Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 10 [1] December 2020 : 65-73

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.876
Universal Impact Factor 0.9804
NAAS Rating 4.95

ORIGINAL ARTICLE **OPEN ACCESS**

A New dimension for empowerment of rural women through intervention of small scale integrated duck-cum-fish farming in homestead ponds

Ipsita Paul[1], Ashis Kumar Panigrahi[2], Subhendu Datta[3*]
1 Research Scholar, Fisheries and Aquaculture Extn. Laboratory, Department of Zoology, University of Kalyani, Kalyani, Nadia, West Bengal, India
2 Professor and Head of Dept. of Zoology, Fisheries and Aquaculture Extn. Laboratory, Department of Zoology, University of Kalyani, Kalyani, Nadia, West Bengal, India
3 Professor in Fishery, Regional Research Station, New Alluvial Zone, Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, Nadia, West Bengal, India. PIN-741234,
E-mail ID: drsubhendudatta@rediffmail.com
*corresponding author

ABSTRACT
In a predominantly agrarian society as found in India, the integrated farming systems are the most convenient ways of resource utilization and environment protection which offers cost effective farm income and cheap source of animal protein for the economically weaker section. It is one of the best efforts to empower the rural women within their socially safe place. For the present study 10 economically backward rural women possessing homestead ponds have been selected by a previously tested questionnaire from Chinili and Chougacha villages of Nadia district under the New Alluvial Zone of West Bengal to empower them through participatory integrated duck-cum-fish farming. Infrastructures have been developed accordingly for rearing 20 ducks and culturing Indian major carps (@ 7500 nos/ha) for one year. Excessive use of livestock manures in the homestead ponds may create unbalanced conditions in the aquatic ecosystems, such as eutrophication and anoxic condition as well. By pilot experimental trial through monitoring the activity of nitrogen cycle bacteria and water quality parameters, it has been found that regular application of duck droppings with a dose of 50 kg/ha/day or rearing of 360 ducks/ha is beneficial with bi-monthly lime application @ 37.5 kg/ha. Water quality parameters have been found to be congenial for carp culture during the culture period. The activity of duck-cum-fish farming in homestead ponds is supportive to their empowerment with annual income generation ranging between INR 20028.80/- to INR 38385.40/- per year.
Key words: socio economic status, women empowerment, duck droppings dose, ammonia oxidizing bacteria, water quality parameters and income generation.

Received 20.07.2020 Revised 03.10.2020 Accepted 29.11.2020

INTRODUCTION

In rural areas, especially among weaker sections of the society, women empowerment should focus on slavery reduction, gender sensitization, scope building and advancement of micro-enterprises [1]. The pace of social change in West Bengal has accelerated in recent years, but the problem of gender inequality in West Bengal has revealed as a new dimension. Thus, empowerment of women, rural in particular, is the first and foremost need to develop our society as contribution of person power of women to our society is nearly 50%. Efforts for capacity building of rural women for income generation would be one of the propositions to empower them which in turn will be beneficial for children of the family [2]. On the other hand it has also been found that women who are empowered become solutions to poverty, domestic violence, poor health and vulnerability for their families and within their communities.

Integrated fish farming in homestead ponds is one of the effective ways to engage women in income generating activities as it is best suited to them with regard to their social security and utilization of their leisure time. Firstly integrated farming approach for utilizing household resources is one of the best

efforts to empower the rural women. It is not only a unique method of sustainable development which minimizes the negative effects of intensive farming with preserving the environment but also a resource-saving practice to provide acceptable profits [3]. Secondly in case of integrated farming system, production of the livestock can solve malnutrition problem of weaker section by providing cheap source of high-quality animal protein [4]. Integrated fish farming is the system of using livestock manure in fish farming ponds [5]. Livestock manure applied to the aquaculture pond is directly consumed by fish, and in addition to that release of nutrients enhance the growth of photosynthetic organisms because about 72-79% of Nitrogen (N), 82-92% of Potassium (K) and 61-87% of Phosphorus (P) in feed given to animals can be recovered in their excreta and as a result it offers an pollution free environment [5, 6]. Homestead ponds provide great opportunity to rural women for participating in integrated fish farming [7].

Integrated fish farming with ducks is the best model of integration of fish and live-stocks [8]. Duck droppings are good source of essential nutrients such as nitrogen (0.9%) and phosphorus (0.4%) which go directly into the pond and in turn enhance growth of natural food organisms [9]. On the other hand, swimming of duck helps in aerating water there by cause increase in the DO of the water body [10]. One mature duck can provide about 125 - 150 gm droppings per day and as a result pond receives 10000 – 15000 kg duck droppings per year when 250- 300 ducklings are stocked per hectare [9]**.** The present study has considered the application of duck droppings at a dose of 50 kg /ha/day is appropriate for fish growth which is approximate to the rearing of 360 ducks/ha under controlled condition.

The present study also focuses on monitoring of microbial communities by considering its role on both maintaining water quality and optimal feeding of cultured animal which have direct impact on fish growth [11]. In that case nitrifying microbes (AOB) were given to special attention because of their efficacy to reduce ammonium nitrogen to nitrite nitrogen which can be utilized by phytoplankton and that in turn may enhance the productivity of zooplankton and of course the productivity of detritus there by offering more foods for fishes [12]. Thus, the present work has been undertaken to empower rural women by involving them in the practice of duck-cum-fish farming in small homestead ponds by regular monitoring of water quality with special reference to the abundance of nitrifying bacteria.

MATERIAL AND METHODS

Two remote villages situated in the New Alluvial Zone of West Bengal namely Chinili (23°01'44.1"N 88°43'05.1"E) and Chougacha (23°02'01.4"N 88°36'56.7"E) under Dewli Gram Panchayat of Chakdah Block, Nadia district with an area of 3.75 and 12 square kilometers respectively have been chosen for implementation of the activity on participatory mode. There are about 60 ponds in the village Chinili and 89 ponds in the village Chouacha of which about 25 and 37 respectively are of homestead in nature with an average area of 5 $\pm$ 1.7 cottah (334.45 $\pm$ 113.71 m^2) and water depth of 1.2 ± 0.16 m during summer and 2.02 ± 0.37 m during monsoon. Ten socio-economically backward women possessing perennial homestead ponds have been selected by random survey with a previously tested questionnaire from Chinili and Chougacha for integrated duck-cum-fish farming in their homestead ponds. Accordingly, infrastructures for the integrated fish farming (*viz.* duck house and pond renovation) have been developed for rearing 20 ducks integrating with composite fish culture of Indian major carps at a stocking density of 7500 fingerlings (10$\pm$0.5 g) per hectare pond area. Indian major carps (*viz.* catla, rohu and mrigal) have been selected for its high acceptability in the locality and stocked at a ratio of 3:3:4. In addition to that three control ponds have been chosen for culturing IMCs with monthly applications of lime (@ 75 kg/ha/month) and raw cowdung (@1000 kg/ha/month) to compare the water and soil quality variables, microbial loads and fish growth with the treated ponds throughout the culture cycle.

Forty 8-day-old ducklings of khaki Campbell breed have been distributed among the beneficiaries, among which male were sold out after attaining maturity and 50% were reared by following standard vaccination schedule for maintaining 18 ducks and 2 drakes at their maturity for each beneficiary. Low-cost duck feed containing about 40% protein which has been formulated with 28% cereals, 10% oil cakes, 5% shell grits, 25% leafy vegetables, 30% rice bran and 2% vitamins and minerals supplements [1].

Standard method of composite fish culture has been followed [13] with initial duck dropping application at a dose of 200 kg/ha for pond preparation and thereafter regular application at dose of 50 kg/ha/day and 37.5 kg/ha quick lime application at bimonthly intervals. In every morning after sunrise duck droppings have been applied at fixed dose (50 kg/ha) which is equivalent to the rearing of 360 ducks/ha, although application deferred on the days at less than 20 cm water transparency in the respective ponds [9, 14, 15]. No supplementary feed has been given to fish and pond area-specific fixed numbers of ducks have been allowed to swim in ponds for six hours in a day to restrict duck droppings (25%) application dose. Raking has been performed throughout at weekly intervals to remove obnoxious gases at the pond bottom and netting has been done at monthly intervals to record fish health and growth.

All the 20 ducks have not been allowed to swim regularly, rather fixed no of ducks depending on pond size have been chosen randomly on every morning for fixed hours to balance the extra manuring during swimming of the ducks there by maintain the application of duck droppings with a dose of 50 kg/ ha/day. It does not hamper the productivity because khaki Campbell ducks do not need much water.

Water samples from the homestead ponds have been collected in neutral plastic containers at a fixed hour of the day (6.00 a.m. to 8.00 a.m.) at bimonthly intervals from January 2018 to December 2018. Physico-chemical parameters (*viz.* pH, alkalinity, free CO_2, NH_4-N, NO_2-N, NO_3-N, PO_4-P) of the ponds have been monitored by following standard methods [16, 17]. Dissolved oxygen (DO) has been determined after sampling in BOD bottles and chemical oxygen demand (COD) of water samples has been determined by digestion method following the standard protocols [16, 18]. Pond sediment samples have been collected in sterilized containers and then suspension of 1 g wet sediment and 99 ml of sterile distilled water followed by subsequent dilutions have been prepared to carry out pour plate method for bacterial isolation [19]. Purpose of the experiment emphasizes on the isolation of Ammonia oxidizing bacteria (AOB) is because of its involvement in nitrogen transformation there by enhancing pond productivity. AOB have been isolated in selective medium following standard methodology [20]. To assess the status of a fish pond for its suitability for supporting fish growth it is necessary to observe seasonal diversity and abundance of zooplankton. For zooplankton monitoring 50 L of pond water from the surface of the pond (0.5 m) have been filtered through plankton net of 50 µm mesh size at fortnight intervals and preserved in 4% formalin [21]. Primary productivity has been monitored using dark and light bottle method [22].

RESULTS AND DISCUSSION

Profile of beneficiaries:

A survey has been conducted to select 10 families suitable for introducing duck cum fish farming. It has been found that about 20%, 30%, 30% and 20% of total respondents belong to age group 20-30 years, 31-40 years, 41-50 years and 51-60 years, respectively. So far literacy is concerned; it has been found that about 10% illiterate, 30% up to class 4, 20% up to class 8, 20% secondary level, 10% higher secondary level and 10% post graduate level. It has also been found that among the selected families only 40% live in *pucca* houses and 100% have sanitary systems in respective house. More over 90% of the selected families have tube-well in their courtyard as a good source of water and 10% have panchayat's supplied water source. All of the homestead ponds of the beneficiaries ranging from 2 cottah (133.78 m^2) to 10 cottah (668.9 m^2) have not been utilized properly before implementing the activity for providing a good economic benefit to those economically backward families. Duck cum fish farming have been selected as the best suitable model for them as it requires minimum input and labor, so, rural women can participate in this programme without hampering their daily domestic activities and of course with small investment. Standard method [13] and the aim of the following study was elaborately described to them and specific calculated dose of duck droppings were suggested to them according to the size of each homestead pond.

Water quality analysis:

Excessive use of livestock manures may present a risk related to the creation of unbalanced conditions in the aquatic ecosystems [23], such as oversupply of nutrients, eutrophication and anoxic condition due to decay of organic matter and presence of enteric pathogens. Our aim is to eliminate the problems associated with integrated fish farming. On that matter microbiological analysis is the most convenient way to determine the proper dose of duck droppings because the microbial activity has been found to supportive for fish growth up to a certain limit of organic fertilizer dose and further increase beyond the pond's threshold level may have negative impact on water quality [24]. Experimental trials have been carried out in the laboratory tanks for three months with three replications for each control and treatment) and regular application of duck droppings with a dose of 50 kg/ ha/day has been found to be beneficial with bi-monthly lime application @ 37.5 kg/ha. Although in field study as ducks have been allowed to swim for maximum six hours in a day so duck dropping dose has been rectified accordingly to balance the unwanted manuring during swimming. The doses of duck droppings and lime applications have been differed according to the condition of the pond water. During prolonged cloudy days application of duck droppings have been avoided to stay away from oxygen depletions or anoxic conditions.

Important water quality parameters which have direct influence on fish health and growth [25] such as pH [26], alkalinity [27], DO [26] were supportive for biological productivity in case of the ponds treated by duck droppings (Table:1). Bacterial load was also supportive for fish culture [28].

Transparency of the water should be within 30-60 cm [26]. In the present study transparency has been recorded more or less within the desirable limit throughout the study period although during summer months it is lowered a little bit because of plankton bloom and during heavy monsoon it is further lowered because of clay turbidity for receiving surface run off. While in case of dissolved oxygen (DO), the

integrated duck cum fish farming ponds were greater than DO of the control ponds even after daily duck droppings application. The probable reason is that swimming and movements of ducks in the pond helps in aerating the pond water [10].

DO is inversely correlated with Chemical oxygen demand (COD) and that is why COD of the ponds were found within the desirable limit in case of duck cum fish farming ponds but in case of experimental trial COD of the tanks treated by duck droppings was higher than the control tanks as supporting aeration system by duck swimming was restricted in case of tanks.

pH of the water body greatly influences the DO, Alkalinity, Free CO_2 and many other water quality parameters. It has been reported that neutral to slightly alkaline pH range is most favorable to fish ponds [29]. In the present study pH is highest in the ponds during monsoon due to surface run off and slightly acidic during summer in the ponds treated with duck droppings. Decrease in water level as well as transparency during summer months is responsible for lowering pH of the ponds treated with duck droppings than control. Although in comparison to the ponds lesser variations have been seen in the treatment tanks.

pH of the water body is directly correlated with free CO_2 and alkalinity. Fish avoid free CO_2 levels as low as 5mg/l but most species can survive inwards containing up to 60 mg/l CO_2 provided DO concentration is high [30]. As pH is increased during monsoon that in turn decrease the free CO_2 and increase the alkalinity. Both carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-) alkalinity have been seen in the treatment tanks and in case of village ponds although most of the time only bicarbonate (HCO_3^-) alkalinity has been found. During monsoon as values of pH of the pond water have been raised, values of carbonate alkalinity have become positive beyond zero and consequently values of Free CO_2 have become zero.

Interaction between water quality and nitrogen cycle bacteria and that in turn with the productivity of the particular systems have been established by the experiment. Nitrifying bacteria have unique correlation with phytoplankton in respect to their usage of ammonia and nitrite as nitrate which are produced by nitrifiers (AOB) are then is utilized by phytoplankton, considered as important primary producers in the aquatic ecosystem [31]. Although in the present study plankton abundance is high during summer when A.O.B concentration is lower than winter season that may be because plankton cause direct intake of ammonia. Bacterial growth requires oxygen and that is why DO of the water body is positively correlated with the abundance of ammonia oxidizing bacteria. Ammonia and nitrite are the toxic form of nitrogen although nitrate is the mostly preferred form. Ammonia is the preferred N substrate for phytoplankton but only when it is present within the desirable limit [32]. The unionized form of ammonia (NH_3) is extremely toxic than ionized ammonia (NH_4^+) because it is able to diffuse across cell membranes [33] and pH cause transition between the two forms with an approximation, at pH 7.3 about 1% is unionized; at pH 8.3 about 10% of ammonia is unionized and at pH 9.3 about 50% of ammonia is unionized [32].

