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REPORT

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Title	Serial No.	Date
Status report March 2002: Environmental and socio-economic impacts of shrimp farming in Bangladesh (2nd Phase).	4534-2002	2002.04.30
	Report No. Sub-No. O-99173	Pages Price 55

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Topic group	Distribution
Geographical area Bangladesh	Printed NIVA

Client(s)
Norwegian Agency for Development Cooperation, NORAD.

Client ref.

Abstract

This years visit to Bangladesh lasted from 25 February to 9 March 2002. Since this was the last visit to Bangladesh as a part of this project, the time was used to arrange a seminar with shrimp farmers in Paikgacha, the main study area, and to attend a national workshop held in Dhaka. Besides, we participated in several meetings with the project group and attended a meeting at the Norwegian Embassy. The seminar at the Brackish Water Fisheries Research Station (BFRI) in Paikgacha was very useful with important feedback from farmers regarding environmental problems, better management and new technology.

The workshop in Dhaka was held at the BRAC Centre with about 60 participants included special invited guests. The guests were The Norwegian Ambassador, Ms Gerd Wahlstrøm, Secretary at Ministry of Fisheries & Livestock, Dr. Z. Karim, Vice Chancellor at BAURES, Prof. M. Rahman and Director at BAU, Prof. Md. Shahjahan. There were participants from governmental institutions, universities, research institutes, shrimp farmers and consultants. This report contains abstracts from the lectures given, participant list, photos and two full papers prepared by Bjørn Braaten and Asbjørn Bergheim, respectively.

4 keywords, Norwegian	4 keywords, English
1. Akvakultur	1. Aquaculture
2. Reker	2. Shrimps
3. Brakkvann	3. Brackish water
4. Miljø	4. Environment

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ISBN 82-577-4188-4

STATUS REPORT - MARCH 2002

Environmental and socio-economic impacts of shrimp farming in Bangladesh (2nd Phase)

Preface

This report presents the outcome of the sixth annual visit to Bangladesh as a part of the Project. The main objectives of the visit were the following:

- to participate in meetings with the Project team to discuss the achieved results at the end of 2nd project period (Phase II),
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- to attend a Seminar at FRI to present Project findings and compare notes regarding management problems and possible solutions in shrimp farms with farmers and other scientists, and
-
- to attend a National Workshop gathering people from the Norwegian Embassy, government administration, research institutions, the shrimp industry, etc. presenting research findings, discussing good management practise (GMP), introduction of Code of Conduct, etc.
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The visit took place in the period 25 February – 9 March. This year represents the end of Project phase II and no field surveys were carried out during the visit. The Project team members are the following:

Prof. Dr. M. A. Wahab, BAU (Project manager)
Prof. Dr. M. S. Islam, BAU
Dr. M. A. Shahid, SPARRSO
Mr. B. Braaten, NIVA, and
Dr. A. Bergheim, RF
Before entering Bangladesh, we stayed six days at NIO in Goa, India discussing plans for another project. The stay in India was financially supported by NIO.

Oslo, 2002

Bjørn Braaten *Asbjørn Bergheim*

M.A. Wahab

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Summary

The visit to Bangladesh was from 25 February to 9 March 2002. Since this was the last visit to Bangladesh for this prosject, the time was used to seminar with shrimp farmers in Paikgacha, the main study area, a national workshop in Dhaka and project meetings.

The seminar at the Brackish Water Fisheries Research Station (BFRI) in Paikgacha was very useful with important feedback from farmers about the environmental problems, better management and new technology.

The workshop in Dhaka was held at the BRAC Centre, with about 60 participants including special invited guests. The guests were Norwegian Ambassador, Ms Gerd Wahlstrøm, Secretary, Ministry of Fisheries & Livestock, Dr. Z. Karim, Vice Chancellor BAURES, Prof. M. Rahman and Director BAU, Prof. Md. Shahjahan. It was participants from governmental institutions, universities, research institutes, shrimp farmers and consultants.

The report contain abstract from the lectures given, name and address of participants, photos and two complete papers given by Bjørn Braaten and Asbjørn Bergheim, respectively.

1. Travel programme

Date	Time	Activity
18 February	7 - 10 am	Departure Stavanger/Oslo
19 February	07:30 am	Arrival Goa, India
19 - 24 February		Stay at NIO, Goa (meetings/preparing joint project)
24 February	02:05 pm	Departure Goa (stay in Calcutta overnight)
25 February	10:45 am	Arrival Dhaka (stay at Golden Deer Guest House)
26 February	10:15 - 11 am 04:30 - 06 pm	Dhaka - Jessore by air, arrival hotel Khulna at 01:30 pm Meeting at hotel in Khulna with the project group (Profs. Wahab & Islam), planning seminar in Paikgacha
27 February	07 - 09 am 11:15 am - 03 pm	Khulna - Paikgacha by car Seminar: "Shrimp farmers - Scientists Exchange of Views" held at BFRI Research Station Paikgacha with 30 shrimp farmers (project presentations, future management practise)
28 February	07 am - 05 pm	Khulna - Jessore by car, Jessore - Dhaka by air, Dhaka - Mymensingh by car
1 March		Meeting at the Guest House, planning of presentations at the Workshop (5 March), preparing Seminar report
2 - 3 March		Further preparing of Seminar report & Workshop planning, Inst. of Fisheries, BAU
4 March	10 am - 01 pm 03 - 05 pm	Mymensingh - Dhaka by car (stay at Golden Deer Guest House) Testing audio-visual facilities at the BRAC centre (Workshop room)
5 March	08:45 - 09:30 am 09:30 am - 05 pm	Preparing - planning Workshop at BRAC Centre National Workshop on Environmental and Socio-economic Impacts of Shrimp Farming in Bangladesh (BRAC Centre)
6 March		Start preparing Travel Report (Golden Deer G. H.)
7 March	10 – 12 am 00:30 – 02 pm	Meeting in Golden Deer G. H. Meeting at the Norwegian Embassy
8 March		Holiday (Golden Deer G. H.)
9 March	06 pm	Departure Dhaka airport
10 March	12 am - 02 pm	Arrival in Stavanger/Oslo

2. Project meetings

1. Hotel Khulna 26 February, 04:30 –06 pm

Participants:

Prof. Dr. Md. Shahjahan, Director BAURES,

Prof. Wahab, Prof. Islam, Mr. Braaten, Dr. Bergheim.

Subjects:

Preparations for the next day's seminar were made. Significant subjects brought up at the seminar should be included in the next project proposal. The importance of introducing Good Management Practise (GMP) and/or Code of Conduct was stressed. Besides, the shrimp fry supply situation in the country was told to be improved as 43 new hatcheries are under construction in the Cox's Bazar region.

Project presentations at the WAS Conference in Beijing, 23-27 April 2002, were discussed. The Project group will give three oral presentations at the Conference describing findings from the main research fields: Water quality and effluent load, Socio-economic consequences, and Denudation of mangrove forests (GIS). Suitable international periodicals for publication of the findings were also briefly discussed. By the end of this year, manuscripts should be submitted for publishing.

2. BAU Guest House, Mymensingh 1 March, 11 – 12 am

Participants:

Dr. Wahab, Mr. Md. Enamul Hoq, BFRI, Mr. Braaten, Dr. Bergheim.

Subject:

Assessing the formal National Workshop programme, invitation letter, and the prepared workshop material (included bag). Mr. Hoq has been responsible for the design of the workshop material.

3. BAU Guest House, Mymensingh 8 March, 10 – 12 am

Participants:

Dr. Wahab, Dr. Islam, Mr. Md. Mustafizur Rahman, Research fellow BAU, Mr. Faruk-Ul-Islam Shamin, Co-ordinator ITDG, Mr. Braaten, Dr. Bergheim.

Main subject:

Preparing the meeting at the Norwegian Embassy (00:30 pm) emphasising the follow-up of the Project, i.e. proposal for a 3rd Project phase.

3. Seminar on "Shrimp farmers - scientists Exchange of Views"

Venue: Meeting Room, BFRI Brackishwater Research Station, Paikgacha.

Time: 27 February 2002, 11 am to 03 pm.

Participants:

About 30 farmers from the Paikgacha - Khulna region, scientists from BFRI, BAU and the Project team (see Participant list in APPENDIX).

Programme:

11:00 am	Welcome address: Prof. Dr. Md. A. Wahab, BAU
11:15 am - 00:45 pm	Session I
00:45 pm - 01:00 pm	Coffee break
01:00 - 03:00 pm	Session II
03:00 - 04:00 pm	Lunch

***Session I**:* *Presentation of research findings*

Chairman: Dr. Md. Jahangir Alam, Chief Scientific Officer BFRI Paikgacha.

Rapporteurs: Mr. Md. Shafiquzzoha & Mr. Pallab Kumar Roy.
Speakers:

Dr. A. Bergheim, Rogaland Research, Norway: Summary of effluent loading and in-pond water quality studies in extensive shrimp culture.

Dr. Md. S. Islam, BAU: Summary of socio-economic impacts of alternate shrimp - crop farming.

Mr. B. Braaten, Norwegian Institute for Water Institute, Norway: Overall comments on the impacts of shrimp farming in Bangladesh and concerns.

(Translation from English to Bengali: Dr. Md. A. Wahab).

***Session II**:* *Workshop on environmental problems and future technologies for shrimp farming*

Chairman: Prof. Dr. Md. Shahjahan, Director BAURES.

Rapporteurs: Mr. Md. Shafiquzzoha & Mr. Hindol Kumar Roy.

Besides, Md. A. Wahab and Md. S. Islam acted as moderators and B. Braaten and A. Bergheim as stimulators of the discussion.

Group A: Farmer participants discussed on environmental problems.

Emphasised problems:

- During dry periods the water level of the rivers are often lower than the level within the ponds *(Gher*). Consequently, water exchange may be eliminated for more than 2 months without available pumping facilities.
- Due to silting, the ponds are gradually getting shallow (often < 1 foot). Among the resulting problems are high diurnal temperature fluctuations (max. even > 38 °C), oxygen deficit, low water exchange, etc.
- Decomposition processes of left straws from the rice harvest often cause poor condition at the bottom layer, such as oxygen deficit, toxic gases (hydrogen sulphide, gaseous ammonia).
- In shallow ponds, sunshine forces the animals to the pond bottom where the conditions are unfavourable (DO deficit, etc.).
- During the second stage of the production cycle (> 100 days post stocking), the stock is vulnerable to disease attack. Early harvest in order to minimise the disease risk, reduces the shrimp size and selling price.
- Post stocking, disease outbreaks among young shrimp are common in the inlet area of the *Gher* due to stressing conditions (fluctuating current velocity, etc.).
- The existing pond conditions are rarely known due to lack of monitoring equipment.
- White crabs are a common problem in many farms often destroying a significant part of the shrimp stock.
- Intake of effluent water from adjacent shrimp ponds is considered a major disease spreading risk.
- Shortage of money to purchase fertilizer and feed is a usual reason for poor in-pond conditions.
- High mortality due to disease is observed during the rainy season when freshwater and surrounding brackish water are mixed.
- Many ponds have inferior soil quality and loose water by leakage. Consequently, the farmers are forced to regularly supply new water.
- The investigated Soladana *Gher* is not a representative system for extensive shrimp farming in the region. Most ponds are smaller and deeper.

Group B: Farmer participants discussed on future development plan and technologies for shrimp farming.

Emphasised future plan and technologies:

- In order to achieve improved control of the pond conditions, the average *Gher* size needs to be significantly reduced. Suitable size range seems to be in the range 1 - 10 ha (different opinions).
- Pond depth should be at least 3 feet. Pond volume is a better criterion than pond area.

- Improved water exchange rate should be encouraged. A relevant attempt is water pumping (and/or aeration), especially in the last stage of the production cycle (e.g. HOBAS technology).
- Farmers need to control the water quality frequently in the future by using purchased monitoring apparatus (e.g. DO, salinity, pH).
- Health status of the shrimp should be routinely sampled throughout the production cycle (aqua-veterinary service).
- Alternate production of shrimp-cum-tilapia is considered a potential production strategy.
- Effluent loading of solids and nutrients from the ponds at harvest should be kept as low as possible.
- Use of a periphyton based technology was mentioned as a possible new technology for extensive shrimp farming.

The research station in Paikgacha has totally 53 experimental ponds at its disposal. The station facilities are highly suitable to perform a future project for testing of improved technology for shrimp farming.

4. Workshop on Environmental and socioeconomic impacts of shrimp farming in Bangladesh, Dhaka, 5 March 2002

4.1 Programme

Venue: BRAC Centre, Dhaka
Time: 5 March 2002 Tuesday
09:00 - 09:30 **Registration**

Inauguration

09:30 - 09:40	Welcome address Prof. Dr. Md. Abdul Wahab, Department of Fisheries Management, BAU, Mymensingh.
09:40 - 09:50	Address by the Special Guest Prof. M. Mustafizur Rahman, Vice-Chancellor, BAU, Mymensingh.
09:50 - 10:00	Address by the Special Guest Ms. Gerd Wahlstrom, Her Excellency the Ambassador of Norway.
10:00 - 10:10	Address by the Chief Guest Dr. Zahurul Karim, Secretary, MoFL.
10:10 - 10:20	Address by the Chairman Prof. Dr. M. Shahjahan, Director, BAURES, BAU, Mymensingh.
10:20 - 10:30	Vote of Thanks Prof. Dr. M. Serajul Islam, Department of Agricultural Economics, BAU, Mymensingh.
10:30 - 11:00	Tea.

Session I: **Status of coastal resources**

Chairman:	Prof. Dr. A.K.M. Aminul Haque, Former Vice-Chancellor, BAU, Mymensingh.
Rapporteurs:	Dr. Ali Reza Mustofa Hossain, M. Enamul Hoq.
11:00	Present status and strategies for future development of shrimp culture in Bangladesh, Mr. M. Rezaul Karim.
11:20	Research strategies and coastal aquaculture development in Bangladesh, Dr. M.A. Mazid.
11:40	Discussion.

Session II: **Environmental impacts of shrimp culture**

Chairman:	Dr. M.A. Mazid, Director General, Bangladesh Fisheries Research Institute, Mymensingh.
Rapporteurs:	Dr. Ali Reza Mustofa Hossain, M. Enamul Hoq.
11:50	Environmental impacts of shrimp farming in the coastal areas of Bangladesh, Dr. Md. Abdul Wahab.
12:10	Water pollution potential of extensive shrimp culture systems: mass budget of *gher* Soladana, Dr. A. Bergheim.
12:30	Shrimp diseases and its consequence on the coastal shrimp farming in Bangladesh, Dr. M.B.R. Chowdhury.
12:50	Impact of denudation of mangrove forest due to shrimp farming on coastal environment in Bangladesh, Dr. M.A. Shahid.
13:10	Discussion.
13:20-14:00	Lunch/Prayer.

Session III: **Socioeconomic impacts and possible solutions to the environmental problems**

Chairman:	Mr. M. Nasiruddin Ahmed, Director General, Department of Fisheries, Dhaka.
Rapporteurs:	Dr. M.J. Alam, Dr. Nesar Ahmed.
14:00	Socioeconomic impacts of alternative crop-shrimp farming in Bangladesh, Dr. M. Serajul Islam.
14:20	A code of conduct for shrimp farming or guidelines for best management practice - Something for Bangladesh? Mr. B. Braaten.
14:40	Discussion.
14:50	Tea.

Session IV: **Future strategy for shrimp farming in Bangladesh**

Chairman:	Mr. B. Braaten, Norwegian Institute for Water Research (NIVA), Norway.
Rapporteurs:	Dr. M.J. Alam & Dr. Nesar Ahmed.
15:00	Open Discussion on Policy Issues: Future Research Need (Group A & B).
16:00	End of Workshop.

4.2 Presentations - abstracts

Environmental and socioeconomic impacts of shrimp farming in Bangladesh

Sustainable utilization of land and water resources is vital if a developing country with a large population, such as Bangladesh, is to ensure national and livelihood security for its people. The production of brackish water shrimp has become an important source for this purpose in addition of being one of the top export income sources for several developing countries. The industry has expanded rapidly in Asia over the last twenty years, and the annual production of 64,000 tones in Bangladesh with an export value of US$ 322 million (DoF 2001).

In spite of vast potential of this sector, there has been an unregulated, uncontrolled and uncoordinated horizontal expansion of the shrimp farming rather than an attained efficiency of the production system. The industry has expanded from less than 20,000 ha in 1980 to about 140,000 ha in 1995. Consequently, this development has caused serious environmental and social impact such as cutting of mangrove forests, occupation of other land resources, intrusion of saline water, decreased fisheries, local water pollution, changed hydrological characteristics, etc.

In the past, coastal people use to produce salt in salt-pan during the summer, followed by traditional fish and shrimp polyculture of paddy-cum shrimp culture in the remaining season without disrupting the natural environment. Today's extensive culture has changed the practice and continuous retention of saline water in the farm and gradually made the soil less productive, particularly in the south-western part of the country.

Mangrove destruction especially Chakaria-Sundarbans due to the construction of shrimp farms has been a major impact in the country as seen in the other countries in the region. In the Cox's Bazar region, one of the oldest mangrove forest Chakaria-Sundarban had an area of 18,200 ha which was dramatically reduced to 5,446 ha. Very recently, in the south eastern part of Bangladesh, the small fringe of the natural mangroves along the bank of Naf River and beautiful Keora *(Soneratia apetala)* forest of the Jaliardwip, a small island and a habitat of crab-eating monkeys have been cleared off and converted to shrimp ponds. The ecological values of these resources are numerous and significant.

Under this BAURES-NORAD collaborative project, the research team carried out a two year long primary investigation. They especially emphasized on shrimp pond effluent concentrations and loading. This study had revealed some interesting results. More such analyses of water quality parameters were felt necessary to reach to a conclusion through which farmers may be advised for better ways management of their farming systems for sustainable development.

One of the effects of shrimp farming is the salinization of shrimp farming on the ground water and wells for drinking water. Salinity intrusion in the surrounding areas has appeared as a serious ecological as well as socioeconomic curse on coastal people. In the south-western part of the country, the salt water has caused loss of crop production, loss of valuable fruit trees, loss of grazing lands, crisis for drinking water and related gastrointestinal diseases. The nature and extent of this problem needed an assessment for public awareness and for the policy makers.

It has been widely said that shrimp farming has caused a reduction and/or loss agricultural land which were previously used for cultivation of varieties of crops. The exact area that has been unsuitable for paddy and other crops due to high salinity is yet to be surveyed. Therefore, documentation on the effects of shrimp farming on the crop diversity and on overall agricultural production has been made as an integral part of this project.

Shrimp farming is mostly done in private land, leased in from small private land owners. The land owners normally refuse to lease out land for shrimp farming in areas where rice cultivation is feasible. They also resist any excavation or topographic changes in their land. The big shrimp farmers, on the other hand, try to flush out the adjoining areas with saline water and compel the small land owners to lease out land for shrimp farming at nominal price. This situation often leads to conflict between big shrimp farmers and small cultivators. The question obviously arises- who gains and who pays? The conflicts that have arises due to shrimp farming and various socioeconomic implications has been thoroughly investigated under this project.

BAURES-NORAD collaborative project in its second phase since January 2000 has passed two years of its three years study. In the last annual meeting held in October 2001, it was decided that the findings of two years of the project would be presented to the various stakeholders for dissemination and exchange of views so that the future course of action can be formulated. With this end in view, this workshop has been organized.

Abstracts

Present status and strategies for future development of shrimp culture in Bangladesh

Md. Rezaul Karim

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Bangladesh has unique and favourable environment for shrimp culture and traditional shrimp culture is an old practice with low production cost. So far, in the early 70s shrimp culture gradually introduced inside the polders with a view to producing alternative cropping of paddy and shrimp. Shrimp farming established in rice-field and salt-pan involving small dyke around it and installation of sluice gate which is used for saline water pass through during high-tide. The main species produced were *bagda*, other shrimps and many other fin-fishes. Meanwhile shrimp culture has received considerable interest because of high market demand and economic return. From this sector yearly income is 15-20 billion Taka. Considering better income than agriculture more areas came under shrimp culture. Presently total number of shrimp farm is about 17,000 and the area under shrimp farming is about 150,000 ha. Out of these, 75% of the cultured area is in Khulna region and 25% is in Cox's Bazar and other areas of the country. Directly or indirectly more than 600 thousand people are engaged in shrimp culture activities at present.

