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DEVELOPING A FISH POLYCULTURE FOR PEASANT CONSUMPTION AND CASH CROP

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Selling small fish species at BAU campus market

Executive Summary

The purpose of this project is to develop a viable fish polyculture technology under Bangladeshi conditions that allow simultaneous fish production of small indigenous species for peasant consumption and of large carps as cash crop

During the last year two types of activities were carried out
1- Observations on food and feeding habits of the small indigenous fish species mola, chapila, punti, chela, reba and bata

2- Polyculture experiment with the large carps rohu, catla and either mrigal or common carp (as cash crop fish), and the small indigenous fish punti (as food for the peasant family) The objectives were (a) assess the effects of adding punti to polycultures of large carps, (b) compare polycultures of large carps in which the bottom feeder is either the native mrigal or the exotic common carp, (c) compare the effects of mrigal and common carp on punti

It was found that
(a) punti addition did not affect rohu, catla and total yield, improved mrigal performance in 50%, and decreased common carp performance in 20%
(b) common carp damaged embankments, had no effect on catla, improved rohu performance in 50% and total pond production in 20%
(c) punti was not affected either by common carp or by mrigal However its performance was not satisfactory, probably due to frequent netting and not to its potential

The results indicate that punti addition to the large carp polycultures is viable since it does not reduce cash crop production and might be a good food source for peasants These results are not in use yet, but villagers are keen to stock their ponds with the small fish along with large carps in the next growing season Considering this interest, a piece of parallel research will be undertaken next year in the rural ponds to compare our on-station and on-farm findings The first year experiment was the first step towards the objectives of the project, and other small fish species will be tested in the following years

Collaboration between the project partners is carried out at all stages of the work The field work and data input into computer files were carried out at BAU Data and information was shared through frequent e-mail communication Data analysis was partially done in Bangladesh and partially in Israel Discussions and final preparation of this report was jointly done during the visit of Dr Milstein to BAU

Section I

A) Research Objectives

General objective
To develop a viable fish polyculture technology under Bangladeshi conditions that allow simultaneous fish production of small indigenous species for peasant consumption and of large carps as cash crop

1st year objectives

a- Basic biology of several small indigenous species
Observations on food and feeding habits of mola (*Amblypharyngodon mola*), chapila (*Gudusia chapra*), punti (*Puntius sophore*), chela (*Chela cachtus*), reba (*Cirrhinus reba*) and bata (*Labeo bata*)

b- Polyculture test
Originally, the first experiment of the project was planed with rohu, catla and common carp as large carps, and mola, chapila and punti as small species Before the start-up of this project, it was realised that (1) common carp seems to damage pond embankments (2) chapila competes with and negatively affects the large surface-feeder major carps (reported by a post-graduate student from his mixed culture system) (3) chapila is not among the appreciated species by peasants Thus it was decided to drop chapila from the list of small species to be tried, and to test which bottom feeder is more convenient to be included among the large carps

The first polyculture experiment of the research project, carried out in the period Apr-Nov 1999 concentrated on the small barb punti (*Puntius sophore*) and the large carps rohu (*Labeo rohita*), catla (*Catla catla*), mrigal (*Cirrhinus mrigala*) and common carp (*Cyprinus carpio*) The specific objectives of the experiment were

-compare polycultures of large carps in which the bottom feeder is either the native mrigal or the exotic common carp Criteria of comparisons include damage to pond embankments, performance of each fish species (yield, harvesting weight, growth rate and survival), effects on environment (water quality parameters and plankton composition)

-compare the effects of bottom feeders mrigal and common carp on punti Criteria of comparisons include amount and timing of punti reproduction and total yield

-assess the effects of adding the small punti to a polyculture of large carp Criteria of comparisons include performance of each large carp species (yield, harvesting weight, growth rate and survival), and effects on environment (water quality parameters and plankton composition)

B) Research Accomplishments

a- Basic feeding biology of several small indigenous species

Fish were collected from natural environments in August, and were kept in separate ponds Water quality and food organisms in each pond were monitored and gut contents of each species were studied The first results indicate that
– Mola is a surface feeder and feed on unicellular and filamentous algae, protozoa, rotifers and debris
– Punti is an omnivore that feeds in the water column and on the bottom, including phytoplankton, periphyton, crustacean zooplankton, and debris
– Chapila and Chela are surface feeders, mainly dependent on green algae, zooplankton, insect larvae and organic debris
– Reba and Bata feed on algae, zooplankton, protozoa and debris

b- Polyculture test

The experiment was conducted in 12 earthen fish ponds of 100 m2 area and 1 5 m depth in the Field Laboratory of the Faculty of Fisheries, Bangladesh Agricultural University Before the experiment ponds were drained to eradicate all the predatory fishes, embankments and slopes were repaired, and agricultural lime (CaCO3) at 250 kg/ha =2 5 kg/pond was applied Ponds were filled up with pumped water and fertilised (urea and TSP each at 100 kg/ha =1kg/pond) to promote algae growth

The experiment had a factorial design (2 x 2), with 3 replications per treatment

	Control (C) without small fish	With punti (P)
Bottom feeder common carp (C)	CC	PC
Bottom feeder mrigal (M)	CM	PM

Ponds were stocked on 9-May-1999 at a stocking density of 10,000 large carps/ha and 25,000 punti/ha as detailed in Table 1 Supplementary feed consisted of rice bran and soaked oil cake (2 1), given 6 times a week at a daily rate of 3% of the large carp body weight Feeding was adjusted each 10 days after fish weighing Fertiliser and manure were applied at 10 days intervals, in the middle between two fish weighing Fertilisers were urea and TSP (1 kg/pond each) Manure (6 5 kg/pond) was applied wet in the four corners of each pond

Table 1 Stocking characteristics fish species composition in each treatment, number per pond and mean weight

Treatment	CC		CM		PC		PM	
Fish species	No /pond	weight g	No /pond	weight g	No /pond	weight g	No /pond	weight g
Rohu	33	18 4	33	21 1	33	17 2	33	19 3
Catla	33	67 2	33	68 4	33	67 7	33	67 0
Common carp	34	25 0			34	25 1		
Mrigal			34	25 1			34	23 0
Punti					250	5 3	250	5 2

Environmental sampling was carried out at 10 days intervals the day before fish weighing, always at the same hour (9 00 AM) The parameters measured were temperature, transparency, pH, dissolved oxygen, total alkalinity, phosphate, nitrogen compounds (NH_4, NO_3, NO_2), chlorophyll-*a*, and plankton composition

Results

All the environmental parameters showed significant differences through time No significant differences among treatments were found for water temperature, transparency, alkalinity, pH, dissolved oxygen, nitrite, and nitrate Only ammonium, phosphate and chlorophyll were affected by the polyculture composition (treatment) These parameters were significantly higher in the polyculture with mrigal than in that with common carp, and were not affected by the addition of punti

Bottom feeder effect. mrigal vs common carp
(comparisons of treatments CC *vs* CM and PC *vs* PM)

Pond embankments monsoon rains damaged the air exposed parts of the embankments of all ponds Besides, ponds stoked with common carp presented embankment damage in the water-air contact area, which let to still higher damage of the air exposed areas Ponds stocked with mrigal did not present damage produced by fish digging activity

Table 2 ANOVA and Duncan mean multicomparisons by treatment of each fish species parameters r^2= coefficient of determination Significance levels *= 0 05, **= 0 01 ***= 0 001 ns=not significant Mean multicomparisons same letters in each column indicate no significant differences at the 0 05 level

	number	biomass	weight	Survival	growth	SGR	yield
	/pond	kg/pond	g	%	g/day	%	kg/pond
ROHU							
ANOVA							
Sign	ns	**	*	ns	*	**	***
r^2	0 21	0 85	0 72	0 21	0 73	0 78	0 86
Duncan by treatment							
CC	A 28	A 9 89	A 358	A 84	A 1 75	A 0 66	A 9 40
CM	A 28	B 7 04	B 253	A 85	B 1 19	B 0 56	B 6 47
PC	A 30	A 9 95	A 334	A 92	A 1 63	A 0 66	A 9 43
PM	A 26	B 6 02	B 230	A 80	B 1 08	B 0 55	B 5 53
CATLA							
ANOVA							
Sign	ns	ns	ns	ns	ns	ns	ns
r^2	0 25	0 29	0 35	0 25	0 34	0 30	0 29
Duncan by treatment							
CC	A 29	A 10 55	A 360	A 89	A 1 51	A 0 37	A 8 57
CM	A 28	A 11 42	A 413	A 84	A 1 77	A 0 40	A 9 50
PC	A 30	A 9 05	A 307	A 90	A 1 23	A 0 34	A 7 03
PM	A 27	A 9 97	A 368	A 83	A 1 55	A 0 38	A 8 13
MRIGAL							
ANOVA							
Sign	***	**	ns	***	ns	ns	**
r^2	0 95	0 88	0 23	0 95	0 26	0 40	0 88
Duncan by treatment							
CM	B 22	B 5 01	A 225	B 66	A 1 03	A 0 49	B 4 47
PM	A 33	A 8 27	A 248	A 98	A 1 16	A 0 53	A 7 50
COMMON CARP							
ANOVA							
Sign	ns	*	ns	ns	ns	ns	*
r^2	0 34	0 78	0 29	0 33	0 30	0 55	0 77
Duncan by treatment							
CC	A 31	A 10 79	A 345	A 92	A 1 65	A 0 59	A 10 00
PC	A 28	B 8 72	A 313	A 82	A 1 48	A 0 56	B 8 00
PUNTI							
ANOVA							
Sign	ns	ns	ns	ns			ns
r^2	0 57	0 24	0 53	0 57			0 13
Duncan by treatment							
PC	A 145	A 0 73	A 10 2	A 58			A 0 08
PM	A 116	A 0 55	A 11 5	A 46			A -0 02
PUNTI FRY							
ANOVA							
Sign	ns	ns	ns				
r^2	0 33	0 41	0 10				
Duncan by treatment							
PC	A 43	A 0 12	A 2 99				
PM	A 16	A 0 05	A 3 34				

Effects on Rohu Differences due to treatment explain 72%-86% of the variability of rohu harvesting biomass, weight, growth rate and yield, while no significant differences in

survival were related to treatment (Table 2) Rohu presented about 40% higher biomass and weight and 50% higher growth rate and yield when the bottom feeder was common carp than when it was mrigal (Table 2, fig 1) Common carp stirring up of the mud bottom improved nutrient recirculation which in turn favoured phytoplankton development in the water column, on which rohu feeds

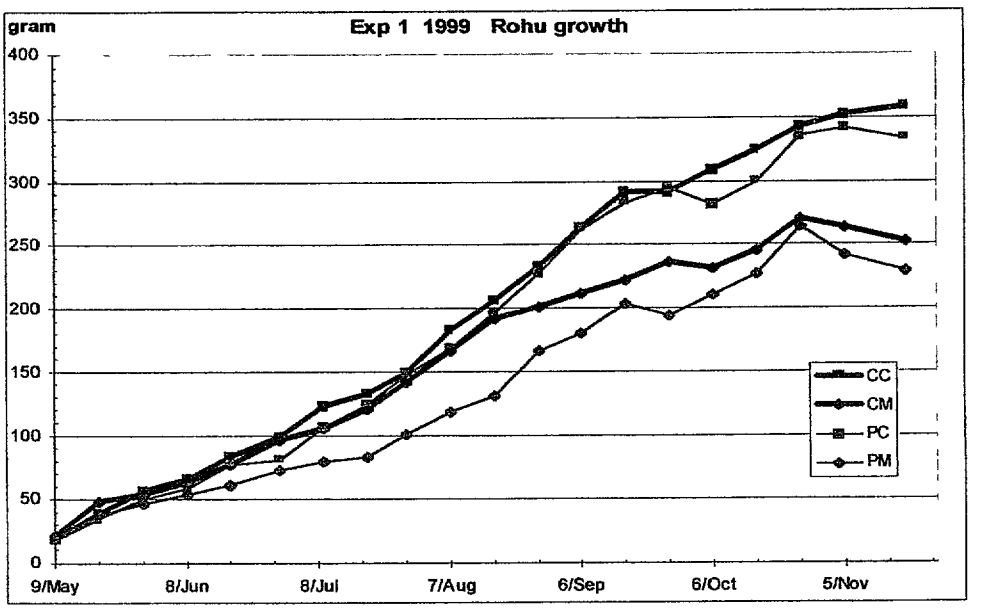

Fig 1 Growth of rohu in each treatment

Effects on Catla no significant bottom feeder effect on catla occurred (Table 2, fig 2) Catla being a surface feeder mainly capturing zooplankton was indifferent to what bottom feeder was present in the polyculture

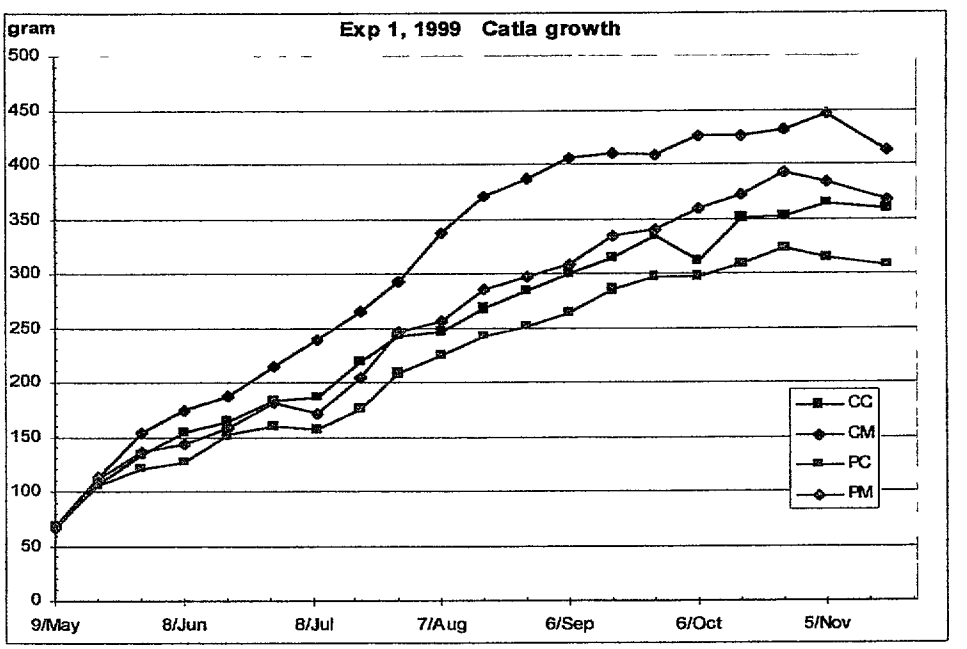

Fig 2 Growth of catla in each treatment

Effects of total fish production Differences due to treatment explain about 80% of the variability of total fish harvesting biomass and yield, and 93% of the variability of food

conversion ratio (FCR) (Table 3) Total biomass and yield were about 20% higher and FCR 20% lower when the bottom feeder was common carp than when it was mrigal

Table 3 ANOVA and Duncan mean multicomparisons by treatment of total fish biomass and yield and food conversion ratio (FCR) r^2= coefficient of determination Significance levels *= 0 05, **= 0 01, ***= 0 001, ns=not significant Mean multicomparisons same letters in each column indicate no significant differences at the 0 05 level

	large carp biomass	total biomass	total yield	FCR
	kg/pond	kg/pond	kg/pond	
ANOVA				
Sign	**	**	**	***
r^2	0 81	0 80	0 78	0 93
Mean multicomparisons by treatment				
CC	A 31 2	A 31 2	A 28 0	C 3 73
CM	C 23 5	B 23 5	C 23 5	A 5 07
PC	B 27 7	A 28 5	AB 24 5	C 3 87
PM	C 24 3	B 24 8	BC 21 1	B 4 30

Effects of bottom feeders on Punti
(comparisons of treatments PC *vs* PM)

Effects on punti production No significant differences in punti harvesting biomass, weight, yield survival, or harvested fry related to bottom feeder occurred (Table 2) Punti being also a bottom feeder was indifferent to what other large carp bottom feeder was present in the polyculture

Effects on punti reproduction in nature punti reproduces in May-Jun and Sep-Oct In this experiment stocking was in May, of rather small fish, so that reproduction was delayed and did not occur in May-Jun In the common carp ponds, punti fry of about 2-5g were caught during the second half of August and in September, and later again by the end of October-November One of the ponds produced much less fry than the other two In one mrigal pond punti fry was caught in the second half of August and at harvest by mid November, with similar punti production figures than in the carp ponds In the other two mrigal ponds recruitment in August did not occur, and at harvest very few fry were recovered One of these ponds was overflowed during the rainy season and punti could have escaped to the contiguous drainage channel The large variation of fry recruitment among the ponds of each treatment and the superposition of the ranges of fry production between treatments account for the lack of significant differences in punti performance at harvest due to the presence of common carp or mrigal in the polycultures In any case, compared to previous records at BAU, punti reproduction was low in all ponds This low reproduction rate was most probably due to punti disturbance by the fishing nets during the frequent samplings (each 10 days), as opposed to monthly samples usually performed at BAU

Punti addition to large carp polycultures
(comparisons of treatments CC *vs* PC and CM *vs* PM)

Effect on Rohu addition of punti did not affect rohu performance, whatever bottom feeder was present (Table 2, fig 1)

Effect on catla addition of punti did not affect catla performance, whatever bottom feeder was present (Table 2, fig 2)

Effect on mrigal the addition of punti to polycultures with mrigal improved mrigal survival in almost 50%, and hence its harvesting biomass and yield also were improved (65% higher in punti ponds) Punti it did not affect mrigal growth rate (Table 2, fig 3)

Effect on common carp the addition of punti to polycultures with common carp decreased common carp harvesting biomass and yield in 20% in relation to the ponds without punti, while the differences in harvesting weight and growth rate were not significant (Table 2 fig 4) The lower performance of common carp might be due to food competition with punti, who partially feeds on the bottom

Effects on total fish production The addition of punti decreased in 12% large carp harvesting biomass in the polycultures with common carp, improved in 15% the FCR in the polycultures with mrigal, and did not affect total biomass and total yield (Table 3)

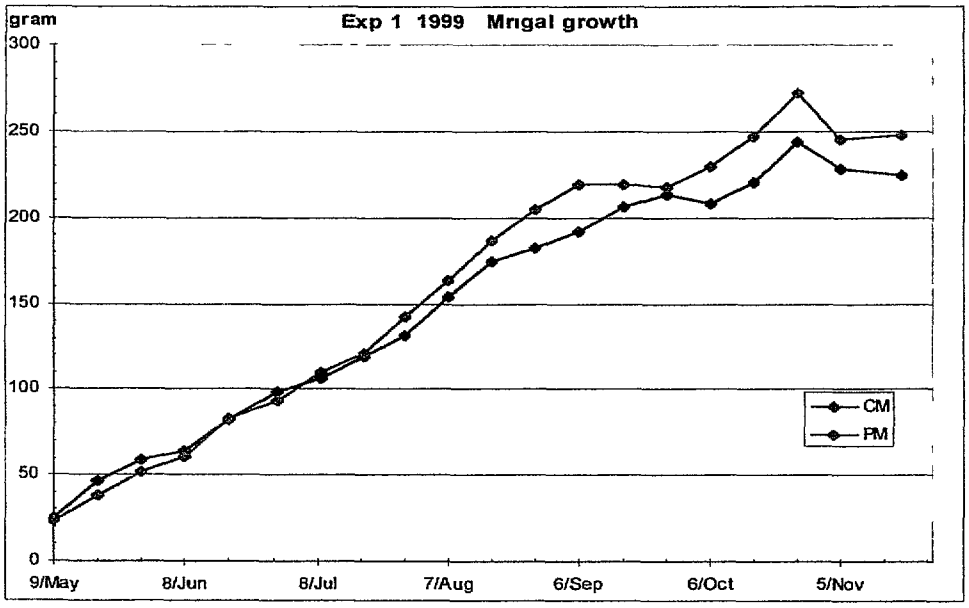

Fig 3 Growth of mrigal in each treatment

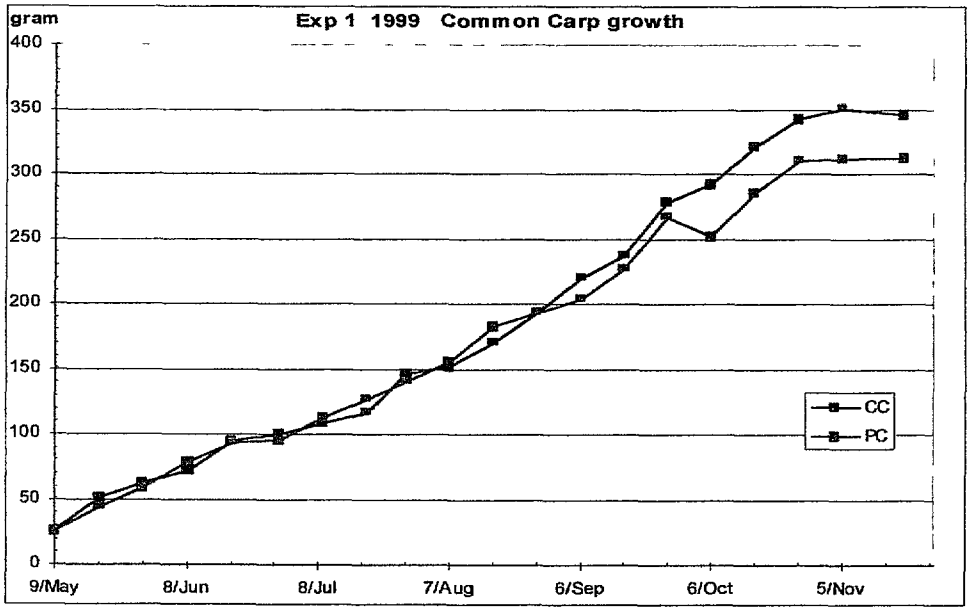

Fig 4 Growth of common carp in each treatment

C) Scientific Impact of Collaboration

The field work and data input into computer files were carried out at BAU Data and information was shared through frequent e-mail communication Data analysis was partially done in Bangladesh and partially in Israel Discussions and final preparation of this report was jointly done during the visit of Dr Milstein to BAU

In the framework of this project two students (Rubel and Shahidul) completed their observations on small fish biology for their theses The main experiment was conducted by Rubel, a M Sc student of Dr Wahab The project allowed his training in experimental and laboratory work, data analysis and report writing He presented his thesis based on this material on 13-Dec-99 The project also allowed the skills improvement of three Ph D and some M Sc students on data handling and analyses using EXCEL package, through a short demonstration-training lecture by Dr Milstein at BAU

Dr Milstein also gave a seminar talk to BAU teachers, students and Fisheries Research Institute's scientists on "Aquaculture in Israel", which has been received by the participants with great interest

D) Description of Project Impact

The results of the research have not been in use yet However, villagers are keen to stock their ponds with the small fish along with large carps in the next growing season Considering this interest, a piece of parallel research will be undertaken next year in the rural ponds to compare our on-station and on-farm findings The project has already created interest among the BAU Faculty and Fisheries Research Institute scientists, who manifested their intention to carry out similar type of work

E) Strengthening of Developing Country Institutions

Through this project, a number of essential equipment have been bought and is being used by over 20 BAU staff members and 50 students The acquisitions include a Hach Kit UV spectrophotometer, a computer, a scanner, a dissolved oxygen-meter, a pH-meter, a microscope, and a Mettler precision balance

The experiments are being carried out by the undergraduate students in the research site of the project for their practical training, which was not done before

There has been a nice opportunity of strengthening collaboration in many aspects of Israeli agriculture with this University The Director of the Research System of the University (BAURES) visited the field activity during harvest of fish, met Dr Milstein and welcomed our collaboration So there has been no institutional problems

F) Future Work

During the 2nd year of this project, the same fish polycultures will be tested simultaneously in BAU experimental ponds and in peasants' ponds The objective of the experiment will be to test the effects of adding punti, mola, or both of them to the large carp polyculture both under experimental controlled conditions and under real farm conditions At BAU, periodical sampling will be carried out once a month to reduce the negative effects produced by frequent netting on the small fish In the farms, pond management during the culture season will be carried out following peasants decisions

Section II

A) Managerial Issues

The small indigenous species chapila (*Gudusia chapra*) was to be the first small species to be tested As indicated in the 1st Management Report, it was observed to compete with the large surface feeder major carps when stocked in mixed culture (reported by a post-graduate student from his mixed culture system) Thus, it was discarded and the small barb punti was tested instead

B) Budget

Bangladesh No changes have been made in the budget

Israel Salary for student was not utilised during the first year, since the data to work with were in process of being generated in Bangladesh Instead, the a much powerful (and expensive) statistical program than the one intended to be bought was acquired This is the SAS package, Statistical Analysis System, SAS Campus Drive, Cary, NC 27513, USA

C) Special Concerns

No special concerns

D) Collaboration, Travel, Training and Publications

Fluent communication between partners is carried out through e-mail Dr Milstein travelled to Bangladesh on 16-25 Nov to participate in fish harvesting and end of the field experiment final steps of data editing, preliminary data analyses, and preparation of this report

The next 6 months will be dedicated to final data analyses and paper writing of the 1st experiment, and preparations for the 2nd experiment during the 2000 summer Dr Wahab will travel to Israel in March, to get in contact with Israeli aquaculture and to discuss project activities

E) Request for A I D or BOSTID Actions

No special actions requested