In the present study growth of nitrifying bacteria (Ammonia oxidizing bacteria) has been regularly monitored to keep all the forms of nitrogen (Ammonia, nitrite, nitrate) in its desirable limit. This is the key way of finding out the appropriate dose of duck droppings conductive for fish growth. In the present study cfu of Ammonia oxidizing bacteria of sediment is highest in treatment ponds during winter and is lowest during summer months as it is positively correlated with DO.

Ranges of Gross primary productivity are within desirable limits for fish growth in treatment ponds and vary between 215.32-450.75 mg $C/m^3/h$, throughout the year where as in control ponds this are within 184.5-245.5mg $C/m^3/h$. Primary productivity is high in the ponds treated with duck droppings than control ponds, which implies the role of nitrifying bacteria in enhancing pond productivity. As a result, better fish growth has been seen in treatment ponds than the control ponds (Fig. 2, Fig. 3, Fig. 4). Significant difference has been seen between the productivity of control ponds and the ponds treated with duck droppings (ANOVA, $P<0.05$).

Zooplankton abundance is higher during summer followed by winter and then monsoon while greater diversity has been seen during monsoon (Fig. 1). On the other hand, higher nitrifiers in the ponds treated by duck droppings than control ponds have shown positive correlation with the zooplankton abundance which implies the role of nitrogen cycle bacteria in the integrated fish farming ponds.

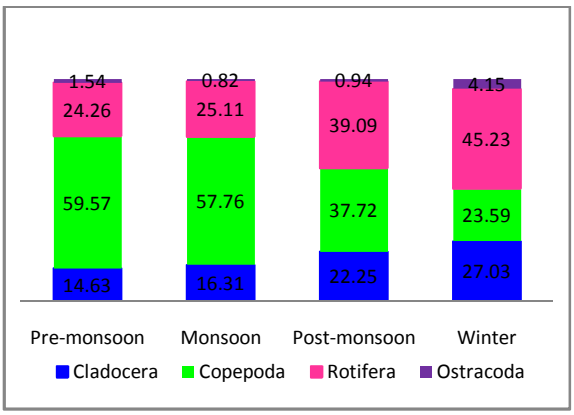

Fig 1: Zooplankton abundance

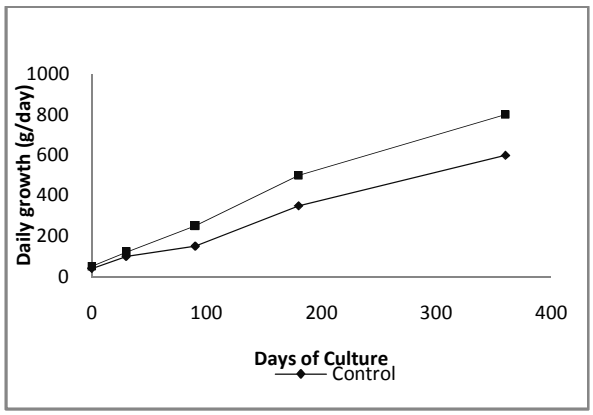

Fig 2: Growth performance of Catla

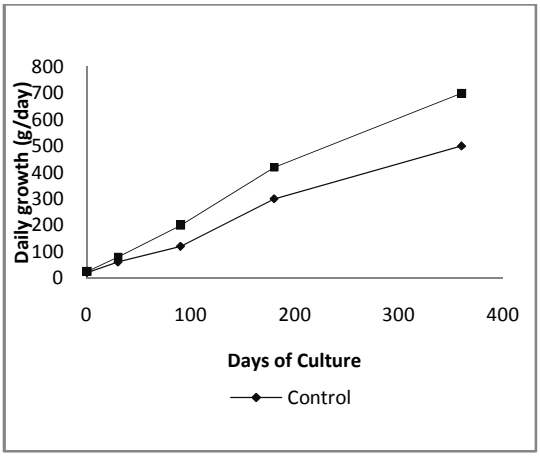

Fig. 3: Growth performance of Rohu

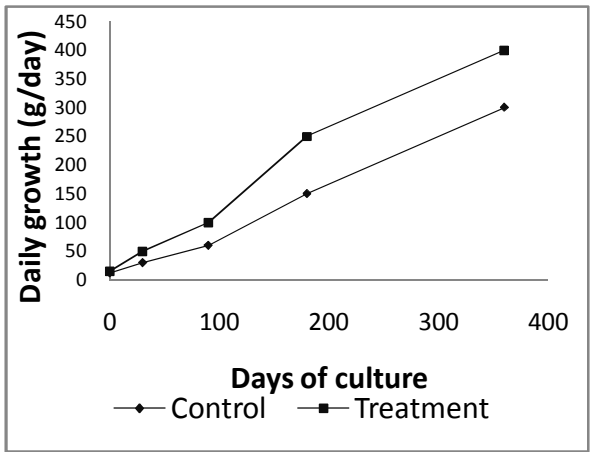

Fig. 4: Growth performance of Mrigal

Production and Economic analysis:

Integrated duck cum fish farming not only offers nutritional security but also reduces the cost of fertilizer and feed in fish culture and maximize the benefits. For the present study Khaki Campbell breed has been chosen mainly for their excellent egg laying ability. Mortality of some ducks has been occurred due to animal attack, common cold, fever and diarrhea and diseases at early stages. Threatens by predator during early age of the birds creates great problem regarding survival [34]. After attaining maturity at the age of 4 months, mortality of ducks has been recorded to 7% and at the age of 6 months drakes have attained the body weight of 1.8 – 2.2 kg and ducks have attained 1.6-2.0 kg. Some of the ducks have been started egg laying at the age of 20-25 weeks. A portion of produced eggs are being sold out by them and the males have been sold out after attaining maturity by keeping 1:9 ratios for the rest of them. Average egg production of the ducks was within a range of 161.33 -180.33 eggs bird^{-1}yr^{-1} with an average of 171.02±7.17 eggs bird^{-1}yr^{-1}.

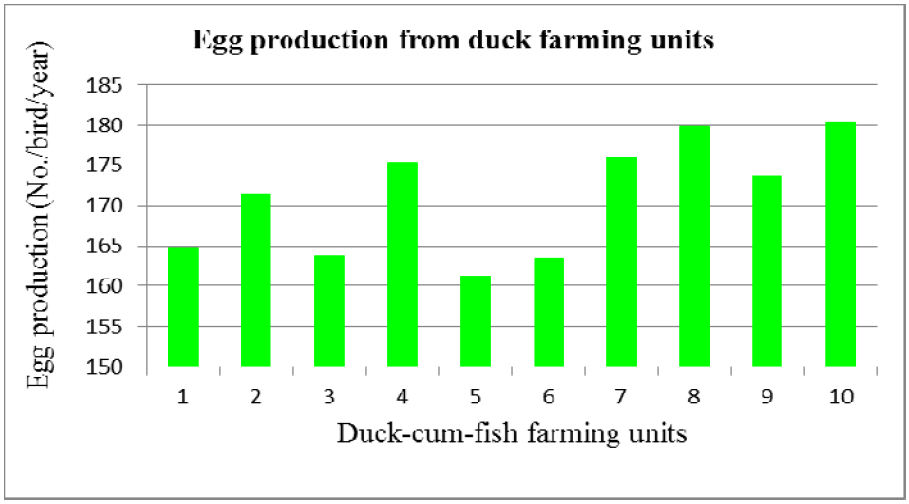

Fig 5: Annual egg laying performance of ducks reared by the beneficiaries

Fish harvesting depends on the consumers demand in the local market. In the present study most of the beneficiaries have been preferred partial harvesting apart from their consumption and final fishing has been done after one year. Survival of 50 -80% of different fish species have been recorded with no disease outbreak. Average weight of catla, rohu and Mrigal are about 700-800 g, 600-700 g and 300-400 g respectively. Although production is less in comparison with semi-intensive carp culture [14] on the basis of investment as it requires zero input and a little bit management it is very much supportive for empowering rural woman (Fig: 6).

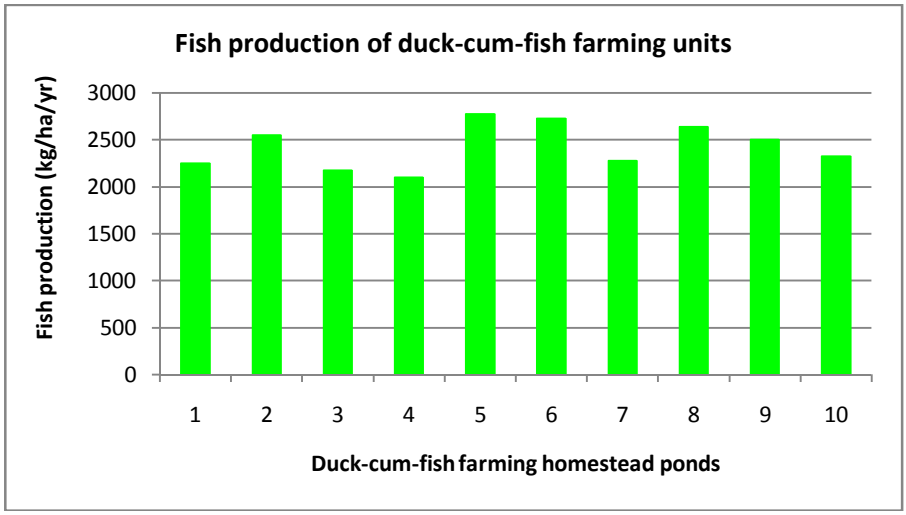

Fig 6: Annual fish production in integrated duck cum fish farming ponds of the beneficiaries

