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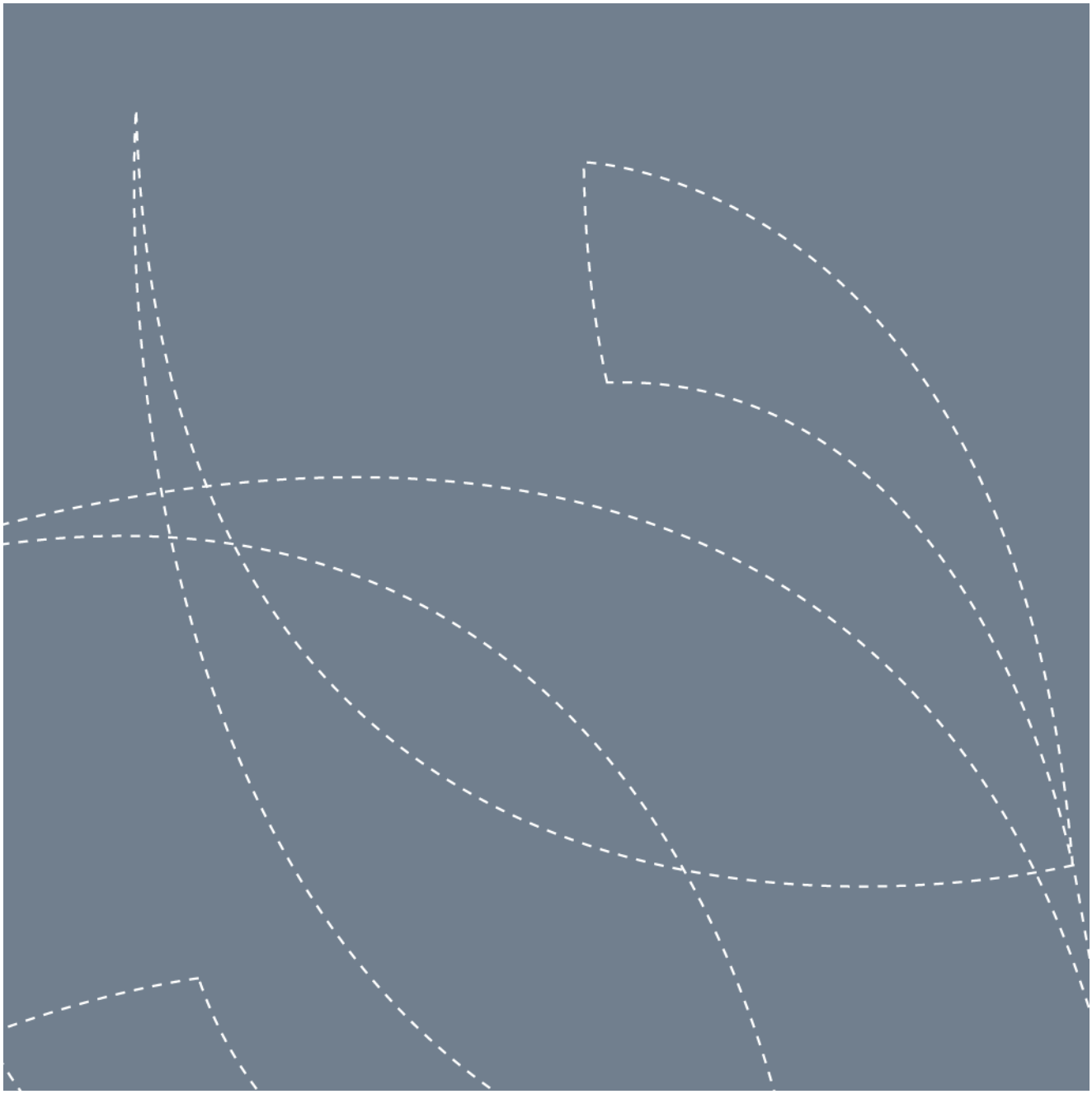
Norway-India-Bangladesh consortium for Hilsa aquaculture in South Asia

Velmurugu Puvanendran



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Report

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Norway-India-Bangladesh consortium for Hilsa aquaculture in South Asia

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Hilsa, Norway, India, Bangladesh

Summary:
Hilsa is an extremely popular fish in Bangladesh and in the Indian states of West Bengal, Orissa, Tripura and Assam and consumed by 250 million people. It is unfortunately though a wild resource in decline, due in large part to hydrological changes in its major spawning habitats in the Ganges river watershed, as well as over-fishing and habitat degradation. Recognizing the importance of the hilsa, scientists in both Bangladesh and India have started trials on the breeding and culture of the species however progress has been slow due to lack of coordinated efforts. Thus, a much more focused and coordinated research and development initiative is required if progress is to be made.

The project has achieved its objectives, and successfully laid a foundation for cooperation in the future development of farming of hilsa (*Tenualosa ilsha*) within the south Asian region. It has also helped bring Myanmar as a further important country in the Bay of Bengal region where hilsa is an important fishery, and where there is strong interest in aquaculture in the future. A partnership between Nofima and partners in India, Bangladesh and Myanmar, together with WorldFish, has now been established, and all the partners remain committed to continue to further such cooperation in the future. The papers prepared for the meeting represent an important collection of scientific knowledge on hilsa. These documents have been circulated to all participants as a workshop proceeding, but could certainly (with some further editing) be published as a monograph.

Table of contents

1 Preface

This project was funded by the Norwegian Research Council (NRC; Project no. 216668/E40). The main aim of this project was to develop a scientific networking among researchers in India, Bangladesh and Norway and ultimately work together in projects in fish culture especially hilsa.

2 Introduction

Hilsa (*Tenualosa ilisha)*, the anadromous Indian shad (Fig. 1), is one of the most important commercial fishes of India and Bangladesh. Availability of hilsa in most of the Indian rivers was largely diminished as their breeding run was severely hindered by construction of a number of dams, anicuts, and barrages and also by over-fishing. As a result livelihood of several fishing communities are affected. While research on hilsa ecology and biology has been carried out by Central Inland Fisheries Research Institute (CIFRI) and Bangladesh Fisheries Research Institute (BFRI) over 3-5 decades, the research efforts have been scattered, with no systematic approach, indicating the need for a coordinated research and development initiative to establish a new aquaculture industry. Thus, bringing Norwegian expertise to South Asia and help in developing consortium to create a new hilsa industry will revive the fishing communities along the river system in India and Bangladesh.

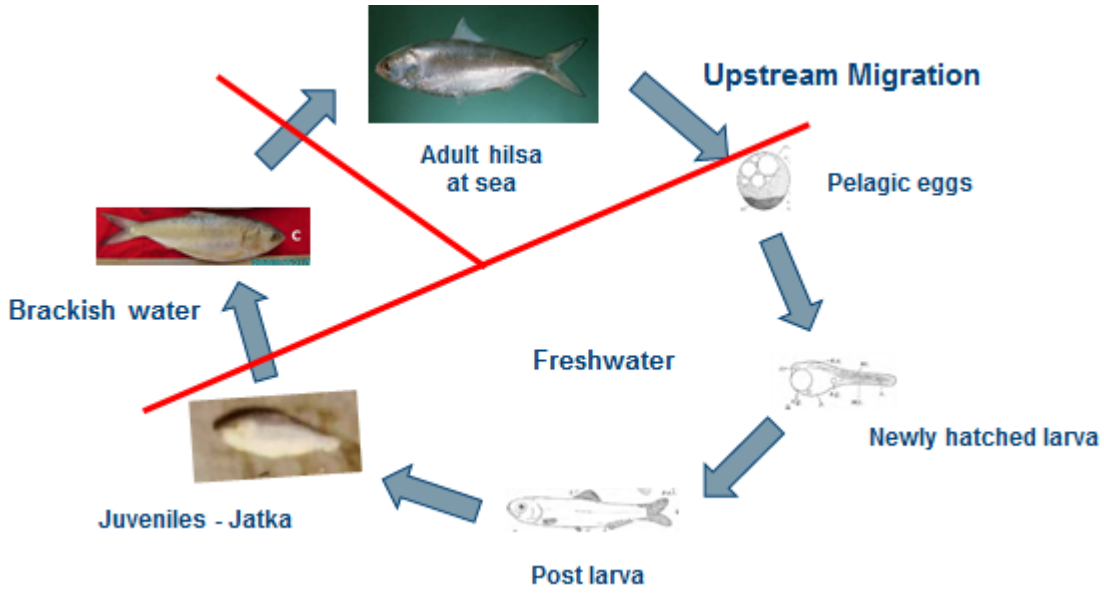

Figure 1 Anadromous life cycle of Hilsa

Recognizing the importance of the hilsa, as well as the significant market demand and opportunities, scientists in both Bangladesh and India have started trials on the breeding and culture of the species. Some progress has been made, but research efforts have been scattered, with no systematic approach, making it clear that a much more focused and coordinated research and development initiative is required if progress is to be made. The purpose of the project is to bring Norwegian expertise to South Asia and help in developing consortium to create a new industry, but critical analysis is needed and different skills/partners. The key activities of the project involve critical analysis of literature and existing experiences, a workshop to bring key partners together to define research needs and development of concept/proposal for follow up. Potential impacts will be a new species suitable for culture in brackish water areas, private investment opportunities, impacts on nutrition and other positive social, economic and environmental benefits.

Species of tropical shads (*Tenualosa* species) live in the estuaries and coastal waters of tropical Asia. *Tenualosa thibaudeaui*, which was one of the most abundant fishes of the

Mekong, is on the verge of extinction probably due to over-fishing and habitat deterioration (Warren 2001) and *T. reevesii* is close to extinction in Southern China due to habitat exclusion, degradation and continued over-fishing (Wang, 1996). While *T. macrura* and *T. toil* in Sarawak are more vulnerable to over-fishing and leading to their drastic population and geographic declines. The most widespread and well-studied species is *T. ilisha* which is found from North Sumatra in the east to Kuwait in the West, and is the basis of important fisheries in Bangladesh, India, Burma, Pakistan and Kuwait.

Of the three countries at the northern end of the Bay of Bengal region, Bangladesh reportedly secures the largest share of the landings with about 150,000 t/annum; in India the annual landing may amount to 27,000 tonnes, and in Myanmar about 4000-5000 tonnes with a total worth of US$ 110 million (FAO/BOBP). After recognizing the commercial importance of hilsa in 1951, the Indo-Pacific Fisheries Council (IPFC) of the FAO constituted a hilsa sub-committee comprising representatives of India, Pakistan and Burma to carry out research on this prized fish for development of both its capture and culture fisheries. However, in the recent past the capture hilsa fisheries is at stake because of over-fishing of adults, juveniles and fry (20 mm) by using destructive fishing gears, habitat degradation due to pollution, and loss of critical spawning and nurseries grounds due to water withdrawals and diversions, as evident by the decline catch from 15799 t in 2000 to 5530 t in 2010 in Hooghly estuarine system (Boblme 2010).

The geographic focus for research is South Asia, and particularly the deltaic areas of the Indo-Gangetic plain in south Asia. It is in this region that the hilsa fish has greatest social and cultural significance, and is of importance to the nutrition of perhaps 250 million people. The Ganga River below the Farraka barrage branches into the Hooghly River in India and Padma River in Bangladesh before joining the Bay of Bengal and several research stations have been established along these rivers to investigate migratory patterns and population dynamics of hilsa. The review will attempt to better understand the current migratory habits and dispersal of hilsa within this river system. Possible research sites will be proposed based on records of breeding and spawning ground of *T.ilisha*.

In view of the critical importance of the hilsa fishery from social, cultural, food, nutritional and conservation perspectives, there is growing interest in farming the species. Some artificial propagation has been practiced successfully for *T. reevesii* and *T. toli* (Wang & Xiong, 2003; Pang & Ong, 2001), but there has been limited progress with hilsa. Several attempts towards artificial fecundation of hilsa have been made by CIFRI, but mass production of seeds and their survival was remaining unsuccessful. Recognizing the importance and present need, the project is to conceptualize in a consortium mode (Fig. 2) (CIFRI, BFRI, Worldfish Center and NOFIMA) focusing on two tasks; 1. Conducting a workshop either in India or Bangladesh and 2. Publishing a workshop report.

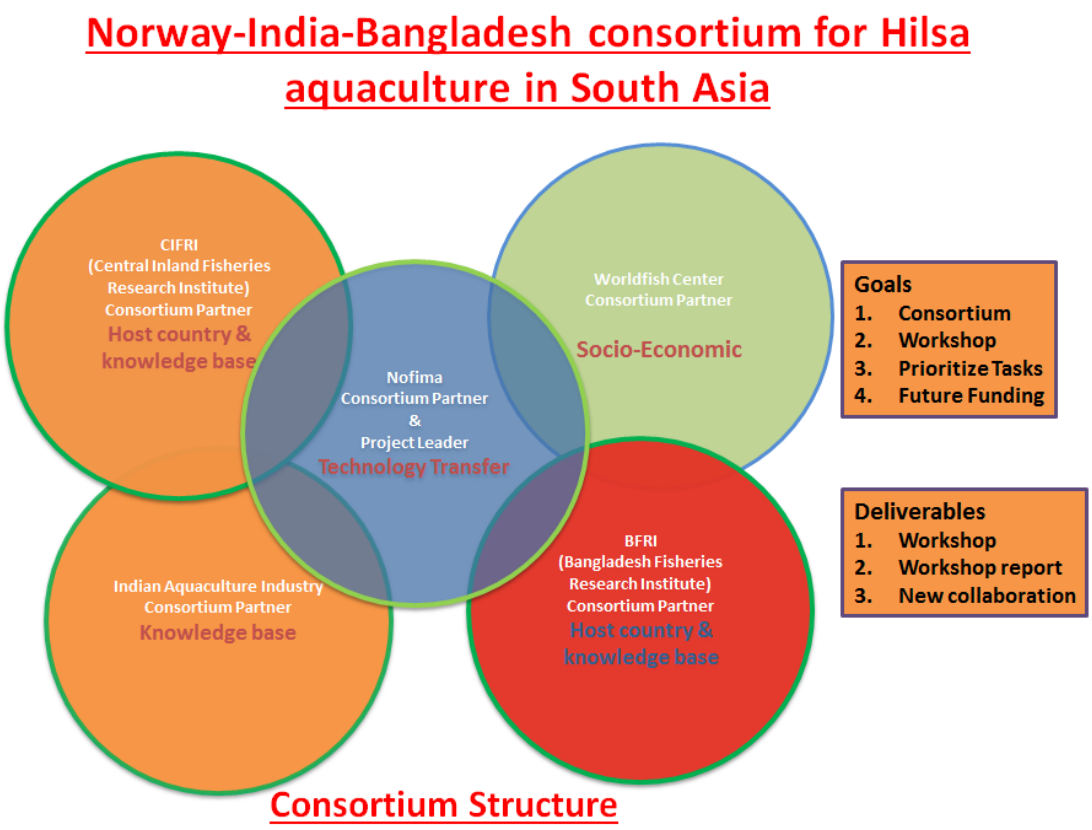

Figure 2 The proposed consortium structure, partners, goals and deliverables

For the task 1 the workshop will focus on the subject area and will analyse the key questions within each subject area (Table 1).

Table 1 Subject area and the key questions that will be discussed in the workshop

Subject area	Key questions
Hilsa fishery, biology and ecology	What is the current knowledge of the ecology of hilsa in the Ganges river? What are the catch trends, status and knowledge of fishery? How does that knowledge inform aquaculture development strategies?
Aquaculture and "culturability"	
Source of fry and fingerlings	What is the current knowledge on wild collection? What is the status of knowledge on artificial breeding and hatchery technologies? What is known about transition of fish from sea to freshwater, and how does this inform breeding/nursing/grow-out technologies?
Grow out systems	What is hilsa performance in ponds and cages? What are the system requirements, stocking density, water quality, feeding regimes, environmental regimes etc…)? What are the optimal systems for future development? How can poor, small-scale farmers benefit? How might hilsa farming fit into agro-ecological systems of the climate-change affected coastal Ganges region?
Feeds and feeding	What are the feeding habits and nutritional of hilsa? What are the feed and nutritional requirements for brood stock, larval rearing, and fingerling production? What are the options for formulation of feed for different developmental stages of hilsa?
Breeding, genetics, selection of desirable traits, including nutritional value	What is the current knowledge on breeding and genetics? How might family based selective breeding programs for hilsa be established? What are the opportunities for increasing nutritional values of hilsa? What other traits for genetic selection such as growth rate, (survival) and disease resistance? What are the risks and ecological safeguards required?
Market demand	What is the current status and trends in the hilsa markets? What is current and future demand? What is known about value chains and how does this inform aquaculture development strategies? Who consumes hilsa, and what is its importance to various groups, including the poor who are known to rely critically on small hilsa (jakti)? How does market demand influence the farming strategy?
Fish utilization, consumption and nutritional values	How is hilsa utilized? How important is hilsa to the diet?
Social and cultural religion and language importance of hilsa	How should knowledge of social and cultural values inform the development of an aquaculture program?

For task 2, a workshop report will be published covering the subject area and review the key questions within each subject area.

3 Results

3.1 Workshop

A 2-day workshop was conducted at the Conference Room, Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka, Bangladesh on 16 &17 September 2012 (Figs. 3 & 4). The workshop was coordinated by Worldfish Center in Bangladesh who contracted a senior scientist from Bangladesh (Prof. M.A.Wahab) to coordinate the preparation of papers for the workshop, and to lead the preparation of the workshop. Approximately 75 delegates from India, Bangladesh, Myanmar, Norway and Malaysia were participated. Mr. Md. Abdul Latif Biswas MP, Hon. Bangladesh Minister of Fisheries and Livestock; Her Excellency Ragne Birte Lund, Ambassador of the Royal Norwegian Embassy in Bangladesh; Dr. B. Meenakumari, Deputy Director General (Fisheries) of ICAR, India and several other top bureaucrats have also participated in the inaugural session of the workshop. From Nofima, Drs. Velmurugu Puvanendran, Atle Mortensen, Helge Tveiten and Rama Bangera participated. During the 2 day workshop, several presentations were made by researchers from these countries. Below are the details of the workshop proceedings and the presentations made.

Figure 3 Chief and special guests of the workshop. L-R: S.A.Azad (DG, DoF), Ragne Brite Lund (Ambassador, Norwegian Embassy), Md. A.L.Biswas (Minister of Fisheries and livestock), U.B.Dutta (Secretory, MoFL) and B.Meenakumari (Deputy Director General-Fisheries, ICAR).

Figure 4 A section of the delegates at the workshop

Table 2 The workshop itinerary

Day 01: 16 September 2012

Inaugural Session: 9:00-11:30 am

Time	Activity	Speakers/Presenters
09:00-09:30	Registration	Nusrat, Romena, Sharif
09:30-09:40	Recitation from the Holy Quran	
09:40-09:50	Welcome address	Mr. William (Bill) J Collis Director, WorldFish Center
09:50-10:10	Hilsa: Status of Fishery & Potential for Aquaculture	Dr. Md. Anisur Rahman, Hilsa Specialist, BFRI
10:10-10:20	Overview of the Concept	Dr. V. Puvanendran, Nofima
10:20-10:30	Speech-Guest of Honour	Prof. Dr. Subhash Chandra Chakraborty, DG, BFRI
10:30-10:40	Speech- Guest of honour	Dr. B. Meenakumari D-DG Fisheries, ICAR, New Delhi
10:40-10:50	Speech- Special Guest	Her Excellency Ragne Birte Lund Ambassador, The Norwegian Embassy, BD
10:50-11:00	Speech - Special Guest	Mr. