EFFECT OF SPECIES COMPOSITION OF CARPS IN PENCULTURE SYSTEM IN BAUYSONA RIVER OF NARAIL DISTRICT

A Thesis

By

Fatema Chadni

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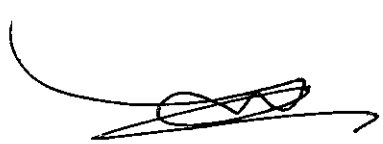

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Professor Dr. Khandaker Anisul Huq

Head

Fisheries and Marine Resource Technology Discipline

Khulna University

Khulna

Declaration

Effect of Species Composition of Carps in Penculture System in Bauysona River of Narail District

The results presented in the thesis with the above mentioned title are entirely of the candidate's own investigations and no part of the results has been accepted for any degree nor is it being concurrently submitted for any degree.

Fatema Chadni

(Signature of the Candidate)

Fatema Chadni

Examination Roll No: MS080610

Session: 2008-2009

(Signature of the Supervisor)

Dr. Khandaker Anisul Huq

Professor

Fisheries and Marine Resource Technology Discipline

Khulna University

Khulna

December, 2009

Dedication

This thesis is dedicated to my beloved parents who sacrificed for me, inspired and blessed me in every way

ACKNOWLEDGEMENTS

It is my great pleasure for being able to complete this thesis, first my appreciation and indebtedness go for the creator of this Universe, the Almighty Allah.

I express my gratitude, heartfelt appreciation and indebt ness with due solemnity to my supervisor, Dr. Khandaker Anisul Huq, Professor of Fisheries and Marine Resource Technology Discipline of Khulna University, Khulna, for his complete guidance and valuable advice during this task.

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It cannot be express properly in printed word but also I would like to express my gratitude to my parents for their inspiration at every stage of my work and for making me confidence to do this work easily and I would like to express my heartiest thanks to all of my friends who wish to see me in the way of progress.

Last of all, I express my deepest gratitude to my parents and to my family for standing all the way in my side.

FATEMA CHADNI

Khulna University

Abstract

An experiment was conducted from April to December 2008 to determine suitable species composition in poly culture of carps *Labeo rohita* (ruhu), *Cirrhinus mrigala* (mrigal) , *Catla catal* (catla) and *Hypophthalmicthys molitrix* (silver carp) in pen enclosures at dead Bauysona river jalmahal of Kalia upazilla under the district of Narail. Three treatments were taken with same stocking density (20,000pcs/ha) but the species compositions were varied. The species composition ratio of ruhu, mrigal, catla and silver carp were 6:2:1:1; 4:2:1:1 and 4:3:1.5:1.5 for T1, T2 and T3 respectively. The initial average body weight of ruhu, mrigal, catla and silver carp were 80.23, 70.41, 90.16 and 85.03g respectively and these were same for all the treatments. Same management technology was used for all the treatments. After stocking supplementary feed like rice polish (RP) and mustered oil cake (MOC) mixture (1:1) was used initially at a rate of 5% body weight of the stocked fish and the doses of feed was reduced up to 2% when average body weight became about 500g. After 8 months of culture period all the experimental species were harvested and recorded. The total production of all the experimental species in T1, T2 and T3 were 8033, 8589 and 7793 kg/ha respectively. Net profit in T1, T2 and T3 were 1, 32,740; 1,36,760 and 1,14,960 Tk/ha respectively. The cost benefit ratio was calculated as 1.31, 1.30, and 1.27 for T1, T2 and T3 respectively. From this study it was found that T1 had the best species composition.

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LIST OF ABBREVIATION

Abbreviation	Elaboration
DO	Dissolved Oxygen
DOF	Department of Fisheries
FMRTD	Fisheries and Marine Resource Technology Discipline
FCR	Food Conversion Ratio
NWG	Net Weight Gain
PWT	Percent Weight Gain
SD	Standard Deviation
SGR	Specific Growth Rate
NGO	Non Government Organization
BRAC	Bangladesh Rural Advancement Committee

CHAPTER 1

INTRODUCTION

Introduction

In Bangladesh the concept of pen culture is very new. A pen is defined as a fixed enclosure in which the bottom is the bed of the water body (SEAFDEC/DRC International workshop on cage and pen culture, 1979(Philippines)-proceedings-summery Report, p.20). Pen is to be distinguished from the cage which is turn is defined as 'an enclosure with bottom and sides of netting or bamboo etc., whether floating at the surface or totally submerged.'' The word 'pen' here is also used synonymous with 'enclosure' as it is used in enclosure culture.

Although the concept of pen culture for commercial production of fish was included in the national development programme in 1977, the actual implementation of the project started very late. During 1981, under ADB assisted Aquaculture Development Project, experimental pen culture activities were undertaken by Department of Fisheries (DOF) in few places in Bangladesh viz. Bahadurpur baor in Jessore, Nabagonga river and Saganna baor in Jenidah and Dhanmondi and Gulshan lakes in Dhaka city (Hossain A, 2008). The reported economic analysis showed a net loss of Tk. 3,729/- for the operation in Bahadurpur baor and a profit of Tk. 3,564/- for Dhanmondi lake (Karim, 1988). Several causes such as water pollution due to jute retting, heavy clogging of pen walls, low pen height, inadequate settlement of the bottom line etc. were attributed for the loss of fish, either because of mortality or escaping from pens in Bahadurpur baor.

Pen culture of fish in dead rivers has also been tried by Bangladesh Rural Advancement Comittee (BRAC), a leading NGO in the country. BRAC in 1994 under its Rural Development programme undertook a fish culture programme in the Kobadak river in Jhikorgacha thana in Jessore district. BRAC organized fishermen group and provided financial assistance for fish culture in the river. Three sections of the river covering areas 31, 40 and 32 acres were leased to three fishermen groups. The sections were partitioned by using split bamboo woven together. Large sized fingerlings of 100-150 g size were stocked in January and harvested during April-May 1994. Out of three culture groups only one group earned profit and two other lost. However, the cost analysis did not

consider depreciation for pen materials. The loss was reportedly attributed to the escape of fish and because of some poaching (Hossain A, 2008).

In 1991 Fisheries Research Institute, Riverine Station, Chandpur has undertaken an experimental research project on pen culture of fish in the Chandpur Irrigation Project (CIP). Polyculture of carps (Major and Chinese) were conducted in six pens and fishes were stocked at the rate of 35, 70 and 105 g/m^2 respectively in three treatment groups with two replicates. The production included the wild fish as well. The retrieval rate was very poor which was reportedly due to sudden flooding and poaching. In the 2nd trial, the stocking density and species combination were changed. Fishes were stocked at the rate of 10,000, 15000 and 20,000/ha (each treatment having two replicates). Production rate of 1.27, 1.69 and 2.69 mt/ha/crop were obtained.

In the year of 2005, department of fisheries, Bangladesh has taken a project namely ''Inland open ware fisheries habitat restoration project'' to extend the technology of pen culture at the marginal fish farmers. Among the whole country 54 water bodies were selected for pen culture demonstration to encourage the marginal fish farmers. Now this project is going with successfully.

Pen culture technology is now widely practiced on a commercial basis in the Philippines, Indonesia and China (Dela Cruz, 1980, 1982; Lam, 1982). The principal species being cultured in these countries are milkfish and carps (e.g. grass carp, *Ctenopharyngdon idella*; bighead carp, *Aristichthys nobilis*; silver carp *Hypophthalmichthys molytrix*. Some experimental pen culture of carps has been carried out in pens in oxbow lakes in Hungary (Muller, 1979; Muller & Varadi, 1980), and other countries such as Egypt have expressed interest in their use (Muller & Varadi, 1980). The production of tilapias in net pens is also currently being evaluated in the Philippines (Hossain A, 2008).In India, experiments have been carried out to raise carp seed using pen culture in oxbow lakes, swampy tanks, *beels* and reservoirs (Banerjee and Pandey 1978),but the technology has not yet been standardized.

In Bangladesh applying polyculture in pen enclosures we can use our water bodies properly. Poly culture makes the ecological balance of the pond water, preventing the formation of massive algae blooms (Cohen *et al., 1983).* Fencing some part of an open water body as like beels, dead rivers, canal, seasonal reservoirs etc can be used commercially. But in Bangladesh yet now this technology is not transferred to the farmer level. Even enough research is not conducted on this subject. In this study we tried to find out the production of carps in pen culture system with related to different species composition. So the main objective of study was to identify the suitable species composition of carps in pen culture for maximum production as well as better economic returns.

Objectives of the study:

The objective of the study were

- To find out the suitable species composition of *Labeo rohita, Cirrhinus mrigala, Catla catla* and *Hypoothalmicthys molitrix.*
- Compare growth, production and cost benefit of different species composition.

CHAPTER 2

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Chand *et al..,* 2002 reported the size variation among the carp species in a given period. Giant fresh water prawn (*Macrobrachium rosenbergii*) was cultured with Indian carps (*Catla catla* and *Labeo rohita)* in a 0.42 ha pond. 10 days old prawn seeds were stocked at 8000/ha while 12-15 cm catla and rohu fingerlings were stocked at 12000/ha each in the pond. The growth was first in catla than rohu. They were found the average weight of catla, rohu and prawns were 926, 785 and 58 g, respectively. Survival rate of the fishes were between 65 and 66% while 49% for the prawns. The production rate obtained from the experiment was 1243 kg/ha for the fishes and 229 kg/ha for the prawns.

Islam *et al..,* 1999 conducted an experiment at Bangladesh Agricultural University, Mymensingh, on the feasibility study of polyculture of *Macrobrachium rosenbergii* with carps in ponds. Juveniles of *M. rosenbergii* were stocked at 10000 and 15000/ha stocking densities along with *Hypopthalmichthys molitrix, Catla catla, Labeo rohiya* and *Cirrhinus mrigala* in the ratio of 1.75: 0.75: 1.50: 1.0 where total number of carps were 50000/ha. Supplementary feed consisting of sesame oil cake and rice brawn (1:1) was applied in ponds daily at 4% of the standing crop. After 12 months rearing, production level 95-172 kg/ha/yr of *M. rosenbergii* 2423-2875 kg/ha/yr fish were obtained from polyculture ponds 2305.45 kg/ha/yr of fish was obtained from the pond where only carps were cultured . It indicated that the production of fish in the pond would not be affected due to polyculture with *M. rosenbergii.*

Mirza *et.al..,* 1978 studied the physico-chemical characteristics of the river Old Brahmaputra at Mymensingh for aperiod of one year. The physical factor, temperature was found to play important role in aquatic medium and the value of dissolved oxygen was positively correlated with photosynthetic activities of the phytoplankton population.

Dewan, 1973 investigated into the ecology in a Mymensingh lake (Bangladesh Agricultural University Campus). He observed higher oxygen concentration during winter and lower oxygen concentration during monsoon. He pointed out that the dissolve

oxygen bears an inverse relationship with temperature and carbon-di-oxide; a direct relationship with pH and total alkalinity.

Azim *et al.,* 2002 conducted an experiment at Netherlands on the production of 3 Indian major carps, catla (*Catla catla*), rohu (*Labeo rohita*) and kalbaush (*L. calbasu*), in a periphyton-based polyculture system. Four stocking combinations were applied: 60% rohu plus 40% catla with a total stocking density of 10000/ha. (Treatment CR), CR plus 15% kalbaush (C15), CR plus 30% kalbaush (C30), and CR plus 45% kalbaush (C45). A treatment with 60% rohu plus 40% catla without bamboo substrate was used as control CR0. Net fish yields of the 3 species were found to be higher in C15. Highest total fish yields, over a 90 days culture period, was recorded in treatment C15 (2306 kg/ha), followed by treatment C45 (1914 kg/ha) treatment CR (1652 kg/ha), treatment C30 (1507 kg/ha), and treatment CR0 (577 kg/ha). Fish production from the periphyton-based system was 2.8 times higher than that of the control.

Goolish and Adelman, 1984 recorded maximum growth rate at 30 ^{0}C temperature of juvenile common carp. They also observed that the temperature of natural inland waters in the temperature regions generally varies between 0 ^{0}C and 30 ^{0}C, the maximum values occurring particularly in shallow waters in summer and the minimum exceptionally fall bellow zero in winter.

Islam *et al.,* 1978 observed minimum values of dissolved oxygen during summer and maximum in winter. They observed water temperature was closely related with air temperature.

Lakshmanan *et al.,* 1111967 studied on survival and growth of cultivated fishes at the Government fish farms in five districts of Assam. They observed the highest temperature on all the ponds during the months July to August and the lowest during the months of December to January.

Martyshev, 1983 stated from the study of the chemical parameters characterizing the suitability of water for carp and trout farms; he observed more than 4 ppm dissolved oxygen and pH 7.0 is optimum values for carps

Michael, 1969 reported that the pH ranging between 7.3 and 8.4 was the most suitable for fish culture. The amount of dissolved gases at any given time was found to be associated with biological activities in water. He further observed variations in total quantity of plankton affected the fish growth and production.
Oppenheimer *et al.*, 1978 observed a declining trend of dissolved oxygen, pH, alkalinity and hardness during monsoon in three ponds in Dhaka city and pointed out that the horizontal bottoms of the ponds were richer in nutrients that the sloping sides.

Singh and Singh, 1975 concluded that in organically manure ponds dissolved oxygen, pH and total alkalinity remained in the range of 3.0-8.5 mg/l, 6.0-7.8 and 30-125 mg/l which were they considered to be favorable for the growth and survival of major carps and related species of fish.

Rahman *et al.*,1982 made a study on the physico-chemical conditions of four selected ponds and the river Old Brahmaputra. The range of water temperature, dissolved oxygen, free carbon-di- oxide, pH, phosphate-phosphorus and nitrate nitrogen were 26.06-31.97 ^{0}C, 6-9.2 mg/l, 7.2-7.6, 0.028-0.173 mg/l and 0.074-.304 mg/l respectively in the river Old Brahmaputra.

Davis *et al.*, conducted fish culture trials in managed farmer's ponds with different feeding and stocking regimes. The species were employed, silver carp, catla, rohu, mrigal, common carp and grass carp while the fish were rice bran, mustard oil cake and rice bran + mustard oil cake and compost. Average fish production from 16 ponds was 2830 kg/ha with a range from 1890 to 3820 kg over the 12 months studies period.

Dewan *et al.*, 1991 stated that least dietary overlap was observed between catla and rohu and between silver carp and bighead carp, whilst highest values (i.e. greatest overlap) were for catla-silver carp and catla-bighead carp in the pond of Bangladesh.

Hepher and Milstein, 1989 studied the interaction between bottom feeding fish (common carp and hybrid tilapia) and a filter feeder (silver carp) in polyculture in fertilized ponds with no supplementary feeding. The silver carps were stocked at two densities; 1,300 and 2,600/ha. Combined yield of all species in the polyculture was highest at the density of 1,300 silver carp/ha (2116 kg/ha in 156 days). At 2,600 silver carp/ha (1690 kg/ha in 156 days) inhibition of growth rate of silver carp itself reduced total yield as compared with the lower capacity.

Jhingran, 1976 reported that culture of silver carps along with Indian major carps has recently been developed in India as composite fish culture. In this method, the production as high as 3000-5800 kg/ha per 6 months and 7000-9000 kg/ha per year in different parts of the country has been achieved.

Mathew *et al.*, 1988 reported the result of a study on composite culture of six species viz., catla, rohu, mrigal, common carp, silver carp and grass carp. They stocked in proportion of 10:5:10:25:30:20 respectively at a density of 8000/ha, yielding a record production of 10183 kg/ha after rearing over a period of one year.

Opuszyanski, 1986 described the increased yield of polyculture as being a function of stocking density, age of fish, fertility of ponds and environmental temperature. He suggested that maximum economic yield should be considered rather that maximum possible yield in case of polyculture practices.

Tang, 1970, Sinha, 1974 and Gupta, 1990 have been shown that different species stocked in polyculture ponds occupy different niches with their complimentary feeding habits, fully utilizing all the natural food in the pond, thus increasing the total fish production from the pond.

Alam *et al.,* 1995 evaluated the economics of different types of polyculture system involving exotic and native major carps. Fish yield of 1640-29995 kg/ha/7 months using the locally available inputs resulted in a net profit of Tk 52,055-87,641 ha.

Awal *et al.,* 1995 assessed the fish production and economic return of carp culture in six polyculture ponds. They recorded a net profit per hectare per 6 months for native, exotic and mixed polyculture system to be Tk. 30,,825.00, Tk. 35,912.00 and Tk. 18,135.00, respectively through production of 1196, 1617 and 982 kg/ha/6 months, respectively.

CHAPTER 3

MATERIALS AND METHODS

Materials and methods

3.1 Study site:

The experiment was carried out at Kalia upazilla under the district of Narail, Bangladesh Three pens were positioned one after another in dead Bauysona river jalmahal. The total area of the river was 74 ha. . In the dry season its average water depth was 1.2m and in rainy season it was about 2.5m. In the dry season water keep stagnant but in rainy season it creates slight current of water. This river is connected with a numerous canal and beels. One end of the river is connected with Modhumiti river and another end is connected with Atharobaki river.

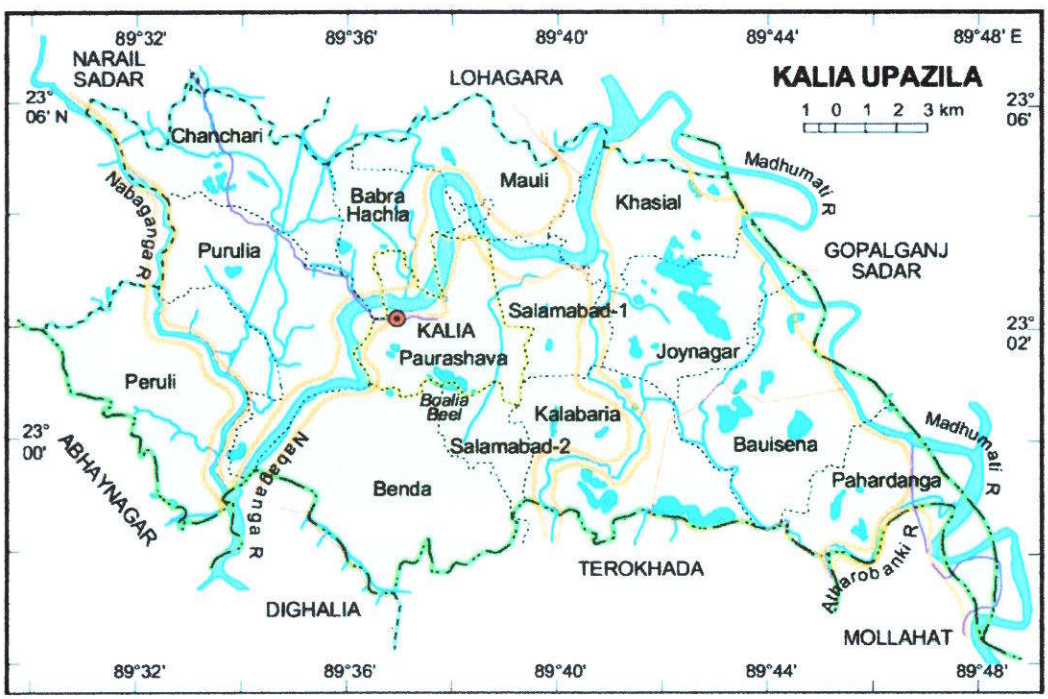

Fig 1: Location of the study area

3.2 Duration of experiment:

The experiment was carried out for a period of 8 months, from April to December 2008. Same size and age fingerlings were stocked in each pen at 30 April and harvested at 29 December 2008.

3.3 Construction and preparation of pens:

For pen construction matured bamboos were split into small strips, 0.7-0.8 cm in thickness (chata) for knitting the screens *(bana*). The screens were made using split-bamboo strips tied by two-ply nylon coir ropes. A layer of commonly available polyethylene net (mesh size 0.1 cm) was set up over the inner wall of the screens to prevent fish movement from and into the pens. The screens (bana) were set up width side of the river one after another. Bamboo poles were pushed inside the bottom mud (up to the hard bottom layer) with an interval of 1 m for the setting up of bamboo screens. Thereafter, relatively longer bamboos (7.0-9.0 m in length) were tied to the poles horizontally below and above the water level at every 1.0 m longitudinal intervals to provide strength to the structures. The bamboo screens were placed along the long bamboo in such away that no gaps were left at the lake bottom. Split (1/2) bamboos (locally known as *kami*) were tied to the outer surface of the screens. To provide further strength it was tied with iron wires all along the length (screen, pole and whole bamboo), at every 0.5 m at the junctions of the poles. The heights of the screens were kept at1.0 m above the water level of the baseline. Three pens were positioned one after another. Dead Bauysona river jalmahal was an area of 74 ha. Among them a suitable place was selected for the study. Three treatments were taken in this study. The entire selected pens were equal in size about 0.5 ha.

3.4 Numbering of pens:

The numbering of pens is necessary to facilitate the proper management like feeding, sampling and to analysis result. The three pens of this study were denoted as T1, T2 and T3

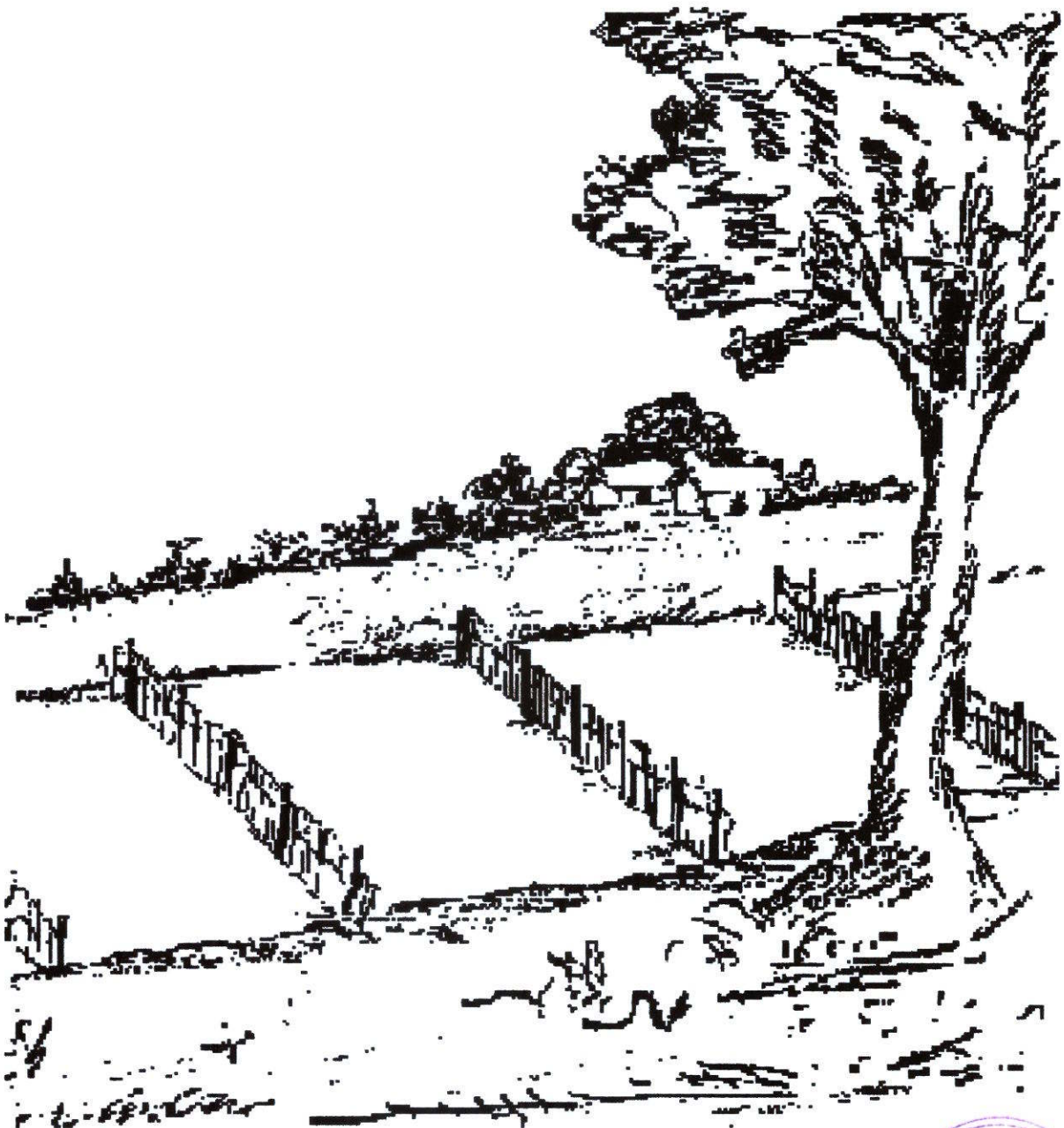

Fig 2: Schematic diagramme of bamboo fencing pen in dead Bauysona river jalmahal.

3.5 Management of pens

3.5.1 Prestocking management of pens:

Before stocking all the weeds were removed manually. By repeating netting all predatory fish were removed. Then lime (calcium carbonate, CaCO3) was applied at a rate of 1kg/decimal. After 5 days of liming fertilizer was applied at a rate of urea 200g, TSP 200g and cow dung 5kg/decimal.

3.5.2 Stocking:

After 5 days of fertilization when the water turned into greenish color then fish fry was stocked. Four species of carps ie. rui, catla, mrigel and silver carp were stocked. Same stocking density with different species composition of the stocked species was in three treatments table 1. Same size and age fingerlings were stocked in each pen. At the stocking time the average weight of rui, mrigal, catla and silver carp was 80.23g, 70.41g, 90.16g and 85.03g respectively.

Table-1: Species composition for the three experimental pens

species	Date of stocking	Stocking density (No/ha)			Date of harvesting
		T1	T2	T3	
Rui	30 April `08	12000	10000	8000	29 December `08
Mrigel	30 April `08	4000	5000	6000	29 December `08
Catla	30April `08	2000	2500	3000	29 December `08
Silvar carp	30 April `08	2000	2500	3000	29 December `08
Total		20,000	20,000	20,000	

3.5.3 Poststocking management of pens:

After stocking supplementary feed like rice polish (RP) and mustered oil cake (MOC) mixture (1:1) was used initially at a rate of 5% body weight of the stocked fish and the doses of feed was reduced upto 2% when average body weight became about 500g. The required quantity of feed was soaked and given in dough form during the early hours of the day. To grow adequate natural feed in the water body at the same time Urea, TSP and cow dung were applied at a rate of 100g, 100g and 5kg/decimal respectively with a 15 days interval.

3.6 Hydrographical parameters:

The six major parameters viz. water temperature, water transparency; water depth, dissolved oxygen and pH of the experimental pens were recorded fortnightly at 10-12 a.m. All parameters were recorded by using water analysis kit box (Model: FF-3, USA)

3.7 Fish sampling:

The weight of the stocked fish from each pen was recorded monthly through random sampling method at the rate of 20% of the total stock fish. Fish weight was measured with a triple beam simple balance nearest to the gram.

3.8 Growth of fishes:

Growth in terms of length and weight were calculated by subtracting the initial length and weight of fishes (at the time of stocking) from final length and weight of the same (after harvesting).

Percentage of growth in length = 100 × Mean final length–Mean initial length / Mean initial length

Percentage of growth in weight = 100 × Mean final weight–Mean initial weight / Mean initial weight

3.9 Average daily weight gain:

Average daily weight gain of each species was computed by subtracting the initial body weight from the final body weight and then dividing by the number of days of culture (i.e., culture period 8 months April to December, that means 243 days).

3.10 Food Conversion Ratio (FCR):

The food conversion ratio expressed by the rate of food consumed to weight gain was determined for fishes. This was calculated as:

Food Conversion Ratio (FCR) = 100 × Dry food fed / Live weight gain

3.11 Survival Rate:

Death of fishes during the period of investigation was recorded and dead or injured fishes were removed immediately after detection. The survival rate was calculated by counting the actual number of fish survived during final harvest, divided by the initial number stocked and multiplying 100.

Survival Rate(SR) = 100 × Actual survived fish / Initial number of fish

3.12 Specific Growth Rate (SGR):

The specific growth rate of ruhu, mrigal, silver carp and catla were determined by using following formula:

$$SGR = 100 \times Log\ W2 - Log\ w1\ /T2 - T1$$

Where,

W2 = Final weight (g)

W1 = Initial weight (g)

T2-T1 = Time interval

3.13 Data analysis:

The growth rate survival rate, gross and net production and cost benefit analysis was calculated using formula of Mahmud *et al.* (1993). Statistical test (T- test) was done at 5% significant level.

CHAPTER 4

RESULTS and DISCUSSION

Result and discussions

4.1 Hydrographical parameters:

The living places of fish is water. The productivity of the pond water and growth of fish are largely depends on the water quality and the environment of the water body. Some common hydrographical parameters e.g. water temperature, transparency, water depth, dissolved oxygen and pH were recorded fortnightly which were shown in (table-2).

4.1.1 Water depth

Culture system of different species follows different water depth. Generally 1.2 -1.5 meter water depth is needed for fish culture (Sarker,2000). The depth of water was measured fortnightly and the range was 1.15 to 1.6 meter (table-2). The maximum depth was 1.6 meter during September at T2 and the minimum depth was 1.15 meter during November at T3. The water depth ranging from 95 to 130 cm is beneficial for the growth of carps (Humayun *et al.*, 1986).

4.1.2 Temperature:

Temperature plays a vital role to the metabolic activity and physical growth. By the falling temperature decrease the feed consumption rate of fish and falls the growth rate. During the study period the value of temperature were varied between 18 to 33^{0}C (table-2. The highest temperature was recorded 33 in pen T2 and T3 during the month of September and the minimum temperature was recorded 18^0 in pen T1during the month of December . Ali *et al.*, (1982) stated that 20.5^{0}C to 36.5^{0}C is favorable for fish culture.

4.1.3 pH:

Another important factor for fish culture is pH. The range of water pH in different pens during the study period was varied between 7.1 to 8.6 (table-2) . Sarkar (2000) noted that the range of pH value 7-8 is suitable for fish culture but fish died when pH reached more than 11. Andrew *et al.* (1972) stated that waters having a pH range from 6.7 to 8.6 are generally support a good fish population. The highest pH value 8.6 was observed in the month of October in pen T2 and the lowest pH was observed in pen T1 in the month of July .

4.1.4 Dissolved Oxygen:

The range of Dissolve Oxygen (DO) level at surface water of three pens were 4-8mg/l (table-2). The highest DO 8mg/l was observed in the month of October and the lowest DO 4mg/l was observed in the month of November (table-2). *Cyprinus carpio* ,can remain alive in water containing as little as 1-2 ppm DO (Andrew *et al., 1972*) . Boyd (1978)stated that minimum concentration of DO tolerated by fish is obviously function of exposure time. A fish might survive 0.5 ppm DO for a few hours but not for several days. Ellis (1937) indicated that 3.0 ppm DO or less should be regarded as hazardous for fish and suitable DO level should be 5.0 ppm or more. Mckee and Wolf (1963) stated that DO for warm water fish should not be less than 5 ppm, at least 16 hours of any day.

4.1.5 Transparency of water:

The turbidity and transparency of water bear upon the normal growth of fish. The transparency of water range was 20-30 cm (table-2). Sarker (2000) reported for carp culture the transparency of water range should be 25-35 cm.. The highest transparency value was 30 cm in T3 during the month of September and the lowest was 20 cm at july in T3 .

Table 2. Hydrographical parameters of the experimental pens during the study period

Parameters	T1		T2		T3		Recommended range
	Lowest	Highest	Lowest	Highest	Lowest	Highest	
Temperature (^{0}C)	18	32.5	19	33	19	33	25-35^0 (Choudhury 2000)
Transparency (cm)	22	26	21	25	20	30	25-35 (Sarker 2000)
Depth (m)	1.2	1.5	1.5	1.6	1.15	1.55	1.2-1.5 (Sarker 2000)
Dissolve Oxygen (mg/l)	4.0	7.5	4.2	7.4	5.5	8.0	5.0-8.0 (Sarker 2000)
pH	7.1	8.4	7.4	8.6	7.2	8.6	6.7-8.6 (Andrew *et al*, 1972)

4.2 Survival rate:

The survival of fish was estimated after the final harvesting of fish. After the rearing period of 8 months , the range of survival rate of rui, mrigal, catla and silver carp were 66-72%, 62-70%, 65-72% and 69-85%respectively (table-3). For *P. hpopthalmus* the survival rate was 92-95% in cage (Azimuddin, 1998) and in cages in polyculture condition it was about 90% (Halder and Jahan, 2001). Chand *et al.,* (2002) found the survival rate of catla and rohu in polyculture system wsa 65% and 66%.

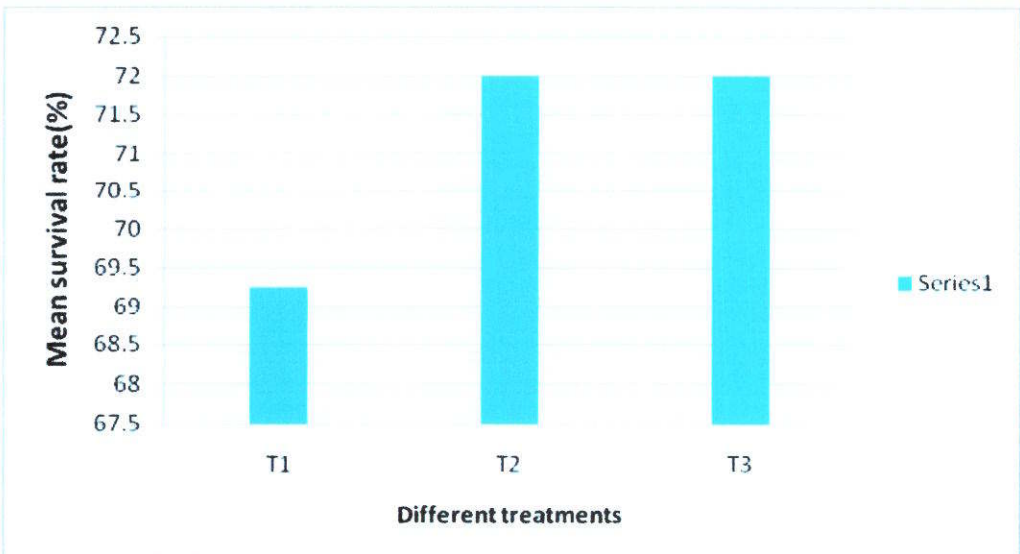

Fig.-3: Mean survival rate of fishes under different treatment conditions.

4.3 Specific Growth Rate:

The highest SGR of *L. rohita* was found 2.65 in T3 and lowest SGR was found 2.53 in T1. For *C. mrigala* same SGR 2.42 was found for three different pens(table-3) . For *C. catla* SGR value was found 2.71 in T2 which was the highest SGR to compare with other carp species. In case of *H. molitrix* the highest SGR of was found 2.66 in T2 and lowest SGR was found 2.55 in T3(table-3). Halder et al. (2001) reported the SGR range 0.91-0.94 for *P. suthi* in a five month culture period in cage culture. Azimuddin (1998) was found the SGR range 3.09% to 3.51% in three months cage culture of *P. suthi.*

4.4 Percent Weight Gain (PEG):

The percent weight gain (g) is demonstrated in (table-3). The highest PEG of *L. rohita* was found 690 in T2 and lowest PEG was found 650 in T1. For *C. mrigala* the highest PEG was 571.43 in T1 and lowest PEG value was 501.43 in T2.. For *C. catla* PEG value was found 803.33 in T2 which was the highest SGR to compare with other carp species. In case of *H. molitrix* the highest PEG was observed 756.47 in T2 and lowest PEG was 577.6 in T3. The highest PWG for *L. rohita* and *C. catla* were 787.85 and 434.44 respectively and lowest were 599.30 and 361.07 for the said species (Halder and Jahan, 2001).

4.5 Average daily weight gain:

The average daily weight gain in weight was recoded for the experimental fishes over the study period are depicted in table-3 . For *L. rohita* the average daily weight gain (g) were 2.41, 2.27, 2.57 for T1, T2 and T3 respectively. In case of *C. mrigala* the average daily weight gain (g)were 1.65, 1.44, and 1.46 for T1, T2 and T3 respectively. For *C. catla* the highest average daily weight was observed 2.96 g in T2 and lowest was 1.92 g in T3. The highest average daily weight gain of *H. molitrix* was found 2.65g in T2 and lowest was found 2.02g in T3. The range of average daily weight gain was .64-.67g in a five month culture period for carps (Halder and Jahan, 2001)

4.6 Food Conversion Ratio (FCR):

The values of food conversion ratio was estimated for the experimental fishes in table-3. For *L. rohita* FCR were 2.30, 2.22 and 2.26 for T1, T2 and T3 respectively. In case of *C. mrigala* the FCR were 2.35, 2.39 and 2.54 for T1, T2 and T3 respectively. For *C. catla* the highest FCR was found 2.38 in T3 and lowest was 2.25 in T2. The highest FCR of *H. molitrix* was found 2.75 in T3 and lowest was found 2.26 in T2. 2.75 was the highest FCR value to compare with FCR value of other carp species of three different pens. The average FCR for T1, T2 and T3 were 2.305, 2.28 and 2.48 respectively. The best average FCR 2.28 was obtained in P2. The range of food conversion ratio was 2.96-3.09 in a five month culture period for carps in cage culture (Halder and Jahan, 2001).

Table 3: Stocking density, growth performance, survival rate, SGR, and FCR under three different treatments in different composition and same stocking density.

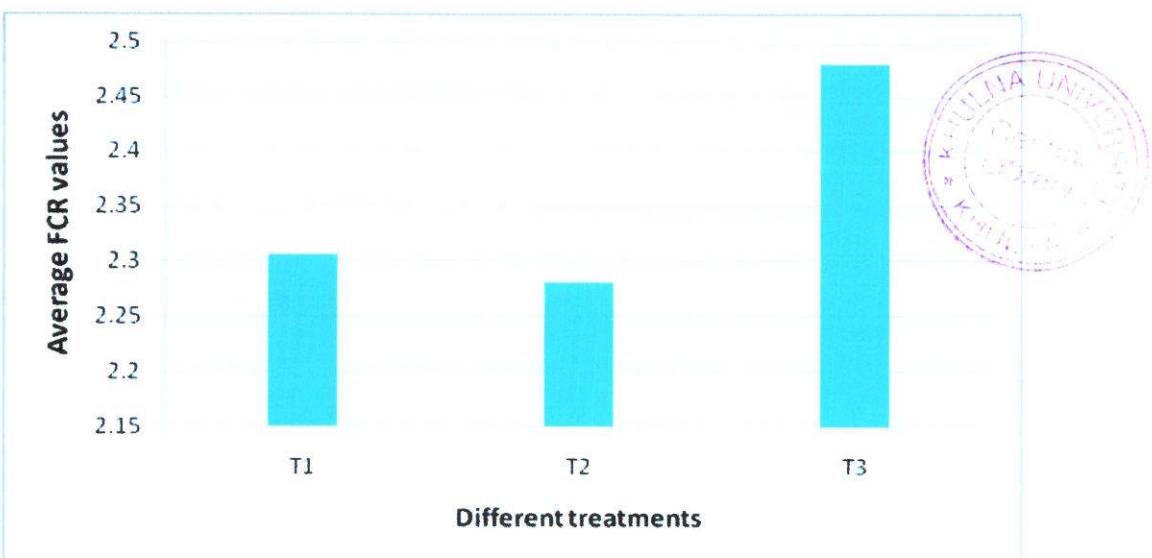

Fig.-4: Comparison of food conversion ratio (FCR) in different treatments.