In Bangladesh, shrimp culture influenced by river water entering from sea coast and it's climate is governed by monsoon regime. The development is based on the experience of local people and the available environmental support. On the other hand, lands are privately owned, shrimp farms are usually large, and scattered subsoil contain iron pyrites, topsoil contains high organic load and water supply is not enough to manage. There is no plan for land use, infrastructure development, supply and drainage canals and other associates services. Under present culture practice, water supply is dependent on tidal influence, water depth remains inadequate, stock density is variable and relatively poor yield. Farmers cannot assess their stock due to free entry of pests, predators, competitors and high mortality rate. Average production is 70-200 kg/ha/yr according to the management capacity. However, to have a reliable production level some improvements in local techniques are urgently needed. A big change may not be possible without infra-structural development and other supporting facilities. But present production level may easily be increased to certain quantity with a little or partial modification in techniques and good management practice. The main objects which need partial modification for development are manageable- site selection, methodical pond preparation, nursery management, optimum stocking, maintaining optimum water level, reducing pollution effect, reducing predators, maintaining natural food growth and reducing diseases. With these improvement production can be increased up to 500-600 kg/ha/yr even by using present available facilities.

Shrimp culture in Bangladesh no doubt offers scope for employment and income opportunities and thus increasing living standard of local people. Therefore, coastal shrimp farming existed for a long time and expanding very fast in terms of area without any definite target. Already several impacts related to the development of shrimp farming have been reported. Considering generation of national economy, foreign exchange, employment opportunities and best land use policy there is a need to clearly defined impact and develop appropriate strategies for the development of environmentally sound eco-friendly culture system.

Research strategies and coastal aquaculture development in Bangladesh

M.A. Mazid
Bangladesh Fisheries Research Institute, Mymensingh 2201, Bangladesh

Coastal aquaculture in Bangladesh is predominated by shrimp culture. Culture practice followed is still traditional where shrimp larvae are stocked at a very low density of 2-3/sq.m in large coastal polders (locally called *gher*) up to a few hundred hectares. Although semi-intensive shrimp farming was initiated in early 1990s, it did not sustain due to outbreak of viral diseases. However, because of its economic importance, traditional culture practice with improved management is progressively expanding which presently covers an area of about 140,000 ha. The range of production is 250-500 kg/ha based on the type of management practices followed is quite low compared to other countries. The quality and test of the product are therefore, natural and good. Extensive culture system as followed in the country does not pose negative environmental impact. However, horizontal expansion in culture area increasingly converting agricultural land into shrimp farms leading to salinization in surrounding areas and involvement of effluents in the business increases social distortion. Alarming collection of seeds from the nature which was a source of seed supply for shrimp farming until late 90s has now drastically reduced with the establishment of over 44 hatcheries and subsequent banning of wild seed collection in 2000.

This paper discusses research areas for sustainable development of the shrimp industry and emphasized a long-term development plan for coastal aquaculture development in the country. The major areas as identified are conservation and proper use of resources, improve culture system, pollution control and environmental protection, quality control and product development, and development of human resources for coastal aquaculture. Implementation of a well managed integrated coastal development plan will increase production and income from the shrimp sub-sector of Bangladesh.

Environmental impacts of shrimp farming in the coastal areas of Bangladesh

Md. Abdul Wahab
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Marine shrimp culture has expanded dramatically since early ’80, resulting in annual increase of 25% or more in yield worldwide. With the increase in production, shrimp farms have appeared to be a major cause of several environmental and socioeconomic problems. The nature of the problems and its consequence are similar in almost all shrimp producing countries.

Commercial shrimp culture in Bangladesh has accelerated as elsewhere in this region following high demand in the international market and its potential as an option for making quick profit. In spite of vast potential of coastal shrimp aquaculture development in this country with her fertile plain-coastal lands, detritus and food rich marine water and cheap labour, there has been unregulated and uncoordinated horizontal expansion of this aqua-industry. Large farm size, low stocking density, very low inputs, high mortality and low production may characterize most shrimp farms here. The need for long term sustainability of these valuable coastal resources through attaining efficiency and minimizing environmental and socioeconomic impacts has long been felt but not properly addressed. Therefore, shrimp farming in this country remains either traditional or improved traditional or extensive systems capable of producing merely 70-200 kg/ha.

The shrimp-farming sector, in most Asian countries including ours suffered a serious setback during 1995-96 due to serious disease outbreaks. This has caused tremendous impacts on the rapidly growing semi-intensive shrimp farming in the Cox’s Bazar region and resulted in abandonment. While the most shrimp producing countries including Thailand, India and Equador have been successful in increasing the production and making economic success through better management practices, eco-friendly culture technologies and improved environmental management, Bangladesh has been struggling with her low per unit production and high production cost. To keep pace with the development in other shrimp growing countries and to survive in the competitive world market, she has to stride most to increase shrimp production at a lower cost and maintain the quality of the product. For doing this the causes behind the low production, risks of diseases, environmental and socioeconomic impacts hindering the introduction of better management practices and improved eco-friendly technologies deserve thorough analysis.

This paper aims to present an updated picture of the environmental problems of shrimp farming in general with particular reference to Bangladesh with a view to improve our understanding and decide the future course of action towards the sustainable production systems and technologies.

Water pollution potential of extensive shrimp culture systems: mass budget of *gher* Soladana

A. Bergheim[1], M. A. Wahab[2], and B. Braaten[3]
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[3]Norwegian Institute for Water Research (NIVA), 0411 Oslo, Norway

Last year, frequent sampling was carried out of inlet and outlet water of *gher* Soladana during one production cycle from March to September 2001. The *gher* is a typical extensive pond system with a surface area of 94 ha (mean depth: 2-3 feet), a stocking rate of 1-2 PL/m^2 and two annual production cycles. At full moon, the water volume is regularly exchanged twice a month during four days. Water level was daily monitored throughout the sampling period in order to estimate the exchange rate.

Except for the final sampling, the concentrations of phosphorus (TP) and nitrogen (TN) were consistently reduced in the *gher*, i.e. Conc. INLET > Conc. OUTLET. On average, TP was reduced by 70% and TN by 40% throughout the whole production cycle. The inflowing nutrients must have been trapped by settling of solids, algae and detritus, on the bottom of the *gher*.

The results are consistent with other sparse reports: extensive systems producing less than 1,000 kg/ha/year are unlikely to pollute surrounding water. Extensive systems rely on natural feed, moderately stimulated by input of manure and fertilizers, and may be net removers of nutrients from coastal environment.

Based on the *gher* Soladana sampling, ca. 140,000 ha of shrimp pond area in Bangladesh represent a significant sink or settling system for solids and nutrients in river water led to the system.

Shrimp diseases and its consequence on the coastal shrimp farming in Bangladesh

M.B.R. Chowdhury and M. Muniruzzaman
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

Shrimp production is often suffered from both infectious and non-infectious diseases which ultimately cause great loss to the national economy. Like other Asian countries, disease has been becoming a serious threat to the coastal shrimp farming of Bangladesh since 1994 started from the Cox's Bazar area and gradually spread over Khulna region. Disease caused serious losses of the total shrimp production during 2001, especially in the Khulna region. Outbreak of viral diseases, White Spot Syndrome (WSS), or simply White Spot has been known to play the major role to cause such drastic losses. However, other diseases like yellow head disease, red coloration, Vibriosis, black spot, soft shell, external fouling and environmental disorders are also damaging factors of the total production. The present paper provides information on the occurrence of different diseases in coastal shrimp farming, their causes, research aspects and recommendations for sustainable coastal shrimp farming in Bangladesh based on experience and review.

Impact of denudation of mangrove forest due to shrimp farming on coastal environment in Bangladesh

M.A. Shahid and J. Islam

Bangladesh Space Research and Remote Sensing Organization

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The paper describes the application of remote sensing and geographical information system (GIS) for monitoring denudation of mangrove forests due to shrimp farming, the consequent impact on coastal environment and shrimp production. Black and white aerial photographs (1975 and 1995), infrared color aerial photographs (1983 and 1990), Landsat MSS data (1975-76 and 1984-85) and Landsat TM data (1998-99) were analyzed using PC based ERDAS Imagine image processing and ARC/INFO GIS software. The whole coastal area was overviewed to identify the possible areas of mangrove denudation due to shrimp farming. On the basis of the overview results, the area near the northern boundary of the Sundarbans mangrove forest in the south-western and the Chakaria-Sundarbans mangrove forest area in the south-eastern coastal region were finally selected for detail investigation. In the south-eastern coastal region, part of Maiskhali island, Matarbari island, part of Naf river at Anjumanpara of Palongkhali and Jaldia (Totadia) island near Teknaf were also included.

The results of the study indicate that the area of the Sundarbans remained unchanged from 1975 to 2001. However, it was observed from the images that a small patch of 108 hectares had been encroached by local people for shrimp farming before 1975.

In the south-eastern coastal region of the country, 8,540 ha mangrove forest of the Chakaria-Sundarbans has been totally encroached due to shrimp farming. The production of shrimp in the mangrove cleared area has been gradually decreasing due to increasing soil acidity and decreasing mangrove litter fall in the area.

Once the Jaliardwip island near Teknaf along the Naf River was covered with green mangrove forest and was a habitat for crab eating monkeys. It is found from the study that 133 ha of mangrove forest of this area have been denuded for shrimp farming. An area near Naf river at Anjumanpara of Palongkhali was also covered with natural mangrove forest. The study reveals that all the mangrove forest covering 667 ha was denuded and the area is being used for shrimp/fish cum rice culture by rotation.

A total of 9,734 ha of mangrove forest (less than 2% of the total mangrove forest coverage of the country) is found denuded due to shrimp farming. Though, the percentage of denudation of mangrove forest due to shrimp farming is negligible compared to other countries of the region, it has been creating social and environmental problems in the coastal region of Bangladesh.

Socioeconomic impacts of alternative shrimp-crop farming in Bangladesh

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The study was designed to analyze the comparative economic returns of alternate shrimp-crop farming and to determine the socioeconomic and environmental impacts of shrimp farming in coastal areas of Bangladesh. Along with shrimp farmers other group of people such as land lessors, shrimp farm labourers and shrimp seed collectors who are directly benefited and affected, were selected for this study. Accordingly, an appropriate number of all these sample households were selected from four different areas of Khulna and Cox's Bazar region.

In shrimp growing areas, four different farming systems were studied - alternate shrimp-rice farming, alternate shrimp-salt farming, and year round shrimp or rice production in shrimp farming areas. In alternate shrimp-crop farming, shrimp was the principal crop, and rice and salt were secondary crops. It was found that, under alternate shrimp-salt farming per hectare production of shrimp was higher compared to the production of shrimp under alternate shrimp-rice farming. Secondly, combined gross returns and net income from producing shrimp and salt was substantially higher than those of combined returns from shrimp and rice production under alternate shrimp-rice farming system. In shrimp growing areas, shrimp and rice were also produced individually as year round crop. In year round shrimp farming per hectare production of shrimp was higher compared to the production of shrimp under alternate shrimp-crop farming but in terms of receiving farm income, farmers producing year round shrimp earned lower income than that of the combined income earned from shrimp and salt production. Under this farming system, total farm income was higher than alternate shrimp-rice farming. Farm income from year round rice production within the vicinity of shrimp growing areas was the lowest among the four different farming systems in the study areas.

The results of the study clearly indicate that shrimp farmers and other related people accrued socioeconomic benefits from shrimp farming. By providing income and employment opportunities and accelerating many activities, coastal communities including women had chances to improve their socioeconomic condition through their direct and indirect involvement in coastal aquaculture. The study revealed that the existing unplanned shrimp culture has affected the production of cereal crops and vegetables, trees and plantation, poultry and livestock in shrimp growing areas. Shrimp farming has also negative effects on coastal environment and agro-ecosystem, which have moderately changed the bio-diversity in the study areas. However, due to social intervention natural and social environments in the coastal areas have been gradually improving.

A code of conduct for shrimp farming or guidelines for best management practice - Something for Bangladesh?

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Shrimp farming in Bangladesh has developed very rapidly and a number of environmental and socioeconomic problems have appeared. Many of these problems are comparable to the situation in other countries. However, some of these countries have realised that there is a need for both regulations and better management practices. Thailand is a good example, and other countries are following. FAO has prepared an analyses made of the legal framework for shrimp culture in a few countries and some of the results are presented. Internationally, the most important instrument is the use of "The Code of Conduct for Responsible Fisheries" with special reference to aquaculture. The code is voluntary and should be developed in co-operation with the shrimp farming industry and aquaculture experts.

Government policies in relation to shrimp culture have played and are playing a major role in the development of the shrimp culture industry. The situation in Bangladesh is discussed specifically.

The situation for shrimp farming in India has recently changed dramatically, and the situation in Thailand, - the leading shrimp producer in Asia, is discussed in detail. They have developed some important guidelines for better management practices, which seems to be highly useful.

In 1999, World Wildlife Fund joined with NACA, the World Bank and the United Nations Food and Agriculture Organization to create a consortium dedicated to the identification of ways that the environmental and social impact of shrimp aquaculture could be reduced.

Over the past two years the consortium has commissioned some 80 studies from more than 20 countries involving more than 150 scientists. Part of this study has been published and some of the main results will be presented and discussed with particular reference to the situation in Bangladesh.

As a conclusion, it is vital for Bangladesh to utilize the existing information to develop a national policy for the development of a sustainable shrimp industry. This can be done if the government work closely together with the shrimp farming industry and the scientists. If not, Bangladesh could easily loose in the increasing inter-country competition to deliver quality product to a competitive price on the world market.

The main aim of this paper is to present the experiences gained in other countries and compare it to the present situation in Bangladesh. We hope this can initiate a discussion about the possible need and usefulness for a Code of Conduct or guidelines for BMP in the Bangladesh shrimp farming industry.

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Photos

Figure 1. Workshop at BFRI Brackishwater Research Station, Paikgacha, 27 February 2002, where shrimp farmers meet scientists for exchange of information. Prof. M.A. Wahab gives a welcome speech.

Figure 2. Planning of the last details of the workshop at BFRI at the directors office.

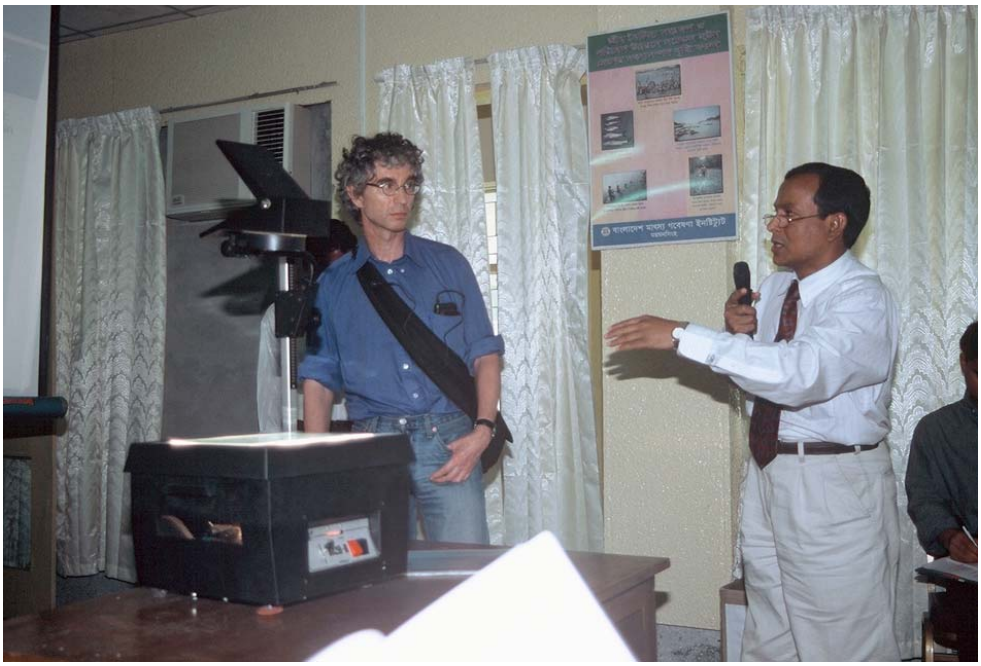

Figure 3. Dr. Asbjørn Bergheim informs about the ongoing research project, and Prof. M.D. Wahab translates to bengali.

Figure 4. Workshop in BRAC Centre, Dhaka, 5 March 2002 with invited guests. From left Prof. M. Serajul Islam, Direktor BAURES Prof. M. Shahjahan, Secretary MoFI Dr. Zahural Karim, Ambassador of Norway Ms Gerd Wahlstrom and Vice-Chancellor BAU Prof. Mustafizur Rahman.

Figure 5. Prof. M.A. Wahab welcome all the attendants to the workshop.

Figure 6. Chief guest Secretary MoFL, Dr. Zahurul Karim.

Figure 7. Vice-Chancellor BAU, Prof. M. Mustafizur Rahman.

Figure 8. Director BAURES, Prof. M. Shahjahan.

Figure 9. Mr. Bjørn Braaten explains the Code of Conduct to the audience.

Figure 10. A cow has problems to find enough fodder in the shrimp farming area near Paikgacha.

Figure 11. Shrimp Gher near Paikgacha.

Figure 12. Shrimp Gher near Paikgacha.

Appendix - Two papers presented at the workshop in Dhaka

4.4 A code of conduct for shrimp farming or guidelines for best management practice (BMP). Something for Bangladesh?

By
Bjørn Braaten , Norwegian Institute for Water Research, NIVA

Part I Overview of legislation and policies applying to shrimp culture

Introduction

The rapid growth of shrimp culture in the coastal areas particularly in Asia and South-America the last decade has been accompanied by controversial debates over the environmental, social and economic impacts. At the origin of the impressive growth rates of shrimp culture lie the economic incentives created by high returns on investment and the speed of which new farms could be established (FAO, 1999).

No type of aquaculture has attracted a similar level of global public attention than shrimp culture, and no other type has generated so many publications in the main stream and specialized scientific journals in recent years (FAO, 1999).

The Code of Conduct for Responsible Fisheries ("CCRF") was adopted by the Conference of FAO at its twenty-eight session in 1995. The Code is very wide at its scope. It is made of different articles, one of which deals exclusively with aquaculture development. In relation to aquaculture development in general, the Code of Conduct for Responsible Fisheries reflect in Article 9 a broad based international concencus on the principles which should be followed in pursuing aquaculture in a sustainable and responsible manner. In 1997 FAO arranged an Consultation with specialists and organisations to discuss the policies for a sustainable shrimp culture.This paper gives an overview of the results from the discussions and the papers presented at the meeting (FAO, 1999).

Since then, Thailand has developed a Code of Conduct for Shrimp Farming (Tookwinas et al. 2000), and part of the content of these guidelines and good management practices are also presented in this review.

In 1999 World Wildlife Fund joined with NACA, the World Bank and the United Nations Food and Agriculture Organisation to create a Consortium dedicated to the identification of ways that the environmental and social impact of shrimp culture could be reduced. Some results from the work in the Consortium was presented at a Conference in West Virginia in November, 2001 (Clay, 2001) and are discussed in this paper.

This overview shows clearly that shrimp farming is still a "hot issue" in many countries and needs to be taken seriously both internationally and nationally.

For Bangladesh, shrimp farming has developed very rapidly, and a number of environmental and socio-economic problems have appeared. Many of these problems are comparable to the situation in other countries, and the present situation in Bangladesh is discussed in the light of these findings. The possible need and usefulness for a Code of Conduct or guidelines for BMP in Bangladesh is also discussed and should be an important issue for a national policy discussion.

Legislation and policies applying to shrimp culture

International Instruments

FAO has prepared an analyses made of the legal framework for shrimp culture in a few countries. These countries are Ecuador, Honduras, Malaysia, Sri Lanka, Thailand and India.

Internationally, the most important instrument is the use of "**The Code of Conduct for Responsible Fisheries ("CCRF")** with special reference to aquaculture in Article 9. In addition, there is a number of other codes with some relevance to shrimp culture. An "**International Code of Conduct on the Distribution and Use of Pesticides**" was adopted in 1985.

When food is concerned, standardization are defined and codes of practises are present. At the International level there is "**A Joint FAO/WHO Food Standard Programme - Codex Alimentarius Commision".**

A draft Code of Hygienic Practice for the Products of Aquaculture has been prepared and amended/redrafted since 1990. The scope of this code is limited to finfish and crustaceans produced by commercial aquaculture and intended eventually for human consumption.

Beside the above instruments, a few other international agreements could be of relevance. The Ramsar Convention on Wetlands of International Importance (1971) and the UNESCO Convention for the Protection of the World Cultural and Natural Heritage (Paris 1972), both based on site protection.

National Policies

Government policies in relation to shrimp culture have played and are playing a major role in the development of the shrimp culture industry. Until now they have largely concentrated on providing financial and technical support to the shrimp industry, which has been the case in India, Sri Lanka and Thailand.

Thailand have given considerable attention to the provision of technical support to the medium size and small farmers, and now they developed a "Cod of Conduct for Shrimp Farming".

Governments have introduced land lease policies with the view of facilitating the acess to coastal areas (India) or protecting of mangrove areas (Equador) and of organising the allocation of coastal resources (Sri Lanka, Equador, Thailand). As means to site shrimp farms, zoning technique were provided for.

Regulatory frameworks for the development of aquaculture in general and shrimp culture in particular, is legally and institutionally complex. Shrimp culture occurs in coastal areas where issues are complex and all concerns legitimate. It involves legislation of a variety of issues as land use planning and tenure, water quality, fish movement and disease, pharmaceutical use, food quality and public health.

Laws and regulations covering specifically shrimp culture are not very frequent. The primary aim of existing regulations concerning shrimp culture, respond to the need to protect the development of the activity (regulate its access or stimulate investment). The regulations wants to deal with a few management aspects (water quality treatment) and with specific threats of environmental pollution and degradation which are affecting and/or caused by the development and conduct of shrimp culture activities (e.g. the destruction of mangroves).

In the countries that have been under review (FAO, 1999) the following measures were found:

- **Thailand** - Technical support for medium and small scale farmers.

- **India** - Government introduced land lease policies to facilitate access to coastal areas.
- **Equador** - Protection of mangrove areas.
- **Sri Lanka** - Organising allocation of coastal areas.

National legislation Preventive measures

- Licensing system: Most of the countries reviewed have a general licensing system for aquaculture (**Equador, Honduras, Sri Lanka, India, Malaysia).**
- EIA-procedure: **Sri Lanka, India Honduras.**
- Zooning**: Equador, Sri Lanka, India, Thailand.**
- Standard setting (development and management***)*****: Equador, Sri Lanka, Thailand.**

Classified on the basis of: Production/ha/year **India, State of Tamil Nadu** (Governmental guidelines).

- Extensive brackish aquacult. - Max 2 tons/ha/year.
- Semi-intensive culture - - Max 5 tons/ha/year.
- Size of the farm **- Malaysia.**
- Certain environmental standards - **Thailand.**

- Economic incentives for environmental protection:
- Effluent charges - **Sri Lanka.**
- Tax incentives - **Equador, Honduras, Sri Lanka.**
- Deposit schemes - **India (Tamil Nadu** - Eco-fund).
- User Charges - **Thailand.**
- Bank lending policies - **Thailand, Sri Lanka.**

- Centralized surveillance, monitoring and assessment in a single governmental agency: **Thailand and Malaysia (state of Kedah).**

- Enforcement action:
- Civil actions - **Malaysia.**
- Administrative remedies as fines, suspension, refusal, etc. - **Honduras, Equador, Sri Lanka.**
- Criminal prosecution - **Malaysia.**

- Codes of practice:
- Guidance for the establishment and conduct of eco-friendly aquaculture operation - **India, Sri Lanka.**
- Limited to specific aquaculture systems - **India.**
- Cover aquaculture in general - **Sri Lanka, Thailand.**

National legislation - The situation in India

- The Supreme Court of India ordered in 1995 the demolition of farms which were not following traditional or improved traditional systems of shrimp farming within the Coastal Regulation Zone (CRZ) I.e. 500 m from the high tide line.

- The Aquaculture Authority of India (AAI) has been set up under the Ministry of Agriculture, Government of India to regulate shrimp farming in the country.

- The AAI has framed guidelines to grant licences to shrimp farms adopting improved technology. The ultimate aim is to ensure sustainable, eco-friendly shrimp farming practises through optimum utilisation of the resources, with increased production, productivity and returns to the farmer.

The improved technology according to AAI guidelines relates to:

Improved farm design

- Optimum soil and water conditions, through **application of lime and fertilisers**.
- Monitoring of shrimp growth and health.
- Removal of pests and predators through **complete pond draining** if possible or application of mahua oil cake and tea seed cake.
- Qualitative and quantitative aspects of stocking the hatchery - reared healthy shrimp seeds only at a **stocking density** of **4-6/m^2.**
- Supplementary feeding with **dry, pelletized formulated feed** of appropriate schedule.
- Soil and water quality management involving **periodical water exchange.**
- Improved methods of harvesting the produce and post-harvest management.

- **Before:** The traditional and improved farms in India were up to **100-200 ha.**
- **Now:** Individual culture should be within **5 ha** area (for better management)**.**
- Changes in farm design have been necessary as
  - suitable feeder channel system,
  - use of pumps,
  - reservation of 10% of the area over 5 ha as waste **stabilisation ponds.**
- Adoption of improved technology is expected to achieve a production of 2-3 t/ha/year.
- There is no closure of farms.
- **Farms with viral attack have to stop operation.**

Thailand develops Code of Conduct for Shrimp Farming

- The Code is **voluntary.**
- The code includes the development of a series of operating guidelines and procedures.
- The objective is to establish Good Management Practices - **GMP.**
- Step 1 **Identify key impacts.**
- The manual was developed by input from international and national experts on shrimp farming operations.
- The manual was reviewed by shrimp farmers in a series of workshops in 1999.

Content of the code

Vol. 1 Shrimp farms.
Vol. 2 Hatcheries and brood stock capture.
Vol. 3 Processing facilities.
Vol. 4 Feeds and chemical suppliers.

Operating guidelines

1. Site selection for new shrimp farms.
2. General pond management.
3. Stocking density.
4. Feed management.
6. Shrimp health management.
7. Effluent and solid waste management.
8. Social responsibility.
9. Farmers Associations and education.
10. Data collections.

National legislation - The situation in Bangladesh

The policies for sustainable shrimp culture in Bangladesh has been described by Rahman (1999) and only a short summary will be given here. Rahman states that fish and shrimp occupy with a share of 7.75% the third position of the country's total export earnings. Of this about 82% are derived from shrimp exports alone. Shrimp production makes a significant contribution to the country's GDP. Until now, shrimp farming is almost entirely dependant upon the supply of local inputs (about 99%). Since 1994 - 95, a trend has been observed of intensification of farming systems which in the future is likely to increase the share of foreign input.

However, in the last part of 1990, most of the semi-intensive shrimp farms in the Cox's Bazar area has closed down or changed to fish farming due to diseases and destruction of the shrimp farms by cyclones and flooding. The most important area for shrimp farming to-day are in the greater Khulna area (Khulna, Satkhira and Bagherat). The farming is extensive or improved extensive and is used in rotation with paddy cultivation.

Most of the shrimp farms in the Khulna region were established on private rented land. The shrimp farmers have taken the land on lease from the local agriculture farmers on a yearly or long-term basis. The present farm sites were selected primarily on land availability and not suitability. The ponds are excessively large with no regular shape, uneven bottom, very shallow depth, faulty sluice gates, etc. It is inadequate infrastructure development and absent or defective flushing and drainage canals which impede proper farm and water management (Rahman, 1999).

Although shrimp farming plays an important role for national economy and have created new job opportunities and trade, it has also had a negative impact on the environment because of unplanned and unscientific culture practices. Just as important is the lack of a national policy for proper use land and coastal areas considering technical, economical and social aspects.

- There is **no licensing system** in the shrimp farming industry.
- **Guidelines are not developed.**
- **Law** and **order situations** are **very adverse**, specially during harvest season.
- The Marine Fishery Ordinance (1983) is the only legal support for management, development and conservation of marine fishery resources.
- There is **not enough legal support in fisheries development and management** including quality assurance of fish and fish products.
- **It does not cover all the legal issues associated with shrimp culture and quality control.**

There is an urgent need to change this situation and to develop BMP or to develop a Code of Conduct for shrimp farming. Such a task will demand input from all actors, -the government, the shrimp farming industry, the farmers and the scientists.

As we have seen from other countries, shrimp farming is a new practice, and laws and regulations covering this industry are not very frequent. According to Rahman (1999) environmental concerns such as aquatic pollution, ecological imbalance, etc. are completely new concepts in Bangladesh. Shrimp culture practised in the coastal areas are gradually changing the nature and social environmental patterns, generating a number of adverse situations. This has affected the daily life of a number of people and created social problems.

Many of the problems described for Bangladesh have been experienced in other countries. However, some of these countries have realised that there is a need for both regulations and better management practices. Thailand is a good example, but other countries are following. It is therefore vital for Bangladesh to use the experience gained already and develop a national policy together with the industry and the scientists. If not, Bangladesh could easily loose in competition of producing shrimp in an economic and sustainable way, for delivery to the world market.

