village of Chhattisgarh to study the physico-chemical and biological parameters in fish-duck integrated farming system for two years. The ponds were stocked with 8000 fingerlings/ha of Indian Major Carps (IMC) to utilize the maximum energy in the tanks through polyculture. Their average size was 90±20 mm. This ponds containing the fingerlings of Indian major carps was then integrated with ducks (*Anas platyrhinos*) to serve the purpose of obtaining the eggs and meat as also deliver the excreta into the tank during wild grazing. Under such cultural practice at village level no supplementary feed was given to the fish while the ducks were fed with fresh kitchen leftovers and agricultural by products as kanki (broken cereal grains), kodha (rice bran), etc which are easily available commodities in rural areas. The mean dry matter loading rate of duck excreta was 6.1 kg/ ha /day into the pond and as a result the physico-chemical parameters as dissolved oxygen, pH, alkalinity changed significantly in treated pond and plankton volume also improved considerably. These parameters in totality affect the overall fish production raising from 1.7 to 2.8 tonnes / ha/year. The average egg production was 122 ± 9 bird^{-1} yr^{-1}. The results conclude that integration of fish with duck is more profitable than farming fish alone with no inputs under rural conditions of Chhattisgarh.

Keywords: Fish- duck integration, plankton, village pond, Chhattisgarh

Introduction
Fisheries is destined to play an important role in human nutrition but the cost is beyond reach of many people. Utilization of grain and animal protein as feed in aquaculture may not be economical as it might lead to food crisis and attention is being redirected to wider use of all resources and integrated fish farming offers a solution to the problem. Recycling of organic wastes for fish culture serves the dual purpose of cleaning the environment and providing economic benefits. In India about 40% of cultivated area is under irrigation and 60% of cultivated area is under rain fed condition. Where as in Chhattisgarh the irrigation percentage to net sown area is 32.10% and the rest is rain fed (67.9%). At village level in Chhattisgarh the main water resource is village ponds. The village ponds are used for irrigation, fish culture and other multipurpose domestic activities (bathing, washing etc). These ponds are rain fed. In which no inputs are given and nutrient availability is very poor, as a result there is low fish production. In such ponds, recycling of nutrients through integrated farming is a suitable alternative (Anonymous, 2006) [1]. The recycling of animal dung/ wastes in fish ponds is important for natural fish production as also sustainable aquaculture and to also reduce expenditure on costly feeds and fertilizers which form more than 60% of the total input cost in semi intensive fish culture systems. However, the indiscriminate use of these manures in fishponds, instead of improving the pond productivity, may also lead to pollution. Although some work has been done on animal manures like cow dung, poultry droppings and biogas slurry which are suitable substitutes for costly feeds and fertilizers (Schroeder 1980; Dhawan and Toor 1989) [13, 6], there are few reports on the recycling of duck manure in fish ponds and more so under Chhattisgarh and Indian conditions. Chhattisgarh has large number of water bodies as village ponds to the tune of 60,028.8 ha which can efficiently be utilized for fish production and will add to the microeconomics of the village. Presently the village tanks are being utilized for domestic purposes and no inputs are allowed into it for fear of killing the aesthetic value of the pond. So only fish seed as input is allowed and any other input is taken as a cognizance offence by the village folk hence fish production is very low. To overcome this problem integration of fish with duck farming is a suitable alternative for which the village folk do not have any objection.

The ducks can be fed on locally available agricultural by products and kitchen leftovers by the farmers. These ducks make their way into the ponds during day time and release the droppings into the water. These droppings contain undigested grains that can be consumed by the fish and is also nutrient rich, which will improve the plankton (ultimately fish production) through nutrient accumulation over a period of time. At harvest in addition to fish, duck eggs and duck meat will also become available to the farmers as an additional source of income as also nutritional security to his family.

Materials and Methods

The study involved two years with four ponds – three with ducks (0.5 ha.) another without ducks (0.6 ha). All ponds are perennial in nature and shrinking in nature. Unwanted fishes were removed with repeated netting. In August, advanced fingerlings of Indian Major Carps (Catla, Rohu and Mrigala) were stocked @ 8000/ ha in the ratio of 3:3:4 measuring 90±20mm and weighing 8.5±2.75g. After one month of stocking the fingerlings 90 days old ducks were brought into use. These ducks were given to all families of the village in equal numbers. Water quality parameters of ponds were analysed fortnightly for temperature, dissolved oxygen, pH, free carbon dioxide, alkalinity, hardness, conductivity, nitrate nitrogen, ammonical-nitrogen, chloride, calcium, phosphate, BOD, phytoplankton and zooplankton (APHA,1989) [3]. Soil parameters like pH (Piper, 1950), Nitrogen (Subbaiah and Asija, 1956) [14], Phosphorus (Olsen's *et al*., 1954) [11], Potassium (Hanway and Hiddle, 1952) [8], Organic Carbon (piper, 1950) were also analyzed on monthly basis. Manure loading rates in treated tank were determined by randomly collecting samples from 6 ducks over a week's period. The duck manure was tested for phosphorous (Yoshida *et al*., 1971) [15], nitrogen and ash (AOAC, 1975) [2] also. No supplementary feed was given to the fish, whereas the ducks were attuned to go to the village pond in the morning (9.00 am) and come back to their habitat (farmer's house) in the evening (5.00 pm). Under the exiting conditions here, farmers could not afford to have duck house and conduct stall feeding, therefore, scavenging mode/wild grazing was adopted at the out-farm trials. Ducks were fed (average 75 g.) with fresh kitchen leftovers and agricultural by products as kanki (broken grains), kodha (rice bran) etc by the farmers. Growth of fish was recorded every month from sample catches obtained by cast netting.

Results and Discussion

Duck manure composition and mean loading rates: In the present study four ponds were studied for fish production in which one was not treated (T_1) and the other treated with ducks (T_2). The mean loading rate of duck manure in treated pond was 6.2 kg ha^{-1} day $^{-1}$ at a stocking density of 300 ducks/ha. The proximate composition of duck manure and mean loading rate are depicted in Table 1.

Water quality parameters: Water quality parameters of both the treatments are presented in Fig 1a and Fig 1b. Water temperature fluctuated widely between 20.1 to 33.2 ºC, and followed closely with climatic changes. The pH of water varied from 6.3 to 8.15 with moderate fluctuations. In treated pond, maximum pH was observed during summer periods, especially in March. Golterman (1970) [9] while analyzing natural waters for relation between pH and percent of free CO_2, HCO_3 and CO_3 found that an increased pH means higher carbonate values. In the present study negative correlation was found between pH and CO_2. The higher values of alkalinity were observed in T_2 (108-187 ppm) in comparison to T_1 (85-166 ppm). Alkalinity is negatively correlated with pH and DO in the present study. Chari (1980) [4] also found inverse correlation between pH and alkalinity. Dissolved oxygen was highly significant among all others parameter, the mean DO was 6.99 which indicates favourable condition for fish growth. It may be assumed that movements of ducks in the pond helped in aerating the water. In integrated farming system, monitoring BOD is absolutely essential as thick organic sediment settles at the pond bottom, which hastens the depletion of oxygen and enhances the production of toxic gasses which can result in fish kills. In the present study, BOD level was quite low in treated pond in the range of 5.0-9.1 mg/1. There was a negative relation between DO and BOD. The observed concentration ranges of the ammonia-N, nitrate-N, phosphate-P and potassium in water were 0.004-0.040, 0.136-0.380, 0.010-0.260 and 0.82-70.00 ppm, respectively. The above values were lower initially when ducks were not introduced but later when ducks entered the pond almost all values increased due to cumulative effect. It has been found that phosphates are essential for the growth of green algae (Jana, 1973) [10]. However, the present studies established a positive correlation (r = 0.717) between these two. A direct correlation was observed with nitrate and the population density of Chlorophyceae and nitrate-nitrogen during the present investigations. Similar result was also obtained by Chari (1980) [4].

Physico chemical properties of soil: The pH of soil sample were slightly acidic throughout the experimental period in T_2 (6.50-6.75) and T_1 (6.35-6.65). The pH was found to be significant between treatments. The Central Inland Fishery Research Institute (CIFRI) recommended that pond soil pH between 6.5-7.5 is productive range. The present studies are also in agreement with these observations with minor difference. The highest mean value of nitrogen in soil was found in T_2 (18.55 mg/100 gm soil) and low in T_1 (16.46 mg/100 gm soil). In case of phosphorous, it was found that average mean was higher in T_2 (0.66 mg/100 gm soil) and low in T_1 (0.55 mg/100 gm soil). The organic carbon at different periods in experimental soil was found highly significant between the two treatments. Among the treatments the highest mean value of organic carbon was found in T_2 (0.71%) and lowest in T_1 (0.53%). In T_2 it was found that organic carbon increased from 0.69% to 0.74%. The fertilizer schedule developed by CIFRI based on nutrient requirement of ponds, classied them as low, medium and high productive ones. In the present studies both the ponds T_1 and T_2 are falling in medium productive range.

In pond eco-system the soil water interaction plays an important role. Nutrient comes from upper layer of soil which ultimately increases the plankton production. The present studies conclude that duck droppings increased the nutrient content in soil and water which affect the plankton production and ultimately the fish production.

Plankton abundance: In the present study, plankton biomass was significantly higher in T_2 than T_1. Duck droppings is an organic manure, which contributes to the growth of plankton, a high protein natural feed for certain fish species in

communal tank (Edwards 1986) [7]. A total 16 genera of phytoplankton comprised mainly of four groups (Chlorophyceae, 5; Cyanophyceae, 4; Bacillariophyceae, 3 and Euglenophyceae, 2) and 7 genera of zooplankton (Crustacea, 4 and Rotifera, 3) were recorded in both the ponds. The other phytoplankton groups like Dinophyceae, Chrysophyceae and zooplankton like cladocera, protozoans population were also present in both the treatments. Among phytoplankton the most common genera were *Chlorella sp, Spirogyra sp, Ulothrix sp, Volvox sp, Anabaena sp, Microcystis sp, Nostoc sp, Oscillatoria sp, Navicula sp, Pinnularia sp, Euglena sp and Trachelomonas sp*. Whereas *Daphnia sp, Moina sp, Cyclops sp, Diaptomus sp, Asplanchna sp, Brachionus sp and Keratella sp* were among the most abundant zooplankton genera. The plankton production was found to be significant between treatments, the highest mean value observed in T_2 (262 no/l) and lowest in T_1 (89 no/l). In T_2 plankton population was highest where phytoplankton ranged from 48 to 256 organisms litre^{-1} and zooplankton ranged between 28 to 273 organisms litre^{-1}(Fig. a). T_1 showed a lower population with phytoplankton ranging from 41 to 52 organisms litre^{-1} and zooplankton ranged between 30 to 40 organisms litre^{-1} (Fig. b). T_2 achieved a peak plankton production in April and May and then a certain decline was observed in December. The total phytoplankton and zooplankton were significantly higher (P<0.05) in treated pond than that of non-treated pond. Correlation between nutrients and different phytoplanktonic groups were made (Table-3) and it was found that Chlorophyceae, Bacillariophyceae and Euglenophyceae were influenced by phosphate, ammonia- nitrogen and nitrate-nitrogen.

Growth of fish: The growth parameters of fish species under different treatments are shown in Table 2. The average initial weight of fingerlings at the time of stocking was 8.5, 7.5, 7.0 g in T_1 and T_2 for catla, rohu and mrigal respectively. At the end of culture period, the average final weights (g) of each fish species in the treatments (T_1 followed by T_2) were : catla 490, 760; rohu 450, 680 ; mrigala 410, 610. Irrespective of treatments, the yield of catla was highest followed by rohu and mrigala.

Growth of ducks: Growth performance was studied at fortnightly interval measuring weight gains of ducks reared for one year. The average initial mean weight of ducks in was 820g. The maximum weight of ducks increased to 1304g. At the end of experimentation period the final weight of ducks was 970g. During experimental period, the peak mean weight of ducks was observed in March and a decline was observed in April to May, due to increase of ambient air temperature. The duck survival rate was 85%. Chand *et al.* (2006) [5] recorded survival rates at different stocking densities i.e. 93%, 91% and 90% in D_{200}, D_{300} and D_{400} respectively.

This present experiment concludes that duck excreta is a good source of nutrients, which are readily soluble in water and available for plankton production. On the other hand, the duck excreta is improving the nutrient level in fish pond ecosystem at productive range. The physico chemical parameters of water and soil in T_2 are in more productive range giving good survival of fish and ducks. The cost and returns of fish cum duck farming is more profitable than fish farming alone (Table 4). Therefore, the integrated fish cum duck farming gives better returns in terms of pond productivity, fish growth, survival and profit as compared to fish farming a

Table 1: Duck manure composition and mean loading rates

Proximate composition of manure, % Moisture	76.6 ± 1.2
Proximate composition of manure, % DM basis	
Nitrogen	4.5 ± 0.6
Phosphorus	1.5 ± 0.2
Ash	25.1 ± 1.2
Mean loading rate, kg dry wt. ha^{-1} day $^{-1}$	
Total input	6.20
Total nitrogen	0.29
Phosphorous	0.10
Ash	1.62

Table 2: Growth parameters of fish species in different treatments

Parameters	**T_1**	**T_2**
Growth rate of catla (g day^{-1})	1.71	2.65
Survival of catla (%)	66.5	72.6
Average weight at harvest (g)	490	760
Yield of catla (Kg)	352.31	497.04
Growth rate of rohu (g day^{-1})	1.57	2.37
Survival of rohu (%)	61.8	65.8
Average weight at harvest (g)	450	680
Yield of rohu (Kg)	300.15	403.24
Growth rate of mrigal (g day^{-1})	1.43	2.13
Survival of mrigal (%)	63.3	68.3
Average weight at harvest (g)	410	610
Yield of mrigal (Kg)	373.92	499.95
Total yield (Kg)	1026.38	1400.23
Productivity (Kg/ha)	1710.63	2800.46
Mean survival (%)	63.8	68.9

Table 3: Correlation coefficient computed between different physico-chemical and biological parameters

Temperature vs Dissolved oxygen	-0.49
DO vs BOD	-0.94
Free CO_2 vs DO	-0.96
Total Alkalinity vs free CO_2	-0.31
Calcium vs Phosphate	0.72
pH vs Alkalinity	0.96
Total phytoplankton vs DO	0.32
Chlorophyceae vs phosphate	0.71
Chlorophyceae vs nitrate	0.69
Chlorophyceae vs ammonia-nitrogen	0.64
Bacillariophyceae vs nitrate	0.48
Bacillariophyceae vs phosphate	0.37
Bacillariophyceae vs ammonia-nitrogen	0.56
Zooplankton vs phosphate	-0.29
Zooplankton vs DO	-0.19

Table 4: Benefit- cost analysis of fish – duck integration system (1 ha. area)

Parameter	**T_1**	**T_2**
Fish yield (Kg/ha/crop)	2800.46	1700.10
Egg yield (Nos/yr)	-	28060
Duck meat (Kg)	-	147.35
Total expenses (Rs.)	15,800.00	36800.00
Income (Rs.)	54,403.20	198955.47
Net profit (Rs.)	38,603.20	1,62,155.47
Benefit: cost ratio (Income: expense)	3.44	5.40

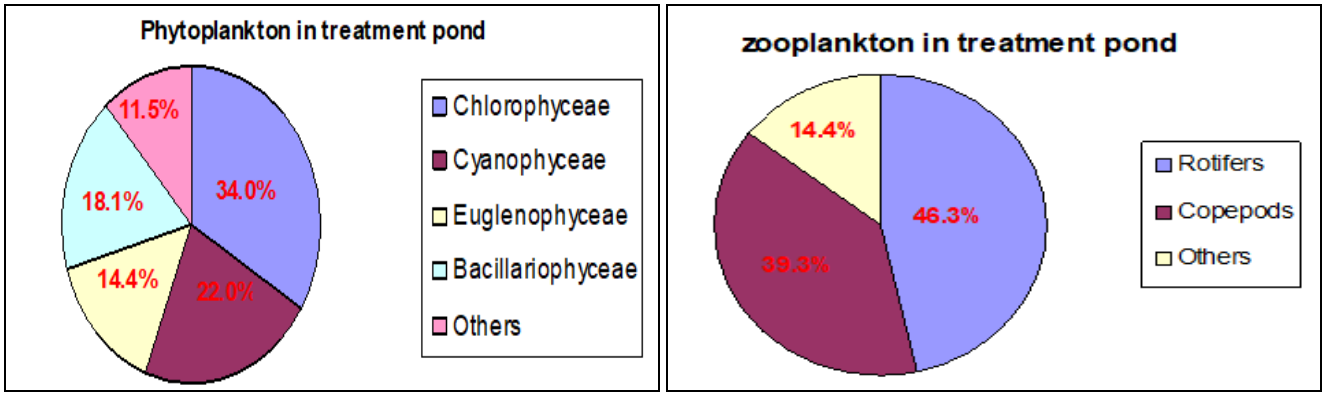

Fig a: Average quantity of plankton (%) in treated ponds

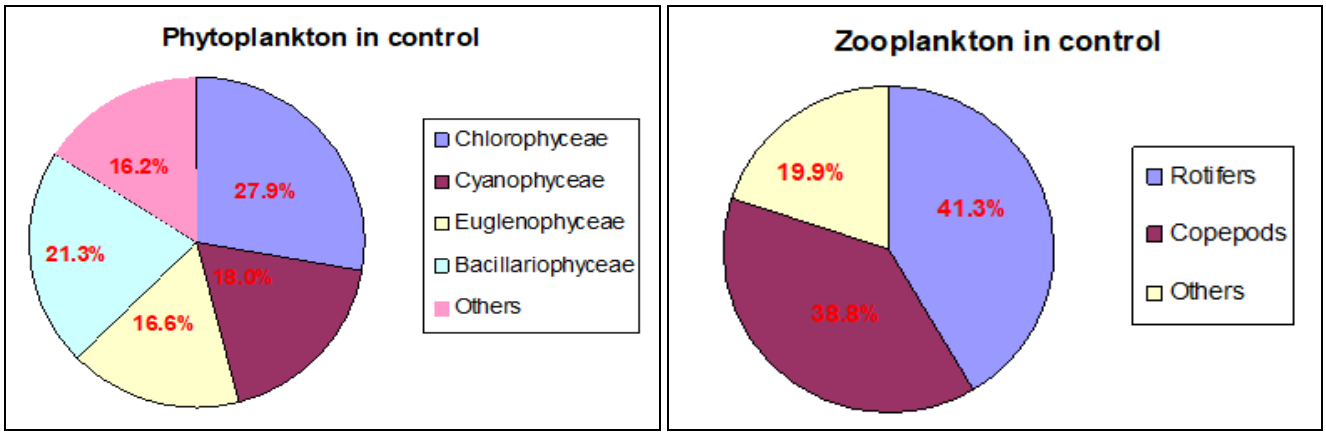

Fig b: Average quantity of plankton (%) in control ponds

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