Economics of Different Livestock-Carp Integrated Farming Systems over Traditional Non Integrated Farming System in Terai Region of West Bengal

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ABSTRACT

Economics of different integrated farming systems in Terai region of West Bengal were studied by observing three treatments as T1 (Control): Traditional farming system, T2: Integrated cattle farming with aquaculture and T3: Integrated cattle and ducks farming with aquaculture. The fish and milk production was significantly higher (Pd"0.05) in T3 as 27.8±0.5 kg and 441.3±81.4 l., respectively followed by T2 as 20.6±0.3kg and 405.4±27.8 l., respectively and T1 as 10.7±0.3kg and 219±5.6 l. with addition of 2,939±32.0 numbers of eggs in T3. Hence, the profit was significantly higher in T3 (Rs 25,126.8±394.0) than T2 (Rs 9,566.8±185.7) and T1 (Rs 4,982.2±206.1).

Key Words Cow-dung, Grass carp, Indian Major Carp, Livestock-Carp Integrated Farming System, Water Quality, Economics

INTRODUCTION

Integrated Farming Systems (IFS) have received considerable attention in recent years due to the reason that the resources being used under non-integrated farming system are depleting and thus the prevailing farming system is not sustainable in long run resulting threat to the environment. During past three decades great emphasis was given on the incorporation of animal manures as fertilizer and nutrients for promotion of feed and fauna in fish ponds and utilized by the fish . According to Dhawan and Toor (1989) more than 50 per cent of the total input cost in fish culture may be reduced by recycling the animal waste. Hence integrated livestock- carp farming became important to ensure waste management as well as in reducing the production cost (Nnaji *et al.,* 2011)

As the integrated farming system seems to be profitable by reducing the input cost and probable solution to meet the increased demand for food stability, the present study was therefore executed to observe the economics of two IFS models, using different existing components such as cow, ducks and fish ponds in Terai region of West Bengal.

MATERIALS AND METHODS

Study area

The experiment was carried out during the years 2010 and 2011 at a village Belacoba of Jalpaguri district, situated in the northern region of West Bengal, India having a sub- tropical humid climate at 26Ú58´N latitude and 88Ú58´E longitude (43 m above msl). The soil of the research field was sandy - loam in texture.

Experimental design

Nine ponds were selected in triplicates for each treatment of same size 0.01 hectare (ha) to carry out the three treatments T1, T2 and T3 (Table 1). Ponds were stocked with Indian Major Carp (IMC) as *Catla catla, Labeo rohita* and *Cirrhina mrigala* and Exotic Carp *Ctenopharyngodon idella*, in the stocking ratio of 3:3:3:1 as suggested by Jena *et al.,* (2007).

Pond Management under different treatments

All the ponds under experiment were seasonal (April to September) from 2010 to 2011 with an average size of 0.01 ha and depth of 1.5 to 2.0 m. During March, ponds were dried and the bottom

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soil along with aquatic weeds and unwanted fishes were removed. Raw cow-dung at 3 t/ ha was applied as the basal dose 15 days prior to stocking. Lime was applied @250 kg/ha three to four days prior to stocking. The fingerlings were stocked in the month of April @ 10,000 fingerlings/ha in the ponds under T1, T2 and T3. The average weights of the fingerlings were 14-15g. Application of cow dung @ 2600kg/ ha once in ten days was followed for the ponds under T2 and T3. Optional application of lime @ 200kg / ha was done to maintain the pH of the ponds between 6.5 to 8.5. Supplementary feed in the form of Mustard Oil Cake and Rice Bran in the ratio 1:1 was applied after stocking @ 2 per cent of total body weight once a day. The cow-dung was collected everyday and stored for application in the pond after each 10 days. The cow-dung was spread equally covering the whole pond. Starting application of manuring was 10days after stocking of fingerlings. The methology followed was as suggested by Jha *et al.,* 2004 and Jena *et al.,* 2007.

Livestock Management under different treatments

The livestock considered in this study was non descriptive (local variety with no specific breed character) cows and ducks mostly prevalent amongst small and marginal farmers of this area with the production potentiality of 500 to 800 l./ lactation and 80-120 eggs/year , respectively. In T1 the cattle was reared in extensive system of rearing where, the cow was allowed to graze whole day and at night shelter was provided along with some paddy straw and water. The cow dung was not stocked to integrate with aquaculture. Milking of the cow was done twice a day.

The cattle under T2 and T3 were reared in semi-extensive system where the cows were allowed to graze for 6 hours every day considering the climatic condition to avoid stress. In cattle house, the cows were provided concentrate feed @ 1kg /day along with some green grass and paddy straw. The cow dung was collected to integrate with aquaculture. De-worming of the cows were done routinely thrice in a year.

Additional twenty ducks were reared in extensive system in T3 along with the cattle. After one month of stocking five months old ducks were brought into use. Ducks were allowed to graze on the pond from 9.00 am to 5 pm daily and fed with kitchen left overs and agricultural by - products @75g/d. The eggs produced were collected in the morning.

Sampling of pond water

Water samples were collected from different sites of the ponds at bimonthly intervals at a fixed hour of the day (9:00 am). The water quality parameters were analysed following the standard methods as described by APHA (2005).

Cost-benefit analysis

Cost-benefit analysis of the data was carried out on the basis of current market prices for the investment made as input cost and the total returns of fish harvested , milk and egg produced as gross output from the farm and following the simple procedure as suggested by Jolly and Clonts (1993).

Profit = Gross output –Total Cost

Statistical analyses

One-way ANOVA (Gomez and Gomez, 1984) was used for the analysis of data. If the main effect was found significant, the ANOVA was followed by a least significant difference (LSD) using Duncan's Multiple Range Test (DMRT). All statistical tests were performed at a 5 per cent probability level using the statistical package SPSS-18.

RESULTS AND DISCUSSION

Water Quality

It was found that within the treatments i.e., T1, T2 and T3 the values of all physico-chemical parameters except total hardness were significantly different (pd" 0.05). Total alkalinity, concentration of chloride, ammonium-N, nitrite-N, nitrate-N and phosphate- p were found to be significantly higher (pd"0.05) in T2 and T3 than the Control (T1). T3 significantly had the higher (pd"0.05) Phosphate- p concentration indicating that duck grazing may have affected the Phosphate- p concentration in pond water. Phosphorus is commonly considered the major limiting nutrient in freshwater, and additions of phosphorus often result in increased primary production in aquaculture systems (Daina *et al.,* 1991).

Table 1. Experimental Designs under different Integrated Farming Systems.

Treatment	T1(Control)	T2	T3
Components of farming	Fish and cow	Fish cum cow	Fish cum cow cum duck
Type of farming	Non-integrated (Traditional)	Integrated	Integrated
No. of ponds	3	3	3
Average size of pond(ha)	0.01	0.01	0.01
Manuring	No manuring	Manuring @ 2600kg/ ha / ten days with cowdung	Manuring @ 2600kg/ ha / ten days with cowdung
No. of ducks per pond	nil	nil	20
Stocking density of fingerlings/ha	10,000	10,000	10,000
Types of fish stocked	IMC+Grass carp	IMC+Grass carp	IMC+Grass carp
Stocking ratio	3:3:3:1	3:3:3:1	3:3:3:1
Fish feeding schedule (on daily basis)	@ 2% of total body weight with Mustard oil cake and Rice Bran (1:1)	@ 2% of total body weight with Mustard oil cake and Rice Bran (1:1)	@ 2% of total body weight with Mustard oil cake and Rice Bran (1:1)
No of Cattle	1	1	1
System of cattle rearing	Extensive	Semi extensive	Semi extensive
Feeding schedule of cow	12 hours grazing with	6 hours grazing and Concentrate feed and green grass along with paddy straw	6 hours grazing and Concentrate feed and green grass along with paddy straw
Type of cow	Non descriptive	Non descriptive	Non descriptive
System of duck rearing	Nil	Nil	Extensive
Type of Duck	Nil	Nil	Non descriptive
Duration of Study	2008-2011(4 years)	2008-2011(4 years)	2008-2011(4 years)
Harvesting of Fish	Six months	Six months	Six months

Table-2: Mean ± SE of water quality parameters under T1, T2 and T3.

Parameters	T1	T2	T3
Temperature (°C)	29.70 ± 0.23^{b}	28.67 ± 0.20^{a}	28.86 ± 0.20^{a}
pH	8.17 ± 0.07^{b}	8.11 ± 0.05^{b}	7.74 ± 0.07^{a}
Dissolved oxygen (mg l^{-1})	7.38 ± 0.08^{b}	6.72 ± 0.05^{a}	9.25 ± 0.15^{c}
Free carbon dioxide (mg l^{-1})	11.02 ± 0.17^{c}	10.34 ± 0.13^{b}	9.45 ± 0.09^{a}
Total alkalinity (mg l^{-1})	22.64 ± 0.33^{a}	23.15 ± 0.28^{ab}	23.97 ± 0.29^{b}
Total hardness (mg l^{-1})	44.54 ± 0.62^{a}	44.17 ± 0.59^{a}	44.58 ± 0.76^{a}
Chloride (mg l^{-1})	17.14 ± 0.54^{a}	24.17 ± 0.70^{b}	29.18 ± 0.67^{c}
Ammonium-N (mg l^{-1})	0.04 ± 0.01^{a}	0.08 ± 0.02^{b}	0.08 ± 0.02^{b}
Nitrite-N (mg l^{-1})	0.40 ± 0.02^{a}	0.40 ± 0.03^{ab}	0.49 ± 0.03^{b}
Nitrate-N (mg l^{-1})	0.21 ± 0.04^{a}	0.49 ± 0.03^{b}	0.48 ± 0.03^{b}
Phosphate (mg l^{-1})	0.24 ± 0.023^{a}	0.41 ± 0.03^{b}	0.59 ± 0.02^{c}

Different superscripts (a, b and c) denotes significant difference and similar superscripts denote non-significant difference between treatments at 5% level. N=72 for all the parameters.

Table 3. Mean ± SE of different productions of fish, milk and eggs under different Treatments.

Treatments	*Catla catla*	*Labeo rohita*	*Cirrhina mrigala*	*Ctenopharyngodon idella*	Total fish production (kg/six month)	Milk (l/year/cow)	Eggs (no./year)
T1	4.93± 0.11[a]	3.65±0.22[a]	0.48±0.04[a]	1.61±0.11[a]	10.67±0.33[a]	219±5.56[a]	.0000[a]
T2	9.48± 0.19[b]	6.65±0.14[b]	1.37±0.11[b]	3.07±0.14[b]	20.57±0.33[b]	405.42±27.81[b]	.0000[a]
T3	12.59± 0.26[c]	8.84±0.17[c]	2.93±0.15[c]	3.42±0.15[b]	27.78±0.50[c]	441.25±18.42[b]	2939±32.41[b]

Different superscripts (a, b and c) denotes significant difference and similar superscripts denote non-significant difference between treatments at 5% level. N=12 for all the parameters.

Table 4. Mean ± SE of net income (profit) under different Treatments.

Treatments	Total Expenditure (Rs)	Gross income (Rs)	Net Income(profit) (RS)
T1	1175.50±50.70[a]	6157.75±212.22[a]	4982.25±206.09[a]
T2	2812.50±81.48[b]	12379.25±257.76[b]	9566.75±185.74[b]
T3	3873.00±153.03[c]	28999.75±541.07[c]	25126.75±393.99[c]

Different superscripts (a, b and c) denotes significant difference between treatments at 5% level. N=4 for all the parameters and 1$=50 Rupees.

The pH and temperature were found to be within the moderate range maintaining the favourable condition for fish growth (Jana *et al.* 2012). Biswas, *et al.* (2006) expressed the values at three different concentration levels of ammonium (a) favourable concentration range : 0.262 to 0.294 mg/ l , (b)growth-inhibiting concentration range : 0.313 to 0.322 mg/ l and (c) lethal concentration range : 0.323 to o.422 mg/ l. In the present study, all the values of ambient ammonium concentration in T1, T2 and T3 remained lower than the threshold concentration of 0.313 mg/ l and, therefore, perhaps favourable for fish culture under waste fed condition. Murad and Boyd (1991) stated that ponds should have at least 20 mg/ l total alkalinity for good fish production. In the present study, the total alkalinity was found to be more than 20 mg/ l in three treatments throughout the experiment where T3 had significantly higher total alkalinity than T2 and T1. Hence, the use of organic inputs may keep total alkalinity at higher levels.

T3 has significantly highest dissolved oxygen followed by T1 then T2 indicating that manuring decreases the dissolved oxygen and Duck grazing on pond increases the same. Ammonia is more toxic when dissolved oxygen concentration is low. No significant difference were observed in T2 and T3 regarding total alkalinity, ammonium-N, nitrite-N and nitrate-N. Free carbon dioxide is observed to be significantly higher in T1 followed by T2 and T3, respectively.

Economics Under Different Treatments:

Total Mean±SE of yearly production during the study period was significantly (pd"0.05) higher in T3 (27.8 ± 0.5 kg) followed by, T2 (20.6 ± 0.3kg) and T1 (10.7± 0.3 kg) (Table 3). High fish yield were also obtained in Israel, 30 kg/ha/d with cattle manure (Schroeder, 1975), 40 kg/ha/d with duck manure and waste feed (Wohlfarth, 1978) and 20 kg/ha/d with chicken manure (Milstein *et al.* 1995). It has also been reported that the application of 15,000 kg/ ha of cow manure resulted in an average fish yield of 300 kg/ ha while the control ponds averaged 97 kg/ ha of fish. T3 has significantly highest production of *Catla catla* (12.6±0.3 kg); *Labeo rohita* (8.8±0.2 kg); *Cirrhina mrigala* (2.93±0.2 kg) and *Ctenopharyngodon idella* (3.4± 0.2 kg) followed by T2 then T1. It was also reported by Schroeder (1975), that manures could achieve75 per cent of the yields attained by using supplementary feeding of grains and 60 per cent of the yields possible with protein-rich pellets. Fish yield in properly designed and managed manure loaded ponds can reach 5 to 10 t/ha./yr without any supplemental feeding (Schroeder, 1978). The Mean±SE of milk yield was also observed to be significantly higher in T2 (405.4 ± 27.8 lt.) and T3 (441.3±18.4 l. than T1 (219±5.6 l.). This was due to the improved feeding practice followed during the integrated farming systems. T3 had additional production of duck eggs (2939±32.41). Sharma and Olah (1986) and Sharma *et al.,* (1988) observed, that the excreta of 35 to 45 pigs, 200 to 300 ducks and 250 to 300 layer poultry birds or 150 to 200 broiler birds produced 6 to 7 t, 3 to 4 t and 4 t of fish /year, respectively when recycled in one hectare of water area under the polyculture of Indian and exotic fish.

Cost benefit analysis was done considering the expenditure incurred on the fingerling (@Rs250/kg) and feed (@Rs14/kg). It was observed, that T3 has achieved significantly (pd”0.05) higher profit (Rs 25,126±394.0) than T2 (Rs 9,566±185.7) and T1 (Rs 4,982.3±207.0), indicating that the undigested fraction in animal waste was eaten by fish which may reduce the feeding cost of aquaculture along with the higher zooplankton production which further facilitates the fish growth rate resulting in maximum profit inT2 and T3. Studies of Afzal *et al.* (2007), Sarkar *et al.*(2011) and Bhakta *et al* (2004) on animal wastes revealed that fish yield in ponds fertilised with animal excreta was 5-7 times higher than normal fish pond. Panda (2002) indicated, that the approach of integration of duck farming is profitable and acceptable to the farmers in the developing world for maximum utilization of land and water resources. The droppings of ducks act as a substitute to fish feed and pond fertilizer up to 60 per cent of total feed cost.

CONCLUSION

It was concluded that integrated farming system responds well when the number of component involved are increased. T3 had ducks as additional component which increased the potentiality of the farming system resulting in highest return (BC ratio 7.5) than T2 and T1. The BC ratio in T2 (4.4) was found to be lower than T1. Hence, in the northern part of West Bengal, integration of livestock-carp and duck can be considered the best integrated farming system model for income generation among the small and marginal farmers.

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