Part II Operating guides and good management practices for Thailand (Tookwinas et al. 2000)

Site selection for new shrimp farms

- Shrimp farm owners should have a **clear title or right to their property** or other legal land concession agreements.
- All stakeholders should be involved in area zoning for shrimp farming.
- The **carrying capacity** of an area would be determined in order to prevent too many shrimps in one place.
- The **water and soil quality** should be **suitable** for shrimp farming and farmers should be located **far away from pollution sources.**
- Farmers should register with the appropriate government agencies.

General pond management

- **Good pond management** helps prevent water pollution, loss of biodiversity and other negative environmental impacts, and it will improve the efficiency of the farm.
- **Good water quality** should be maintained by using **stocking and feeding rates** that do not exceed the assimilative capacity of the culture system and by using high quality feeds and good feeding practices.
- **Water exchange should be reduced** as much as possible.
- Fertilizer, liming materials and all other chemicals should be used in a responsible manner and only when as needed.
- Good shrimp **health management** should be practiced.
- Aerators should be positioned and operated to **minimise erosion** and creation of sediment mounds in pond bottoms.
- Water inlets and outlets should be screened to prevent entrance of competitors and release of culture species.
- Predator control methods that do not require destruction of ecologically important species in receiving water should be used.

Stocking density

- **Stocking density** is particular important in intensive culture systems.
- Stocking density should be based on anticipated survival, desired size at harvest, and **carrying capacity of pond.**
- The size and age of shrimp fry should be considered.

Feed management

- Feed is the basis for high levels of shrimp production in intensive culture.
- Feed should be purchased **fresh** and not stored for more than a few months.
- Feed should be stored in cool and dry areas.
- Feed management practices should be implemented to assure the **shrimp consume the the feed as completely as possible.**

- **Medicated feed** should be used **only if necessary** for the control of a specific diagnosis of disease.
- Cut fish should not be used as shrimp feed, but if it is, care should be taken to **prevent overfeeding.**
- Pond managers should keep careful **records of daily feed application rates** so that feed conversion ratio can be assessed.

Shrimp health management

- Water quality evaluation and management should be implemented to **avoid stressing shrimp**, but when stressful conditions are observed, shrimp should be checked for diseases.
- For non-infectious diseases related to pond conditions, carry out the best option for disease treatment or for correcting pond conditions.
- For **infectious diseases** that may spread widely, **isolate the pond**, net harvest the remaining shrimp, and **disinfect** the pond before discharging water.

Therapeutic agents and other chemicals

- Shrimp farmers should **follow** reliable information regarding **dosage**, **withdrawal periods**, proper use, storage, disposal and other constraints on the use of a chemical including environmental and human safe precautions.
- When potentially toxic or bio-accumulative chemicals are used in ponds, water should not be discharged until compounds have naturally decomposed to non-toxic forms.
- **Careful records** should be maintained regarding **use of chemicals in pond.**
- Store therapeutants in a cool place and in a secure manner where they will be in-accessible to unauthorised personnel, children and animals. Dispose of unused material by methods that prevent environmental contamination. Drug, antibiotica and other chemical treatments should be done in accordance with **recommended practic** and comply with all national and **international regulations**.

Effluent and solid waste management

- Canals and embankments should be maintained in a manner to **reduce erosion** of above-water portions.
- **Minimise water exchange** to extent feasible.
- Use efficient fertilisation and feeding practices to **promote natural primary production** while minimising nutrient input.
- Store safely and use fuels in a reasonable way, feeds and other products to avoid accidental spills that could contaminate water. An emergency plan should be made for containing accidental spills.
- **The effluent** should be **treated before discharge** if it does not comply with existing standards.
- Ponds should be drained in a manner to **minimise re-suspension of sediment** and prevent excessive water velocities in canals and at effluent out-falls.
- Design out-falls so that no significant impacts on effluents on natural water occur beyond the mixing zone.
- Shrimp pond **effluents** should **not be discharged into freshwater areas** or onto agricultural land.

- Sediment from ponds, canals, or settling basins should be put back into areas from which was eroded, used as earth-fill, or disposed in other environmentally responsible ways.

- Sanitary facilities for disposal of human wastes and other health facilities should be provided.
- Garbage and other farm waste should be managed by acceptable methods.
- Shrimp farm should comply with existing governmental regulations related to effluent and other wastes.
- Managers should routinely evaluate waste management proceedures and continually attempt to improve them.

Social responsibility

- Shrimp farmers or associations should **communicate** with community leaders. This is particular important in the planning stage of new farms or expansions.
- Shrimp farmers or associations should attempt to accommodate traditional uses of coastal resources and **encourage mangrove replanting** activities through a co-operative attitude towards established local interests and environmental stewardship.
- Shrimp farmers or associations should contribute to community efforts to improve local environmental conditions, public health and safety and education.
- **Local workers** should be **employed as possible**, and they should be fairly compensated with respect to local wage scales.
- Healthy and safe living and working conditions should be provided.
- Shrimp farming management should have clearly defined and posted security policies.
- Employees should have a **clear understanding of their duties** and of company expectations regarding performance.

Farmers associations and education

- Farmers associations should be encouraged. Meetings among members should be routinely held for **exchanging information** on shrimp culture.
- The farmers would participate in training in the aspects of shrimp farm management, in the manner of friendly environment practises, and for law and regulation for shrimp culture industry.
- The associations should promote **”environmentally friendly practices”.**

Data collection

Data collection on the above topics and farm accounts should be done.

Part III Lessons learned about better and worse practices (Jason Clay, World Wildlife Fund) Aquaculture Engineering Society, November 11-14 2001, West Virginia.

Preliminary findings

1. Every use of natural resources has an impact.
2. The lower cost producers are often the most polluting.
3. Reducing the impact of the industry will cost money - who is prepared to pay?
4. Findings from 80 studies from more than 20 countries involving nearly 150 scientists.
5. There are probably no “best” practices.
6. Most of the impacts in any operation arise from only a few activities, perhaps 3-4.
7. Usually, mitigation measures pay for themselves in 2-3 years.
8. Most BMP (Best Management Practices) were discovered by producers trying to solve a problem.
9. The price of land, labour and other inputs are increasing. Disease impacts are generally increasing. Shrimp prices are stable - to decreasing.
10. The producers are seeking ways to:
    - reduce waste,
    - create by-products,
    - increase resource use efficiency,
    - increase the net income from their activities.

11. The learning curve in aquaculture is steep.

12. Who’s role is it to gather the lessons learned and to teach?

13. Regulations do not tend to yield BMP.
    These are never the innovative practices that reduce impacts the most. While regulations are absolutely essential for the establishment of what is acceptable behaviour.
    We need better, probably fewer, and certainly more cost effective indicators to monitor impacts.

14. Reducing the impacts of shrimp aquaculture is all about the details.

15. There is no **"one-size-fits-all" approach**.

1. Siting of operations

Worse Practices

- Destroys mangroves or other important coastal habitats.
- Affects local hydrography, including salt water intrusion.
- Requires more inputs and production downtime.
- Results in more stress and disease.
- Discharges effluents into intake zones for other farms.

Better Practices

- Built above high tide.
- No net loss of mangroves or other fragile land.
- Intake and effluent canals sufficiently separated.

It is suggested that up to 90% of all subsequent impacts result from **the siting.** The impacts are compounded by the cumulative impact of many different operations being built in an area over time. The first operation in an area will have some impact, but he 10 th, the 100 th or 1000 th will cause the biggest problem.

BMP changes over time
20-30 years ago farmers were advised to build on former **mangrove areas**. Today it is known that this should never happen. **This is the worst place to build.**

Ponds in the wrong place require more inputs (lime, labour etc), more time before restocking. The site perform more poorly (lower survival rates, more down time, higher water exchange rates).

While building over the high tide creates higher pumping costs, it also closes the ponds off from the sea, and can thus reduce other inputs and management costs and increase net profits.

2. Construction of operations

Worse practices

- Causes erosion.
- Affects hydrology.
- Requires continuous maintenance.
- Leaves soil pits and borrow pits that increases malaria vectors.

Better practises

- Save and replace top soil.
- Re-establish ground cover.
- Use proper grading for slopes.

3. Water exchange

Worse Practises

- Use of freshwater to reduce salinity.
- Release of brackish water into freshwater systems.
- 15% exchange per day or 200 m.per harvest.

Better Practises

- Closing the system.
- No use of freshwater.
- 2 to 3% exchange per day for traditional systems.
- 67% exchange per 130-day cycle in closed system.
- Water exchange rate based on objective reasons.

The general trend around the world is to reduce water exchange rates.
The better run practices in Asia use 3% or less.
In Latin America 5% or less.
Exchange rates pose a disease risk - **keep exchange to a minimum**.

People believe - water is a relatively free good. Freshwater will be lacking in the future!

4. Species selected for production

Worse Practices

- Wild-caught PL, by-catch and disease issues.
- Survival rates of 10 to 15%.
- No quarantine proceedures.
- Introduced species through escapes.
- Use carnivorous species (require more fishmeal).

Better practises

- Hatchery produced animals.
- Survival rates of 75% ore more.
- Quarantine procedures.
- Use of local species.
- Use omnivorous species (require less fish meal).

Environmental gain
The biggest environmental gain in shrimp aquaculture are likely to come from domestication and selective breeding programs.

World wide - At least 60% of all shrimp post larvae (PL) used to stock shrimp ponds are produced in hatcheries.

Most hatcheries still depends on the capture of wild brood-stock.
If these hatcheries can produce disease free PL-larvae, much will be gained.

Significant gains have already been made with some hatchery/grow-out operations achieving 90% survival rates.

Omnivorous shrimp species
Omnivorous shrimp species offer the greatest opportunity for reducing the overall level of fish meal in the diet. Many shrimp require 2 - 3 kg of wild fish converted to fishmeal to produce 1 kg shrimp. Omnivorous species as ***P. vannamei*** have been produced at very attractive conversion rates - one operation uses 0.7 kg of wild fish to produce 1 kg of shrimp.

5. Effluents

Worse practices

- Release untreated effluents.
- Release effluents into water bodies with low evacuation rates.
- Foul intake water with effluents.
- Excessive velocity of discharge cause erosion.

Better Practices

- Return better quality water to ecosystem than taken out.
- Use settlement ponds or canals to remove suspended solids.
- Use natural or artificial bio-filters to remove excess nutrients.
- Use polyculture systems to remove nutrients.