Table 3: Stocking density, growth performance, survival rate, SGR, and FCR under three different pens in different composition and same stocking density.

Name of the species	Treatments	Stocking density	No of fish caught	Survival rate(%)	Initial avr. Body wt.(g)	Final avr. Body wt.(g)	Production kg/ha	SGR (%/ day)	FCR	Percentage of growth in weight	Avr. Daily wt. gain
Rui (*Labeo rohita*)	T1	12000	7920	66	80.20	600.05	4752.40	2.53	2.30	650	2.14
	T2	10000	7200	72		632.11	4551.19	2.59	2.22	690	2.27
	T3	8000	5520	69		705.10	3892.15	2.65	2.26	656.25	2.57
Mrigel (*Cirrhinus mrigala*))	T1	4000	2800	70	70.41	470.02	1316.06	2.46	2.35	571.43	1.65
	T2	5000	3300	66		421.03	1389.30	2.41	2.39	501.43	1.44
	T3	6000	3720	62		424.09	1577.61	2.42	2.54	505.71	1.46
Catla (*Catla catla*)	T1	2000	1440	72	90.16	730.12	1052.37	2.66	2.28	711.11	2.63
	T2	2500	1625	65		813.02	1321.15	2.71	2.25	803.33	2.96
	T3	3000	2160	72		556.04	1201.05	2.53	2.38	517.78	1.92
Silvar carp (*Hypophthalmichthys molytrix*)	T1	2000	1380	69	85.03	662.13	914.74	2.61	2.29	678.82	2.37
	T2	2500	1825	85		728.07	1329.72	2.66	2.26	756.47	2.65
	T3	3000	1950	85		576.11	1123.41	2.55	2.75	577.60	2.02

4.7 Growth performance of different carp species at different pens:

4.7.1 Rui (*Labeo rohita*): Average body weight (g) of ruhu in different experimental pens was measured monthly (fig-5). The final average body weight of ruhu in T1, T2 and T3 were 600.05g, 632.11g and 705.10g respectively. Growth performance was highest in T3 comparing with T1 and T2. But there was no significant difference between T1 and T2 ($P< 0.05$). The survival rate of rui in T1, T2 and T3 were 66, 72 and 69 respectively (table-3). The highest individual growth of rui (705.10g) was found in T3 where stocking density was lowest. But the total highest production of rui (4752.40kg/ha) was observed in T1 were stocking density was higher. Though rui production was highest in T1 but total fish production (8589.36 kg/ha) was highest in T2 (table-8). Monthly weight gain of ruhu at three experimental pens was shown in fig-5.

Gorai *et al.*, (2006) conducted an experiment on mixed culture of carps with stocking density of ruhu, catla and mrigal was 15000, 10000 and 5000/ha respectively for a period of 145 days. They found the net body weight gain of ruhu, catla and mrigal was 51.65g, 83.24g and 41.81g respectively.

Table 4. Monthly weight gain of *L. rohita* in three different treatments for a period of 8 months.

Month	Mean growth of *Labeo rohita* (g)		
	T1	T2	T3
May	80.23	80.23	80.23
June	135.11	139.22	132.20
July	187.53	176.29	188.22
August	267.29	293.17	302.07
September	367.07	377.06	421.45
October	473.10	475.23	542.40
November	543.22	564.37	638.12
December	600.05	632.11	705.10

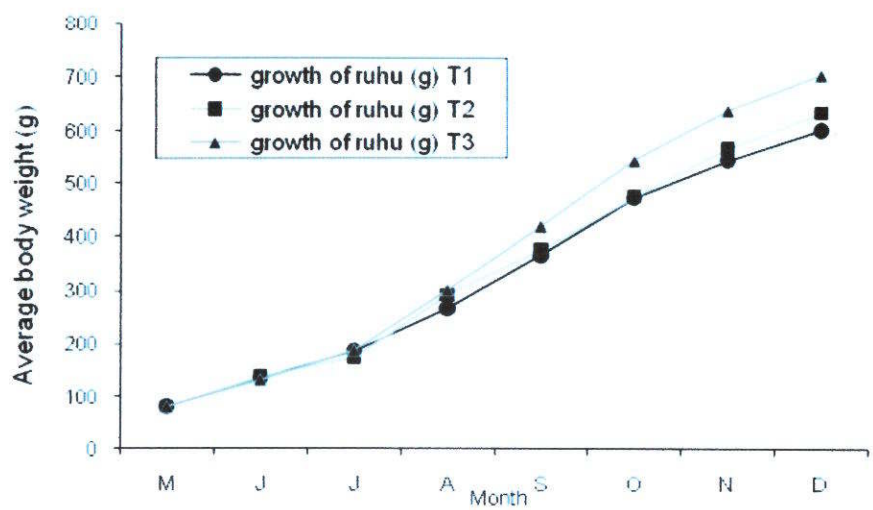

Fig 5: Monthly weight (g) gain of rui (*Labeo rohita*) in three treatments.

4.7.2 Mrigal (*Cirrhinus mrigala*): After 8 month of culture period all the fish was harvested and the final average body weight of mrigal were 470.02g, 421.03g and 424.09g for T1, T2 and T3 respectively. The maximum growth was found in T1 (470.02g). Different monthly weight gain of mrigal was shown in fig-6. The maximum survival rate was also found in T1 (70%) where the stocking rate of mrigal was lowest. From the table-3, it was showed that there was slightly difference in production among the three treatments. The production of mrigal in T1, T2 and T3 were 1316.06kg, 1389.30kg and 1577.61kg respectively. From the table-3 it was observed that though individual growth was maximum in T1 but the maximum production of mrigal was found in T3.

Table 5. Monthly weight gain of *Cirrhinus mrigala* in three different treatments for a period of 8 months.

Month	Mean growth of *C. mrigala* (g)		
	T1	T2	T3
May	70.41	70.41	70.41
June	106.40	89.45	93.23
July	142.51	131.12	115.47
August	197.37	156.43	145.33
September	265.43	223.26	219.30
October	325.10	280.11	268.28
November	411.33	379.10	383.36
December	470.02	421.03	424.09

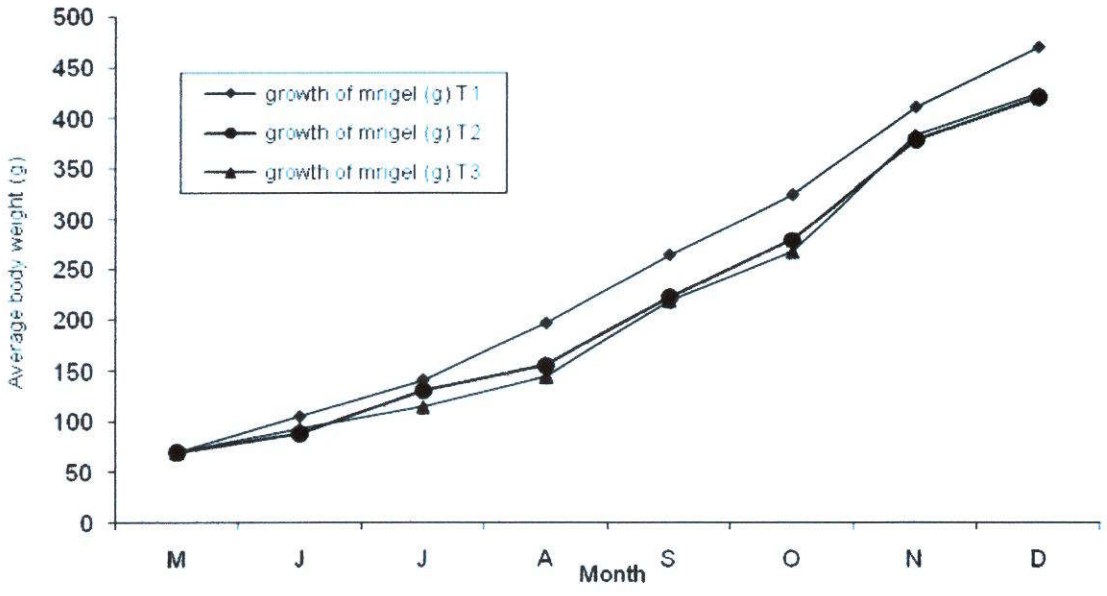

Fig 6: Monthly weight (g) gain of mrigal (*cirrhina mrigala*) in three treatments.

4.7.3 Silver carp (*Hypophthalmicthys molitrix*): The monthly mean weight gain of silver carp in three experimental pens were shown in Fig-7. The highest body weight was found in 728.20g in T2 and the lowest final weight was found 576.44g in T3 though the stocking density of silver carp was highest in T3 but the total stocking density of carps was same in all the experimental pens. The growth performance in T2 was significantly difference from T1 and T3. Alam *et.al.*, (2001) found the body weight of silver carp 460g in polyculture of golda with carps where culture period was 8 months. Huq *et.al.*, (2005) found the average body weight 800g of silver carp in polyculture where the study period was 8 month.

Table 6. Monthly weight gain of *Hypopthalmicthys molitrix* in three different treatments for a period of 8 months.

Month	Mean growth of *Hypopthalmicthys molitrix* (g)		
	P1	P2	P3
May	85.03	85.03	85.03
June	116.12	110.11	101.10
July	199.38	187.23	175.43
August	297.47	310.43	282.23
September	365.45	396.07	360.48
October	468.02	505.26	440.09
November	596.15	659.20	535.02
December	662.24	728.20	576.44

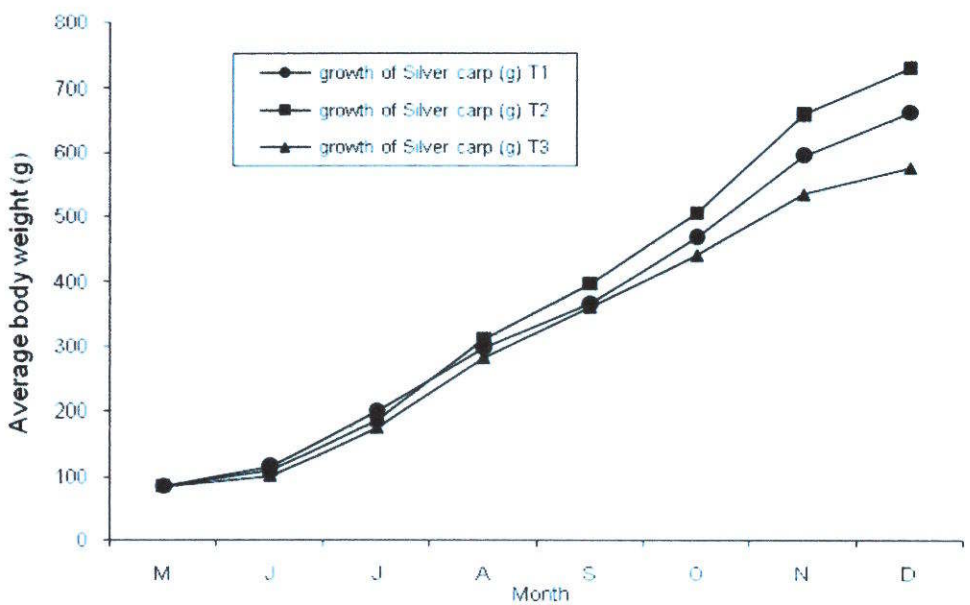

Fig 7: Monthly weight (g) gain of Silver carp *(H.molitrix*) in three treatments.

4.7.4 Catla (*Catla catla*): The highest final body weight of catla were found 813.20g in T2 and the lowest final weight was 556.44g in T3 (table-3). The highest final body weight of catla of the present study was about to same the to the highest final growth of same species studied of Huq *et.al.,*(2005).Growth performance in T2 was significantly difference from T3. Monthly weight gain of catla was shown in fig-8.

Table 7. Monthly weight gain of *Catla catla* in three different treatments for a period of 8 months

Month	Mean growth of *Catla catla* (g)		
	P1	P2	P3
May	90.16	90.16	90.16
June	136.50	139.26	132.42
July	192.32	236.43	188.31
August	297.19	355.44	302.30
September	421.43	509.17	376.16
October	554.41	666.34	445.27
November	649.25	764.12	512.08
December	730.19	813.20	556.44

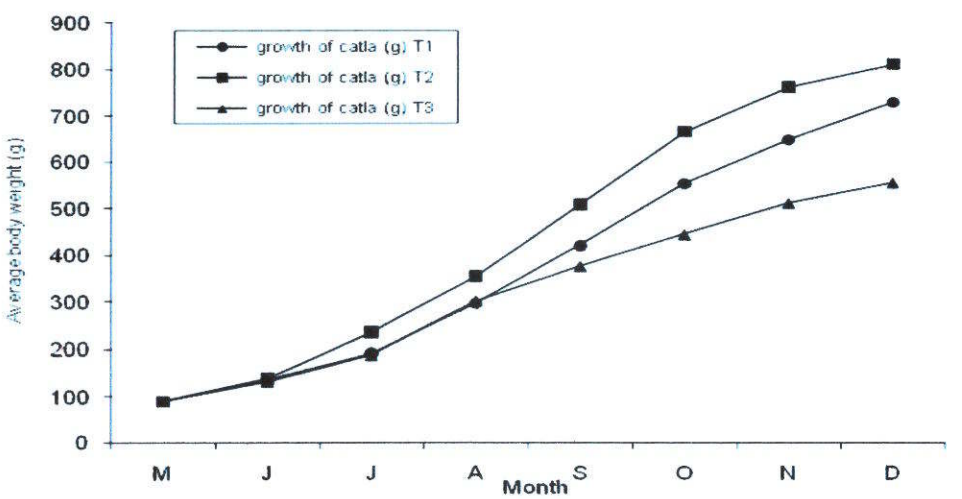

Fig 8: Monthly weight (g) gain of Catla *(Catla catla*) in three treatments

4.8 Production and cost-benefit analysis

The total production of all the experimental species in T1, T2 and T3 were 8033.58, 8589.36 and 7793.22 kg/ha (table-8) and (fig-9) respectively where the maximum production (4752.40 kg/ha) of rui was in T1 and maximum production (1321.15kg/ha) of catla in T2. Maximum production of mrigal (1577.61 kg/ha) and silver carp (1328.72kg/ha) was found in T3 and T2 respectively. Study on pen culture of carp polyculture is not many in this sub-continent. A research on carp polyculture of 5 species viz. silver carp (*Hypophthalmicthys molitrix),* catla (*Catla catla),* rohu (*Labeo* rohita), mrigal (*Cirrhinus mrigala)* and grass carp (*Ctenopharyngodon idella)* was conducted by Hossain.A(2008) where the stocking rate of 30,000/ha and 38,600/ha were in Bahadurpur baor and Dhanmondi lake respectively. Mustard oilcake and rice bran were used as supplemental feed. A total of 1890 Kg fish was produced after 8 months from 0.5 ha pen in Bahadurpur baor and 1195 kg from 0.25 ha pen in Dhanmondi lake after 6 months of culture period. In India Rai and Singh (1990) experimenting to produce table fish of Indian major carps from pens in ox-bow lakes of Bihar have reported a yield of 3362-3962 kg/ha in six month of rearing of advanced fingerlings. Abraham (1990) have also attempted to rear fry in pens for raising stocking materials for reservoirs with moderate success. Fish yield of table fish @ 5545 kg/ha in six months with a stocking density of 1600/ha advanced fingerlings has also been reported from pens of ox-bow lakes in Bihar, India (Anon 1983).

