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POLYCULTURE OF CARPS IN INTEGRATED BROILER-CUM-FISHFARMING SYSTEMS

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Studies were undertaken in 0.1 ha earthen ponds in order to determine fish species combinations that would result in optimum production levels in integrated broiler raising systems. Chicken sheds were constructed over ponds, and Shaver starbro-15 hybrid chicks were raised at a density of 500 chickens/ha of pond area. The ponds were stocked with fish fingerlings at a density of 6,000/ha. Four combinations of different fish species were tested, each treatment with two replications. The ponds were neither fertilized nor were the fish given supplementary feed, except for the chicken excreta falling into the ponds. After twelve months rearing, gross fish production levels between 5,821, and 3,041 kg/ha were obtained. Fish survival rates ranged from 85 to 97%.

Five batches of broilers were raised in seven to eight week cycles. A total of 4,080 kg (live weight) of broilers were produced per hectare, in one year. An economic analysis of the operations showed a net profit of Tk 265,365 ha/yr (US $6,634).

INTRODUCTION

Over eighty-five percent of the people of Bangladesh live in rural areas. Of these, some sixty percent are under-nourished and need not only good sources of animal protein to supplement their diets, but also new sources of employment opportunities and a sustainable income. As their land holdings are small and fragmented, the modern large-scale production technologies with high input requirements offer no practical solution to their problems of low income and low productivity. In addition to small land holdings, however, the majority of small and marginal farmers have backyard ponds and livestock consisting of a few head of cattle or a small flock of ducks and/or chickens, and surplus family labour. Though a vast potential exists in these rural areas for integrating various farm enterprises that would optimize production and returns, an integrated approach for optimum utilization of available resources in terms of maximizing benefits and lowering risks is not practised because research-based advice is not available to farmers.

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Supplementary feeds and fertilizers play a vital role in increasing fish production in aquaculture operations, but as supplementary feeds are scarce and costly, the application of either organic or inorganic fertilizers is a low-cost alternative for fish culture. Since the inorganic fertilizers which are used extensively in agriculture have resulted in an increasing gap between demand and supply, excreta could be used to fertilize fish ponds. Of the various possible sources of livestock excreta, for example, poultry droppings are not widely used for any production purpose in Bangladesh. If the farmers were to recycle their poultry wastes in fish ponds, however, they could reduce operating expenses to a minimum, and at the same time increase fish production. Farmers would be able to produce diversified commodities, lessen risk, and obtain higher benefits

A study was undertaken to determine fish species combinations that would result in optimum production levels in integrated broiler raising systems. Its objectives were: (i) to evaluate the production potential of fish in integrated poultry-fish systems using high yielding varieties[1] of broilers; (ii) to identify which fish species combination would result in optimum production levels; (iii) to estimate the effects of varying ratios of *Catla catla* and *Hypophthalmichthys molitrix* in stocking on gross production; (iv) to assess the production potential of *O. niloticus* in integrated systems; and (v) to assess the viability and economic feasibility of integrating poultry raising with fish culture and to identify the benefits that could accrue from such integration.

MATERIALS AND METHODS

The study was conducted in eight ponds 1000 m², each with a water depth of 1 m. Chicken-sheds 7 m² were built over ponds using locally available materials such as bamboo. The floor was made of slated bamboo splits with a gap of about 1.0 cm between slats, in order to allow the chicken droppings to fall directly into the pond.

Ponds were prepared by draining them of water in order to eradicate predatory and non-valued fishes, and lime was subsequently applied at the rate of 250 kg/ha. Three days after the lime had been applied the ponds were filled with ground water. They were then stocked with four different combinations and ratios of various species of fish—carps *(Hypophthalmicthys molitrix, Catla catla, Labeo rohita, Cirrhinus mrigala, Ctenopharyngodon idella* and *Cyprinus carpio*) and Nile tilapia (*Oreochromis niloticus*) (Table 1), at a stocking density of

[1] The poultry birds presently being raised by farmers are of the scavenging type, a type which gives very low yields, and the government is encouraging the use of high yielding varieties of hybrid broilers such as Shaver starbo-15.

Table 1. Details of species combinations showing the percentage of each species stocked in different treatments.

Species	Treatment 1 (%)	Treatment 2 (%)	Treatment 3 (%)	Treatment 4 (%)
H. molitrix	30	10	40	-
C. catla	10	30	-	-
L. rohita	25	25	20	-
C. mrigala	25	20	30	30
C. idella	5	5	10	-
C. carpio	5	10	-	-
O. niloticus	-	-	-	70

6,000 fingerlings/ha. Two replications were conducted for each treatment and the average size of fingerlings at stocking ranged from 7 to 15 g (11.43 g ± 2.99 g[2]). Apart from the chicken excreta falling into ponds, no supplementary feed was given to the fish, with the exception that green grasses growing on pond embankments were supplied twice daily at the rate of 10-20% of the body weight for grass carp. No fertilizers were applied to the ponds.

Shaver starbro-15 hybrid broiler chicks were raised in a brood house for fifteen days, after which they were transferred to houses over the ponds at a density of 500 chicks/ha. The birds were fed *ad libitum* from 0 to 4 weeks on a starter mash containing 50% crushed wheat, 14% rice bran, 15% sesame oil cake, 19% fish meal, 1.5% bone meal and 0.5% common salt. From 5 to 8 weeks they were fed a finisher mash containing 50% crushed wheat, 16% rice bran, 15% sesame oil cake, 17% fish meal, 1.5% bone meal and 0.5% common salt. While starter mash contained 22.4% protein and 2,917 ME Kcal/kg energy, the finisher mash contained 21.62% protein and 2,922 ME Kcal/kg energy. Vitamin mineral premix was added at the rate of 250 g/100 kg prepared feed. After 7 to 8 weeks of rearing, the birds were marketed and replaced by a fresh batch of chicks. In all, five batches of broilers were raised during a period of one year.

Pond water was monitored at bi-weekly intervals for dissolved oxygen, pH, temperature and transparency. Once a month ponds were sampled to assess the growth and well-being of the fish. At the end of twelve months rearing the fish were harvested by draining the ponds and total production was estimated.

[2] 95% confidence limits.

RESULTS

Physico-chemical characteristics of pond water:

The temperature of the water during the period from March to November was in the range of 24.2 to 31.0°C, which is good for fish growth. It dropped to 17.0 to 21.8°C from December to February, a period which coincides with winter in Bangladesh (Figure 1). The water's pH fluctuated between 6.6 and 8.4 during different months, without any particular trend. A lower pH of 6.6 was observed during the month of November, when transparency was also lower. Dissolved oxygen in pond water ranged between 3.0 and 8.0 ppm during different months. There was a declining trend in dissolved oxygen during the rearing period, due to the higher utilization of oxygen with increasing fish biomass. Secchi disk transparency ranged from 12.5 to 36.25 cm during different months, with the exception that in June it was 62.5 cm. This was the month when chicks were put on the pond for the first time, and hence there was little chicken excreta falling into the pond. As a result there was lower plankton production and a higher Secchi disk transparency.

Fish Culture:

Fish were harvested after twelve months rearing, first by seining and later by draining ponds. Gross production of fish from ponds stocked with carps ranged from 5,390 to 5,821 kg/ha, while it was only 3,041 kg/ha from ponds stocked with *O. niloticus* and *C. mrigala* (Table 2).

In the first three treatments, which were comprised of carps, surface feeders (*H. molitrix* and *C. catla*) constituted 40% of stocking density, mid-water feeder (*L. rohita*) 20-25%, bottom feeders (*C. mrigala* and *C. carpio*) 30% and macrophyte feeders (*C. idella*) 5 to 10%. The contribution of surface feeders to gross production ranged from 40.0 to 46.8%.

That *H. molitrix* contributed more to production than *C. catla* was evident from the fact that *H. molitrix*, whose stocking density was 10 to 40%, contributed 15.9 to 44.2% of gross production (Table 2), while *C. catla*, on the other hand, at a stocking density of 10 to 30%, contributed 9.2 to 24.1% of gross production. *L. rohita*, a periphyton feeder, whose stocking density was 20-25%, contributed 18.9 - 19.1% to gross production. *C. carpio*, which was stocked at 5 and 10% of total density, grew well and contributed 7.7 to 15.9% of gross production. *C. idella*, which was stocked at 5 to 10% of total density, contributed from 6.9 to 13.9% of fish production.