Use of settlement ponds
- Settlement ponds and canals only adress suspended solid issues - nitrogen and phosphorous are still a problem.
- Polyculture -little is done.
- Very few farmers use bioremediation.
- 1 ha of mangrove processes the effluent from 2 ha of semi-intensive ponds.
- Recycling of water will be more common.
- To reduce the creation of suspended solids from walls and bottoms will be essential - settling ponds and canals will be important.
- Learning of how to reuse water will be highly important and financially attractive.

6. Feed management

Worse Practices

- Use poor quality feed (e.g. raw fish, shellfish or fines).
- Feed more than can be eaten.
- Feed one time per day (up to 30% wasted).
- Feed Conversion Ratios (FCR) of 3 to 1.
- 3 kg of more of wild fish to produce 1 kg of shrimp.

Better Practices

- Use formulated, extruded feeds.
- Feed multiple times with feeding trays to reduce waste.
- FCR of 1.1 to 1.
- 0.7 kg of wild fish for 1 kg of shrimp.
- Use water column in the pond to produce feed.
- Use worker incentives to reduce feed waste.

The management of feed has improved tremendously over the past 30 years

- The farmer must know how feed is given and consumed by the shrimp.
- The industry norm is 2:1, some are down to 1.1:1.

7. Reduce social conflict

Worse Practices

- Eliminate or reduce resources used by others.
- Eliminate or reduce access to critical resources by others.
- 25% of labour costs spent on guards.
- Costs of barbed wire, lookout posts, theft.
- Expensive lawsuits.
- Business failure and lost investments.

Better Practices

- Be a good neighbour.
- Regular consultation with local people.
- Reliable, long-term workforce.
- Reduced costs.
- Spin-off business or joint ventures.
- Shrimp aquaculture as cornerstone for local development.

- Perhaps the greatest potential for shrimp farmers to increase the positive impact of the industry, is in the area of **employment**, **benefits** and **equity** from the industry.
- Companies have lost tens of million of dollars as a result of conflicts with their neighbours, community groups and NGO's.
- Perhaps the most promising internal program utilised by shrimp farmers is **worker incentives programs**. Such programs are extremely important ways to increase net profit at the farm level and wages and bonuses to workers as well.

8. Conclusions

- Most BMP pay for themselves.
- BMP can serve as a basis for operating permits or licences.
- BMP screens should serve as a basis of some sort of a certification program.
- It is important for the industry to "wake up".
- The industry does have an impact - any industry does.

- Shrimp aquaculture is a huge industry and it has come to stay.
- Improving the performance of the industry should be an overarching goal for those who are concerned about impacts.

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Mass budget of nutrients in extensive shrimp culture: Sampling of Gher Soladana in the Khulna Region, March - September 2001

By

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Background

World-wide, most brackish water shrimp is produced in semi-intensive and intensive systems with an annual output of more than 1,000 – 2,000 kg/ha. The average production level in Bangladesh is however as low as 200 – 300 kg/ha/year and about 90% of the total shrimp farming area is occupied by extensive systems.

There are published several reports describing the effluent load from both semi-intensive systems (Teichert-Coddington et al. 2000; Paez-Osuna et al. 1997) and intensive systems (Funge-Smith & Briggs, 1998). Due to rather high input of artificial feed and fertiliser (semi-intensive culture), a significant part of the supplied nutrients leaves the pond system, especially at the drainage of the pond during harvest. The total effluent load generally increases with increased water exchange rate of the pond (Hopkins et al. 1993).

Sparse information is available on effluent load from extensive systems. Generally, these systems are considered to be potentially sustainable and are not expected to provide any significant load of organic matter and nutrients to the surrounding coastal environment (Phillips et al. 1993).
This paper describes a study performed in a large extensive *Gher* in the Khulna region with frequent sampling of inlet and outlet water.

The *Gher*

Generally, the construction and management of the so-called *Gher* systems can be described as the following:

- Two crops of shrimp/year (Jan. - April, May - Sep.), then one crop of rice (Oct. - Dec.). In autumn the salinity is too low for shrimp production (< 10 ‰).
- The production is extensive based on a stocking density of 1 - 2 PL/m^2, production 100 - 300 kg/ha/year.
- Mortality 85 - 90% from stocking to harvest.
- The traditional grow-out pond *(Gher)* is large (30 - 100 ha) with a depth of 1 - 3 feet.
- Water transport is tidal based (no pumping), aeration not necessary.
- No supplemental feeding, possibly liming and fertilising.

The Soladana *Gher* is a large pond system with a surface area of 94 ha with one main water inlet point and three different outlet points. In addition, there is a smaller combined inlet/outlet point (Figure 1). The water volume of the *Gher* is routinely exchanged during 4 days at full and new moon every fortnight. Besides, the frequency of inflow-outflow within the 4-day-period is changed from pre-harvest towards the harvest period.

Unlike systems solely producing shrimp, there is no final complete drainage of the *Gher*: At the end of the cycle, a combined harvest of the remaining shrimp and planting of rice takes place. To keep the rice fields wet, the outlet gates are locked to keep a few inches of water within the *Gher.*

There is no peak harvest period at the end of each cycle but frequently harvesting at water exchange over a long period (Figure 2). A total crop of 7,338 kg shrimp at an average individual size of 21.2 g was caught. The quantified crop constituted ca. 78 kg/ha. Planting of rice and the final harvest was carried out in early September.

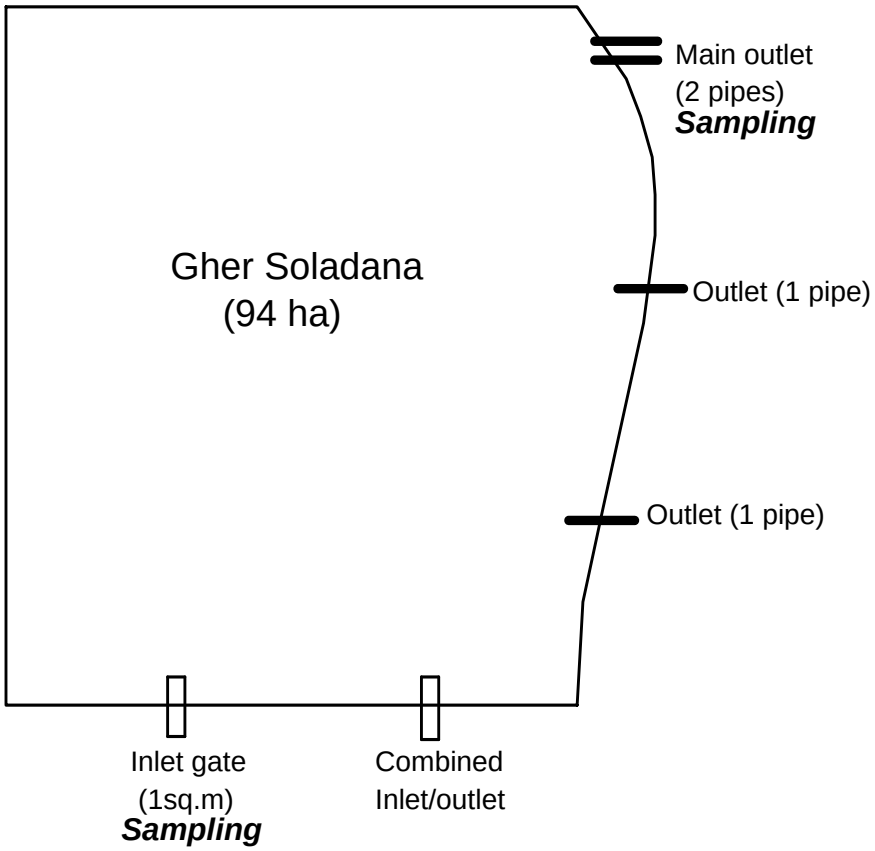

Figure 1. Sketch of *Gher* Soldana in Paikgacha selected for sampling of effluent load during the period March - September 2001 (2nd production cycle). The *Gher* has two flow inlets (squared gates) and three outlets (circular pipes of 1.5 m diameter). Sampling points: Main inlet and main outlet.

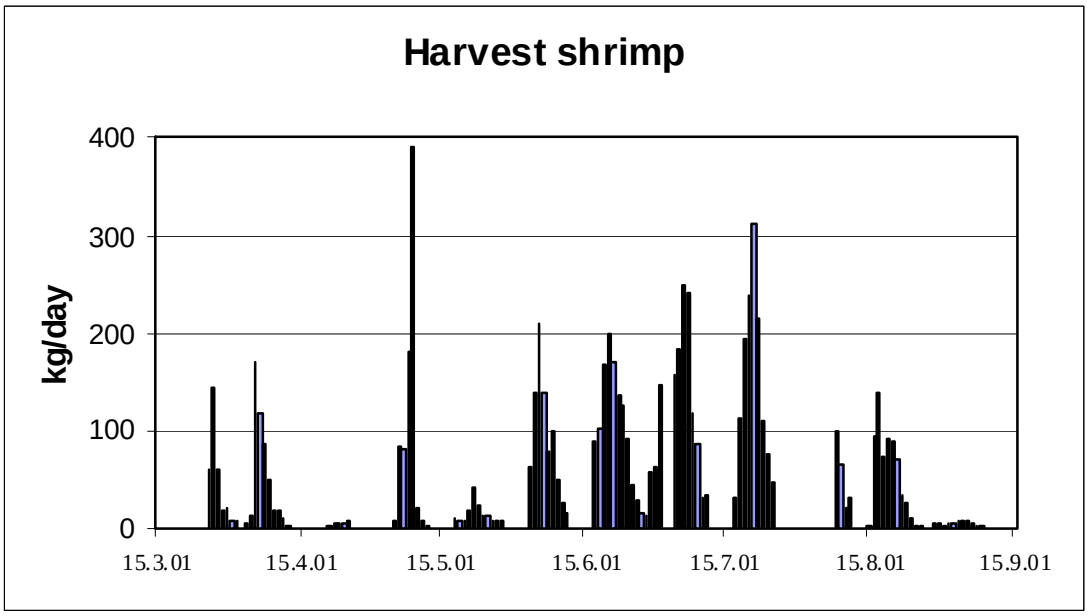

Figure 2. Daily harvest of shrimp in *Gher* Soladana, Paikgacha March - September 2001. Total crop: 7,338 kg.

Sampling procedure

It was found impossible to sample all inlets-outlets of the *Gher* in a representative way. Therefore, it was decided to carry out sampling of the main inlet and the main outlet (Figure 1). An accurate monitoring of the water exchange rate of such a complex system is not possible. For a rough estimate, the water level of the Gher was daily read on a scaled dipstick.

Sampling point:

Main inlet - main outlet.

Sampling Period:

One production cycle, March - September 2001 (5.5 months).

Sampling Frequency:

Every 2nd week (2 samplings/month).

Sampling Procedure:

Diurnal sampling (24 hrs.) – Mixed inlet sample, 6 separate outlet samples (4-hour intervals).

Sampling volume (preservation):
100 ml PVC-bottles (100 units brought from Norway), preservation by adding acid (enclosed preservation procedure).

Analytical Parameters:

Total Nitrogen (TN), Total Phosphorus (TP).

Total numbers of samples:

84 samples, 168 analyses.

Analyses:
Laboratory, Norwegian Institute for Water Research (NIVA).
Monitoring on spot:

Daily reading of water level (dipstick).

Results

Water exchange

The daily readings of the water level are presented in Figure 1. On average, the water level fluctuated between 10 and 20 cm every fortnight, which indicate an exchange rate in the range 1-5% of the volume per day. Obviously, the exchange peaks occur when the gates are opened during the 4-day periods twice a month. In addition, the volume of the *Gher* was gradually reduced throughout the cycle (mean water level reduced from ca. 70 cm to 50 cm).

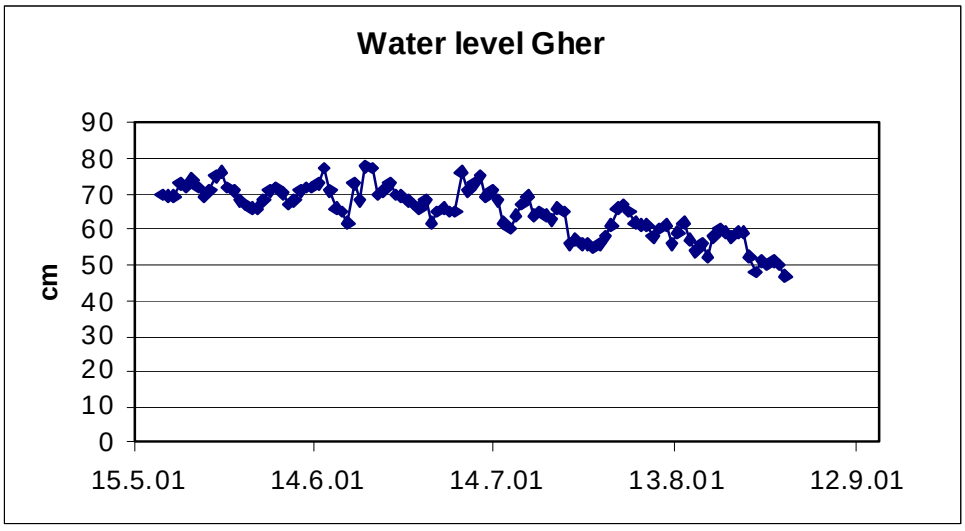

Figure 3. Water level of *Gher* Soladana, Paikgacha May - September 2001.

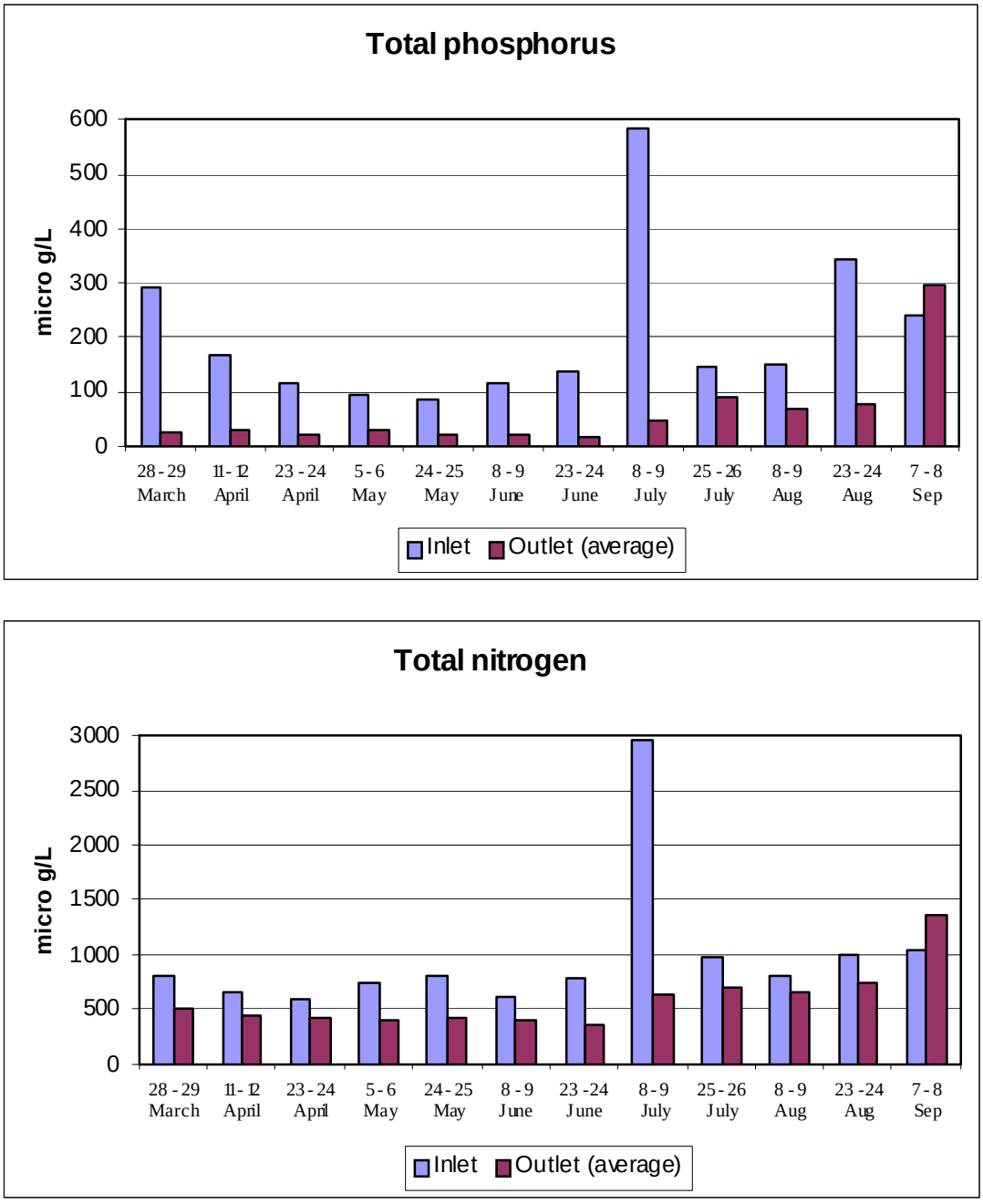

Figure 4. Concentrations of phosphorous and nitrogen of inlet and outlet, *Gher* Soladana, Paikgacha March - September 2001. Based on composite samples.

Concentrations inlet - outlet

Except for the final sampling, the concentrations of phosphorus and nitrogen were consistently reduced in the *Gher*, i.e. Conc. $_{INLET}$ > Conc. $_{OUTLET}$ (Figure 4). On average, TP was reduced from 206 µg/L to 62 µg/L (70 %) and TN from 984 µg/L to 589 µg/L (40 %). Inlet water at the sampling 8 - 9 July might have been influenced by nutrient enriched outlets from local sources.

Estimated mass budget

Only a rough estimate of the nutrient mass balance of the *Gher* can be made. Suggesting an average exchange rate of 1 cm per day, the exchanged volume is 9,400 cu. m/day or 1,410 million cu. m over a cycle of 150 days. Based on these suggestions, the approximate quantity of nutrients trapped in the *Gher* was the following:
Total phosphorus (TP): ca. 200 kg/cycle or 2.2 kg/ha/cycle
Total nitrogen (TN) : ca. 560 kg/cycle or 5.9 kg/ha/cycle

Discussion

This study supports the view that extensive shrimp culture is not expected to represent any significant load of nutrients to the surrounding waters (Phillips et al. 1993). Extensive systems rely on natural feed, moderately stimulated by input of manure and fertilisers, and may be net removers of nutrients from coastal environment. Beveridge (1984) reported that extensive finfish and mollusc farming significantly reduced nutrients in aquatic ecosystems. In an extensive mixed shrimp-mangrove forestry farm Alongi et al. (2000) however, estimated a higher nutrient output than input.

About 70% of phosphorus and 40% of nitrogen entering the *Gher* Soladana in inlet water was trapped in the system. A significant part of the removed nutrients must have been trapped by settling of solids, algae and detritus, on the bottom of the *Gher* (Edwards, 1993). Only a minor part of accumulated sediments is resuspended and flushed out of shrimp-cum-rice producing systems during the careful, not complete drainage at the end of the shrimp cycle. The accumulation of sediments year by year is materialised by uplift of the bottom level. Consequently, the *Gher* has to be dug out after some years and the procedure of this operation influences on the erosion loss to the surrounding waters.

In terms of effluent load per kg produced shrimp, ranges of 16 – 30 g nitrogen (N) and 0.7 – 4.6 g P are reported from semi-intensive/intensive systems. Based on the Bangladeshi shrimp production of 30,000 – 35,000 tons per year and assuming the effluent figures from more intensively producing systems, the nutrient contribution from the industry to surrounding waters would have represented the sewage outlet from several hundred thousands people. Instead, the extensive shrimp culture in Bangladesh seems to act as a sink for solids and nutrients in river water led to the system.

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