Table-1: Physico-chemical parameters of Control and duck droppings treated (Treatment) ponds during the period of investigation

Parameters	Control	Treatment
Transparency (cm)	20.35-39.42	16.5-36.25
pH of water	7.34-8.49	6.98-8.93
Free CO_2 (mg/L)	0-21.63	0-30.80
Carbonate Alkalinity (mg/L)	0-11.76	0-18.41
Bicarbonate Alkalinity (mg/L)	108-220	160-286
Dissolved Oxygen (mg/L)	5.6-11.4	5.9-12.8
Chemical Oxygen Demand (mg/L)	37.42-55.40	39.67-97.87
Ammonium- Nitrogen (mg/L)	0.09-0.25	0.21-0.49
Nitrite- Nitrogen (mg/L)	0.03-0.08	0.04-0.09
Nitrate- Nitrogen (mg/L)	0.05-0.14	0.12-0.27
Ortho- phosphate (mg/L)	0.02-0.12	0.07-0.26
Gross primary Productivity(mg/m^3/hr)	184.5-245.5	215.32-450.75
Ammonia Oxidizing Bacteria (cfu/g) $\times 10^2$	25.33-95	34.44-151

Table-2: Economic analysis of integrated duck-cum-fish farming in homestead ponds (5 cottah/ 334.45 m^2).

Item	Particular	Value(INR)
Economics of duck farming		
Capital expenditure	Depreciation of duck house (capacity for rearing 20 ducks) @ 20% of capiotal cost of INR 2000/-	400
Recurring expenditure	Ducklings-40 nos. @ Rs.40/-	1600
	Duck feed (broken rice, broken wheat, broken maize, mustard cake, rice bran, green leaves and vegetables, vitamins & minerals) @ 125 g/duck/day	8057
	Vaccination for duck plague (4 weeks, 3-4 month, 8-9 month) and duck cholera (5-6 weeks, 4-5 month, 9-10 month) & Deworming	240
	Medicine (Ambiplex, Meriquin, Vita protein, Liv 52, Piperazine, Ostovet) etc.	196
Interest (14%) of capital expenditure & recurring expenditure		1469
Loss		**393.5**
Total expenditure in duck farming		**11962**
Income	**a. Consumption/utilized by beneficiaries**	
	Value of consumed egg (Average income per beneficiaries @ Rs.7.5/- per egg)	5338.50
	Value of consumed duckmeat (Average consumption per beneficiaries @ Rs. 280/- - Rs. 300/- per duck)	1204
	Value of duck droppings used for fish farming (Rs. 2/- per Kg)	1205
	b. Sold out to others	
	Income from selling out of eggs(Average income per beneficiaries @ Rs.7.5/- per egg)	17749
	Income from selling out of male ducks after attaing maturity(Average income per beneficiaries @ Rs. 280/- - Rs. 300/- per duck)	4002
	Income from duck droppings sold out as fertilizer (Rs. 2/- per Kg)	840
Total income (a+b)		30338.50
Net profit from duck farming		17983
B/C ratio of duck farming		1.50
Economics of fish farming (Pond area= 5 cottah (1 cottah= 66.89 m^2)		
Capital expenditure	Depreciation value of pond renovation of INR. 2000/- @20%	400
Recurring expenditure	Fish fingerling @ 2.5 kg/cottah, where 1 Cottah=66.89 m^2	1875
	Organic manure (Duck droppings) and lime	1400
Interest (14%) of capital expenditure & recurring expenditure		514.5
Total expenditure in fish farming		**4189.5**
Consumption	Value of consumed fish (Average consumption per beneficiaries @ Rs. 160/- per kg)	3372.80
Additional income from fish farming	Income from sold out fish (Rs. 160/- per kg)	9600
Income		**12972.80**
Profit	Total profit from fish farming	8783.30
B/C ratio of fish farming		2.1
Total profit from duck-cum-fish farming		26766.30
B/C ratio of duck-cum-fish farming		**1.66**

Yearly income of the beneficiaries varies greatly depending upon the size of the homestead ponds, its positional advantage and management practices for rearing ducks. On an average, total income generated by adopting the proper technology of integrated duck-cum-fish firming is moderate and supportive for woman empowerment [35] in that particular area. Finally, income generation from duck-cum-fish farming has been ranged between INR 20028.80/- (B/C ratio of 1.49) to INR 38385.40/- (B/C ratio of 1.93) per year (Fig 5.12). Average income from the duck cum fish farming in a homestead pond of 5 cottah (1cottah-=6.89 m^2) is about INR 26766.30/- (Table: 2).

The economics of the integrated duck cum fish farming have been revealed that B/C ratio of duck farming is satisfactory and fish farming is good enough due to scientific interventions. On the other hand, as the aim of the study is also to fulfill the nutritional needs of the family so, in that case it has been matched the target and they have earned around INR 19807/- additionally even after consumption. There are so many constrains in the study regarding management of the pond water because organic manuring itself may present a risk of organic overloading, algal bloom and fish diseases etc. In this study we have completely depended on organic manuring to enhance natural food source for fishes. But as the water quality is regularly monitored that help in the successful implementation of the experimental trials. Although

appropriate doses of duck dropping application and lime application are selected by a regular experimental trial of three months but in case of ponds seasonal variation and the surroundings of the pond area have a huge impact on water quality. Doses have been changed occasionally according to the water condition. In addition to that duck swimming may cause extra manuring in case of homestead ponds which have been avoided by allowing a fixed number of ducks to swim and doses of direct application of duck droppings have been corrected accordingly. Activity of the nitrifying bacteria has been monitored to cause maximum organic mineralization and nitrogen transformation there by offering the mostly preferred from of nitrogen to enhance the primary productivity without polluting water.

CONCLUSION

The assessment suggests that duck-cum-fish farming in homestead ponds is an eco-friendly technique which is economically viable and feasible for women empowerment and livelihood security effectively. The study reveals that the constrains of integrated duck cum fish farming such as, organic overloading, disease outbreaks of duck and fish can be managed with scientific interventions. The study suggests that rural women must be aware about the supply of good quality fish seed and ducklings and additional efforts should be given while duck feed formulation, pond management and time to time vaccination. Management differences are the probable reason of difference of egg production of ducks reared by the beneficiaries. In the present study integrated duck cum fish farming not only have increased the social status of village women by empowering them but also have improved their nutritional status. Protein deficiency in children and women in the backward village people is a very common problem which has been resolved among the beneficiaries by giving them opportunity to intake protein regularly without buying from the market. Hence integrated duck cum fish farming or similar kind of ventures should be encouraged by government and non-government development agencies to give the women their individual decision-making authority and to boost up their involvement in their family affairs by shearing their own income without any huge capital investment. Future research and efforts will be carried out to increase income and to adopt duck-cum-fish farming in homestead ponds as one of the best suited models of integration for socio-economic upliftment of the rural woman.

ACKNOWLEDGEMENTS

This work was supported by the Grant-in-Aid F. No. 890(Sanc.)/ST/P/S&T/1G-1/2013 dt. 15.01.2016 from the Department of Science, Technology & Biotechnology, Govt. of West Bengal, Kolkata to (SD). IP is grateful to Department of Science, Technology & Biotechnology, Govt. of West Bengal for providing fellowship for the work.

REFERENCES

1. Paul, I., Mandala, L. & Datta, S. (2018). Feasibility study of the small-scale poultry-cum-fish farming in homestead ponds for empowerment of rural women: A case study in the new alluvial zone of west. Intl. J. Fish. and Aqua. Stud., 6(3):118-122.
2. Rajeshwari, M.S. (2015). A study on issues and challenges of women empowerment in India. IOSR J. of Bus. and Mgnt. (IOSR-JBM)., 17(4):13-19.
3. Gupta, V., Rai, P.K. & Risam, K.S. (2012). Integrated crop-livestock farming systems: a strategy for resource conservation and environmental sustainability. Indian Research J. of Extension Education., 2 (Special Issue):49-54.
4. Elvevoll, E.O. & James, D.G. (2000). Potential benefits of fish for maternal, foetal and neonatal nutrition: a review of the literature. Food, Nutrition and Agriculture., 27:28-37.
5. Little, D.C. & Edwards, P. (1999). Alternative strategies for livestock-fish integration with emphasis on Asia. AMBIO: A Journal of the Human Environment., 28(2):118-124.
6. Singh, U.P., Bisht, H.C. & Pandey, N.N. (2014). Poultry cum Fish culture as an effective tool for environmentally sustainable and economically viable technology for the mid hills. International Journal., 2(2):854-60.
7. Sultana, P. & Thompson, P. (2008). Gender and local floodplain management institutions: A case study from Bangladesh. Journal of International Development., 20:53–68.
8. Baotong, H. & Huazhu, Y. (1984). Integrated management of fish-cum-duck farming. Its economic efficiency and revenue. Network of aquaculture centres in Asia, 1984, Bangkok, Thiland, NACA/WP/84/14.
9. Tripathi, S.D. & Sharma, B.K. (2001). Integrated fish-duck farming. In: Integrated Agriculture Aquaculture: A Primer. FAO Fisheries Technical Paper, No. 407. Rome, FAO, pp. 149.
10. Kumar, J.Y., Chari, M.S. & Vardia, H.K. (2012). Effect of integrated fish-duck farming on growth performance and economic efficiency of Indian major carps. Livestock Research for Rural Development., 24(12):15-19.
11. Van Rijn, J. (1996). The potential for integrated biological treatment systems in recirculating fish culture- a review. Aquacult., 139(3-4):181-201. http://doi.org/10.1016/0044-8486(95)01151-X

12. Yool, A. (2011). Modeling the role of nitrification in open ocean productivity and the nitrogen cycle. In: Methods in enzymology (eds. Klotz, M.G.) Elsevier Academic Press, San Diego., Vol.486, pp.3-32 https://doi.org/10.1016/B978-0-12-381294-0.00001-8.
13. Jhingran, V.G. (1991). Fish and Fisheries of India. 3rd Ed. Hindustan Publishing Corporation, Delhi, pp. 727.
14. Tamuli, K.K. (2006). Integrated Poultry-Fish Farming System, A Training Manual on Polyculture and Integrated Fish Farming, Assam Agricultural Competitiveness Project (AACP).
15. Latif, M.A., Alam, M.J. & Rahman, M.A. (1993). Integrated duck-cum-fish farming in Bangladesh. J. World Aquacult Soc., 24(3):402-409.
16. APHA. (2005). Standard methods for the examination of water and wastewater, 21st Ed. American Public Health Association/American Water Works Association/Water Environment Federation, Washington, DC, USA.
17. Wetzel, R.G. & Likens, G.E. (1991). Limnological Analysis. 2nd Ed. Springer Verlag, New York, pp. 391.
18. Golterman, H.L., Clymo, R.S. & Ohnstad, M.A.M. (1978). Methods for Physical and Chemical Analysis of Fresh Water, 2nd Ed. Blackwell Scientific Publications, Oxford, pp. 213.
19. Lee, P.S. (2009). Practical handbook of Microbiology. Edn 2, Goldman E, Green LH , New York, pp. 18.
20. Drews, G. (1974). Microbiologisches Praktikum, New York, New York: Springer-Verlag.
21. Battish, S,K. (1992). Freshwater Zooplankton of India. Oxford and IBH Publications, New Delhi pp. 233.
22. Vollenweider, R.A. (1974). A manual on methods for measuring primary production in aquatic environments. 2nd Ed. Blackwell Scientific Publications, Oxford, pp. 225.
23. Sasmal, S., Chari, M.S. & Vardia, H.K. (2010). Role of duck droppings on pond productivity through fish-duck integrated farming system. Livest. Res. Rural. Dev., 22(9):41-47.
24. Bhakta, J.N., Bandyopadhyay, P.K. & Jana, B.B. (2006). Effect of Different Doses of Mixed Fertilizer on Some Biogeochemical Cycling Bacterial Population in Carp Culture Pond. Turkish Journal of Fisheries and Aquatic Sciences., 6:165-171.
25. Meade, J.W. (1989). Aquaculture Management. Van Nostrand Reinhold, New York, pp175
26. Bhatnagar, A. & Devi, P. (2013). Water quality guidelines for the management of pond fish culture. International Journal of Environmental Sciences., 3(6):1983.
27. Bhatnagar, A., Jana, S.N., Garg, S.K., Patra, B.C., Singh, G. & Barman, U.K. (2004). Water quality management in aquaculture, In: Course Manual of summer school on development of sustainable aquaculture technology in fresh and saline waters, CCS Haryana Agricultural, Hisar (India), 203- 210.
28. Ajayi, A.O. & Okoh, A.I. (2014). Bacteriological study of pond water for aquaculture purposes. Journal of Food, Agriculture & Environment., 12 (2): 1260-1265.
29. Banerjea, S.M. (1967). Water quality and soil conditions of fish ponds in some states of India in relation to fish production. Indian Journal of Fisheries., 14:115-144.
30. Boyd, C.E. & Lichtkoppler, F. (1979). Water Quality Management in Fish Ponds. Research and Development Series No. 22, International Centre for Aquaculture (J.C.A.A) Experimental Station Auburn University, Alabama., 45-47.
31. Kumari, V., Rathore, G., Chauhan, U.K., Pandey, A.K. & Lakra, W.S. (2011). Seasonal variations in abundance of nitrifying bacteria in fish pond ecosystem. Journal of Environmental Biology., 32:153-159.
32. Hargreaves, J.A. (1998). Review Nitrogen biogeochemistry of aquaculture ponds. Aquaculture ., 166:181–212. http://doi.org/10.1016/S0044-8486(98)00298-1
33. Fernandes, S.O., Kulkarni, S.S., Shirodkar, R.R., Karekar, S.V., Kumar, R.P., Sreepada, R.A., Vogelsang, C. & Bharathi, P.A.L. (2010). Water quality and bacteriology in an aquaculture facility equipped with a new aeration system. Environmental Monitoring and Assessment., 164(4):81-92. http://doi.org/10.1007/s10661-009-0876-y
34. Biswas, P.K., Uddin, G.M.N., Barua, H., Roy, K., Biswas, D., Ahad A & Debnath, C. (2008). Survivability and causes of loss of broodyhen chicks on smallholder households in Bangladesh. Preventive Veterinary Medicine., 83(3-4):260-271.
35. Little, D. & Edwards, P. (2003). Integrated livestock-fish farming systems. Food & Agriculture Organisation of New United Nations; Rome, pp 109

CITATION OF THIS ARTICLE

I Paul, A K Panigrahi, S Datta· A New dimension for empowerment of rural women through intervention of small scale integrated duck-cum-fish farming in homestead ponds. Bull. Env. Pharmacol. Life Sci., Vol 10[1] December 2020 : 65-73