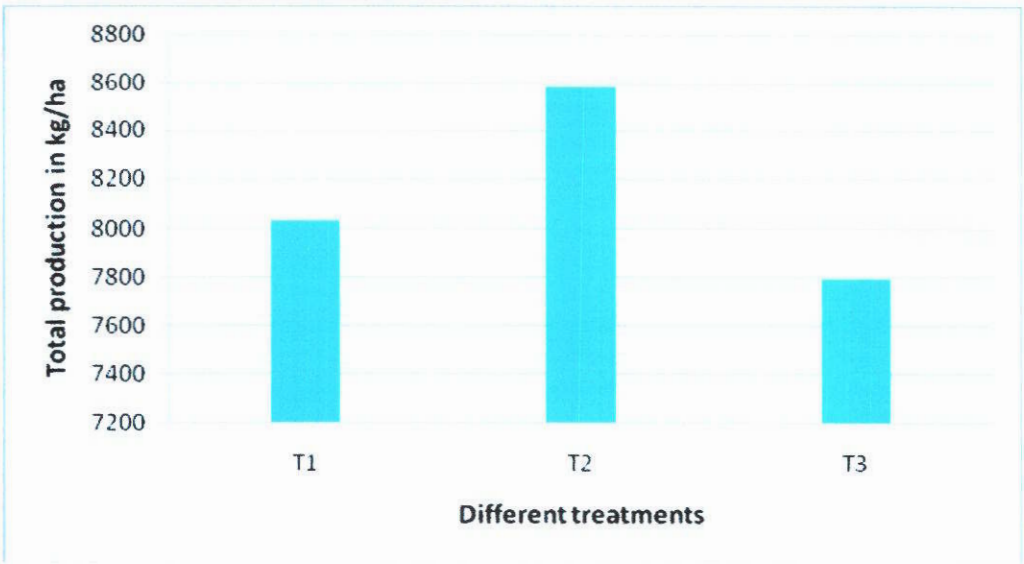

Fig 9: Comparison of total production in (g) among 3 different treatments.

Cost benefit analysis of the study is presented in table-8. The capital cost for making the pens inclusive of the bamboo screens, poles, polyethylene nets etc. could be used at least for three crops. During the second and third cropping, operation capital cost will be more towards repairing cost. So for the experiment 30% of total cost for pen establishment is considered. The experimental species ruhu, mrigal, catla and silver carp were sold at the price of 80, 60, 60 and 40 Tk/kg respectively. Feed cost was about 25 and 5Tk /kg for Mustered oil cake (MOC) and rice polish (RP) respectively. The highest net profit was found in T2 where the stocking ratio of rui, mrigal, catla and silver carp was 4:2:1:1 respectively. But the return on investment was highest (1.31) in T1 (table-8) where the stocking composition of rui, mrigal, catla and silver carp was 6:2:1:1(table-1) respectively. Gorai *et.at.,*(2006) was conducted a research of Indian Major Carps in Pen enclosures in selected floodplain wetlands of Assam, India and the return on investment was found 1.40 in pen culture. In present study the result was nearly same to Gorai *et.al.,* (2006).

Table-8: Cost benefit analysis in the three experimental pens

Items	T1	T2	T3
A. Input cost			
Cost of pen establishment (per crop)	25000	25000	25000
Purchase of fish fingerling	54000	52500	51000
10000 No of fingerlings			
Weed clearance (labour cost)	5000	5000	5000
Lime and fertilizer	10000	10000	10000
Feed (MOC+RP)	90000	100000	89000
Harvest (labour cost)	5000	5000	5000
Labour cost (8 monthx3000)	24,000	24,000	24,000
Total input cost	2,13,000	2,21,500	2,09,000
B.Gross income			
Fish production in pens (kg/0.5ha)	4016.79	4294.68	3897.11
Fish production in pens (kg/ha)	**8033.58**	**8589.36**	**7794.22**
Total return (taka)	2,79,370	2,89,880	2,61,480
Net Profit in each pen (0.5 ha)	66370	68380	57480
Net Profit (taka/ha)	1,32,740	1,36,760	1,14,960
Return on investment (%)	1.31	1.30	1.27

CHAPTER 5

CONCLUSION

Conclusion

The concept of pen culture is not properly disseminated in our aquaculture sector. Adequate research on pen culture in not yet conducted. But we can use our vast water bodies through pen culture. In this research we tried to identify the suitable species composition for carp's polyculture using pen culture system and we found a satisfactory result. But during pen establishment we faced some problem. The materials that were used for pen construction especially the net was not available in local market. Pen construction materials should be available in local area. River pen culture has been developed and operated by the indigenous knowledge of local farmers and provides a significant new income source, helping to diversify farm activities, reduce risk, alleviate poverty and provide employment opportunities during the flooding season. However, since it occurs in an open water body, there is a chance of pollution and the activity is easily affected by the surrounding environment. Therefore, it is necessary to carryout detailed studies on this form of culture in order to maximize the benefits and to avoid negative impacts such as the spread of disease, environmental pollution and the destruction of natural resources. More research is also needed on pen culture at different issue. Government and non govt. organizations should take necessary initiatives to propagate the technology through marginal fish farmers for better fish production.

CHAPTER 6

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CHAPTER 7

APPENDICES

Appendix

7.1 Cost benefits analysis:

Table 9: Economic analysis of treatment T1

Input Cost		**Income**	
Item	Taka	Item	Taka
Cost of pen establishment	25000	Species(kgXTk)	
Fish seed (NoXTk/piece)	-	Rui(2376.20X80)	190096.00
Rui (6000X6)	36000	Mrigel(658.03X60)	39481.80
Mrigel(2000X4)	8000	Catla(525.50X60)	31530.00
Catla(1000X8)	8000	Silver carp(456.30X40)	18254.80
Silver carp(1000X2)	2000		
Fish feed (Mustered oil cake 25 tk/kg and rice polish 5 tk/kg)	90000		
Weed clearance	5000		
Lime and Fertilization	10000		
Harvest(labour cost)	5000		
Labour cost(8monthX3000tk)	24000		
Total input cost	2,13,000	Total return	2,79,370

Table 10: Economic analysis of treatment T2

Input Cost		**Income**	
Item	Taka	Item	Taka
Cost of pen establishment	25000	Species(kgXTk)	
Fish seed (NoXTk/piece)		Rui(2275.60X80)	182048.00
Rui (5000X6)	30000	Mrigel(694.65X60)	41679.00
Mrigel(2500X4)	10000	Catla(660.56X60)	39633.60
Catla(1250X8)	10000	Silver carp(664.36X40)	26574.40
Silver carp(1250X2)	2500		
Fish feed (Mustered oil cake 25 tk/kg and rice polish 5 tk/kg)	100000		
Weed clearance	5000		
Lime and Fertilization	10000		
Harvest(labour cost)	5000		
Labour cost(8monthX3000tk)	24000		
Total input cost	2,21,500	Total return	2,89,880

Table 11: Economic analysis of treatment T3

Input Cost		**Income**	
Item	Taka	Item	Taka
Cost of pen establishment	25000	Species(kgXTk)	
Fish seed (NoXTk/piece)		Rui(1946.06X80)	155684.80
Rui (4000X6)	24000	Mrigel(788.20X60)	47292.00
Mrigel(3000X4)	12000	Catla(600.53X60)	36031.80
Catla(1500X8)	12000	Silver carp(561.71X40)	22468.40
Silver carp(1500X2)	3000		
Fish feed (Mustered oil cake 25 tk/kg and rice polish 5 tk/kg)	89000		
Weed clearance	5000		
Lime and Fertilization	10000		
Harvest(labour cost)	5000		
Labour cost(8monthX3000tk)	24000		
Total input cost	2,09,000	Total return	2,61,480

7.2: Statistical analysis of data:

Observation of production in 3 treatments

Rui:

One-Sample Test

	Test Value = 4550					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Rui	-.583	2	.619	-151.42000	-1269.2126	966.3726

Mrigal:

One-Sample Test

	Test Value = 1400					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Mrigal	.355	2	.757	27.65667	-307.5227	362.8360

Catla:

One-Sample Test

	Test Value = 1200					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Catla	-.109	2	.923	-8.47667	-342.9484	325.9951

Silver carp:

One-Sample Test

	Test Value = 1000					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Silvarcarp	1.024	2	.414	122.62333	-392.8132	638.0598