H. molitrix reached a marketable size of 1,112 to 1,502 g within twelve months. Size attained by Indian carps *C. catla*, *L. rohita* and *C. mrigala* at the time of harvest were in the range of 799 to 992 g, which can be considered as market size. Growth of grass carp was more or less the same (1,516 to 1,593 g), though

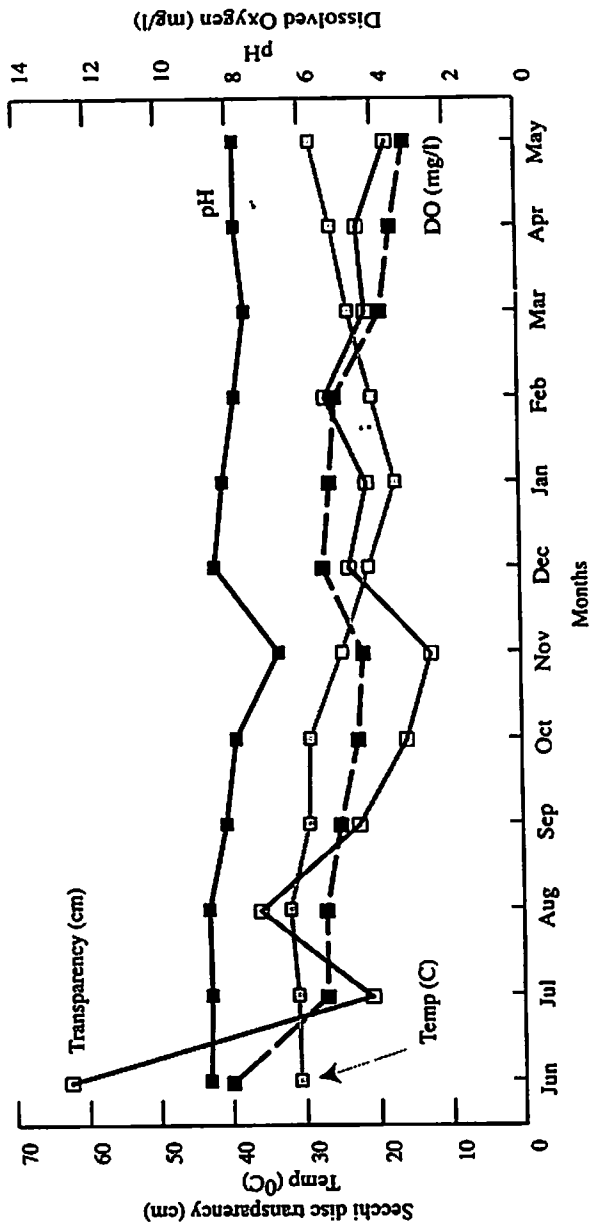

Figure 1. Physico-chemical parameters of pond water during the experimental period (averages of all ponds).

Table 2. Average gross production of fish stocked in different combinations and species ratios in ponds.

Treatment	Species ratio	Initial weight (g)	Final weight (g)	Survival (%)	Gross production (kg/ha/yr)	Net production (kg/ha/yr)
(i)	*H. molitrix* - 30%	15.0	1,293.70	93.9	5,820.6*	5,746.5*
	C. catla - 10%	10.0	991.68	89.6		
	L. rohita - 25%	13.0	808.75	87.0		
	C. mrigala - 25%	10.0	890.20	89.3		
	C. idella - 5%	7.0	1,546.40	86.6		
	C. carpio - 5%	15.0	1,557.97	96.6		
(ii)	*H. molitrix* - 10%	10.00	818.10	88.3	5,389.9*	5,320.3*
	C. catla - 30%	15.0	1,502.50	95.0		
	L. rohita - 25%	13.0	798.90	86.0		
	C. mrigala - 20%	10.0	810.20	94.5		
	C. idella - 5%	7.0	1,592.80	87.3		
	C. carpio - 10%	15.0	1,520.35	95.0		
(iii)	*H. molitrix* - 40%	15.0	1,112.00	92.0	5,558.3*	5,484.5*
	L. rohita - 20%	10.0	843.50	87.5		
	C. mrigala - 30%	13.0	870.30	92.2		
	C. idella - 10%	7.0	1,515.88	85.0		
(iv)	*O. niloticus* - 70%	10.0	226.66	97.2	3,041.3*	2,981.3*
	C. mrigala - 30%	10.0	735.10	91.5		

* Average of two replications.

its stocking ratio varied from 5 to 10% of the stocked fish (Table 2). This may be due to the fact that grass carp were supplied with excess grasses. *C. carpio* attained average sizes of 1,558 and 1,520 g at 5 and 10% of stocking density, respectively.

Survival rates of different species in different treatments were high, and ranged from 85.0 to 96.6%. Gross production from the first three treatments with carps was quite high, and ranged from 5,390 to 5,821 kg/ha/year, though the average size of fish at harvest and gross productions differed slightly from treatment to treatment. It can be concluded that a combination of 40% surface feeders, 20 to 25% mid-water feeder, 30 to 35% bottom feeders and 5 to 10% macrophyte feeder results in optimum production levels in these integrated systems.

Gross fish production from ponds stocked with only *O. niloticus* and *C. mrigala*, was low, being 3,041.3 kg/ha, of

which 60.2% was contributed by *O. niloticus* and the rest by *C. mrigala*. Of the *O. niloticus* harvested, only 51% was of market size (>80 g), the rest being undersize fish and fingerlings. Also, growth of *C. mrigala* was lower (735 g) as compared to the growth obtained by the species in ponds with carps (810 to 890 g). This shows that higher fish productions could be obtained through a culture of carps in an integrated system, as compared to the culture of tilapia, and also that benefits could be much higher due to higher market prices for carps in Bangladesh.

Chicken Rearing

In all, five batches of Shaver starbro-15 hybrid broilers were raised in one year. In each batch, 50 chickens were raised on each of the ponds (500 chicks/ha), for a period of 7 to 8 weeks, by which time they had reached an average weight of 1.7 kg (± 0.07[3]). Average mortality rates in the brooder house (up to two weeks of age) were 3 to 4%, and 0 to 2% on the pond (from 3 to 8 weeks of age). These rates are comparable to those in well managed land-based poultry farms. The average feed conversion efficiency during the first 8 weeks was 1:2.43 (± 0.04[4]). As is evident from Figure 2, feed conversion efficiency decreased from 1.91 to 3.85 with increasing age, and decreased abruptly after the seventh week. In total, 4,080 kg broiler meat (live) were produced from five batches on a one hectare pond during a one year period.

Costs and returns

Table 3 details the costs (capital and operating) and returns from integrated poultry-fish farming for a one hectare pond for one year. Capital costs for the pond lease, chicken house and feeders and waterers totaled to 10,500 Tk (1 US$ = 40.00 Tk) per annum. The annual operating costs associated with raising one batch of 500 broilers were 27,685 Tk, or 138,425 Tk for five batches of broilers. In practice, however, income earned as one batch of broilers is sold is used to finance the operating costs of the next batch.

Operating costs for fish culture, which included the cost of lime, fingerlings, labour and water pumping charges, amounted to 5,110 Tk/ha. By investing a total of 154,035 Tk/year/hectare, it was possible to achieve fish and broiler meat (live weight) production levels of 5,589 and 4,080 kg/ha respectively. Estimates of the market price of fish and live broiler meat (live weight) were 40 and 48 Tk/kg, respectively, resulting in a net benefit of 265,365 Tk/ha in one year.

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[3] 95% confidence limits.
[4] 95% confidence limits.

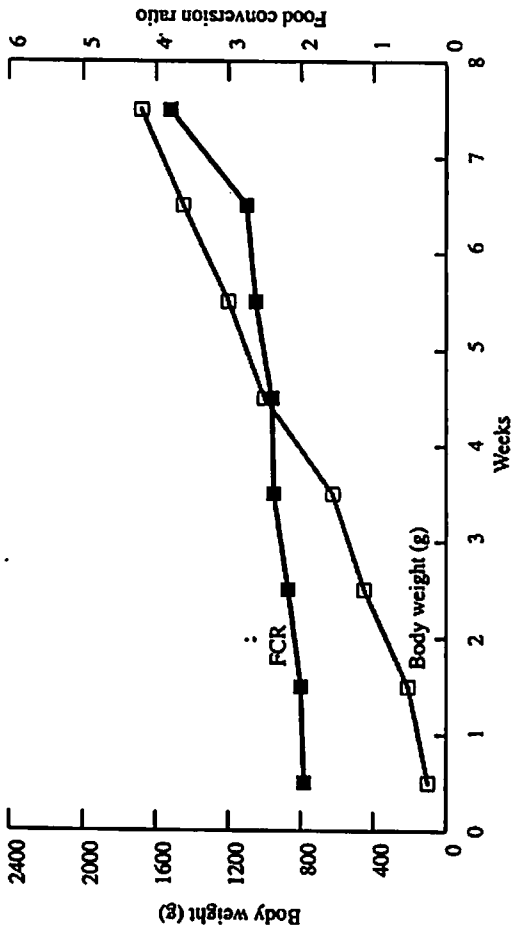

Figure 2. Growth and feed conversion of broiler chickens.

Table 3. Costs and returns from integrated broiler-fish farming in 1 ha earthen ponds for a culture period of 1 year.

Items	Quantity	Rate (Tk)[a]	Total cost (Tk)
Capital costs :			
Pond lease value	1 ha	7,500	7,500
Cost of chicken house (life expectancy 2 years)		5,000	2,500
Feeders and waterers (life expectancy 4 years)		2,000	500
Total capital costs			10,500
Operating costs :			
a) Broilers (for one batch)			
Broiler chicks	500 nos.	15/chick	7,500
Broiler feed	1935 kg	9/kg	17,415
Vaccine	-	-	170
Labour	60 man-days	30/day	1,800
Miscellaneous	-	-	800
Operating costs for one batch of broilers			27,685
Operating costs for five batches of broilers			138,425
b) For fish culture			
Lime	250 kg	3 kg	750
Fingerlings	6000 nos.	0.40 each	2,400
Labor	32 man-days	30/day	960
Cost of pumping water	-	-	1,000
Operating costs for fish culture			5,110
Total operating costs for broiler-fish			143,535
Total costs (capital and operating)			154,035
Income			
Fish	5,589 kg[b]	40/kg	223,560
Broiler meat (816 kg/batch x 5 batches)	4,080 kg	48/kg	195,840
Total income			419,400
Net profit (419,400-154,035)			265,365

[a] 1 US$ = Tk. 40.00.
[b] Average of three carp treatments.

DISCUSSION

Chicken manure, like other organic wastes, can be converted into quality fish food, by stimulating microbial activity in the water column and at the pond bottom and releasing the nutrients and minerals originally bound in relatively indigestible form (Pudadera *et al.* 1986). These nutrients and minerals in

turn provide the substrates for photosynthetic (autotrophic) and microbial (heterotrophic) production which can be utilized by fish (Schroeder 1980). Fresh chicken manure contains 1.6% nitrogen, 1.5% phosphorus and 0.9% potassium (Woynarovich 1979) and so increases the pond's fertility and primary productivity. Furthermore, the total protein content of chicken manure is as high as 20 to 30%. About 80% of the manure represents undigested feed stuff with 25% dry matter content, which can be used directly by fish as feed. This is primarily due to the fact that chickens have a very short digestive tract, and much of their excreta is only partly digested (Chen 1981). Olah (1986) stated that as much as 5 $gC/m^2/d$ organic matter could be processed in ponds as fertilizer. This corresponds to a fertilization rate of 100 kg dry manure/ha/d, and a production rate in polyculture (common and silver carps) of 30 kg/ha/d, without feeding the fish.

This study has shown that when broiler raising and fish culture are integrated less land is required than if both are conducted separately. This is an important consideration in a country such as Bangladesh where land holdings are small. The study has also shown that integration is technically feasible and economically viable. Gupta (1992) found that farmers who are accustomed to raising local, scavenging chickens can adapt to raising high yielding varieties of chicken, and for these farmers the benefits of integration could be substantial. Hossain *et. al.* (1989) inferred from their studies that it is feasible and profitable to raise broilers over ponds, and showed a net profit of 3,721 Tk. in one year from five batches of broilers totaling 250 in number. Das *et. al.* (1993), from their comparative study of the growth performance of broilers raised on land and on ponds, did not observe any significant differences in growth and survival rates.

The present study revealed that in an integrated system, polyculture of Asian carps can result in higher production levels and benefits than could be achieved with a culture of *O. niloticus* and *C. mrigala*. Burns and Stickney (1980) reported *O. aureus* yields of 5.9 t/ha/yr, when integrated with 4,000 broiler chickens per hectare. Hopkins and Cruz (1980) inferred from their studies that 1,000 to 5,000 chicken/ha resulted in good fish production, with manure loading rates yielding maximum fish production provided by around 4,400 birds/ha. In Thailand, a mean annual net yield of 175 kg of fish was obtained from a 200 m^2 pond fertilized with the manure from 27 ducks (Edwards 1983). The number of broilers raised per unit area in the present study was much lower (500/ha), as compared to those suggested by other workers. Though raising larger numbers of birds per hectare would result in higher manure inputs and higher fish production according to Gupta (1994), costs involved in raising larger numbers of poultry birds would

be beyond the means of small farmers, unless institutional arrangements were made to ensure the availability of credit and a supply of needed inputs.

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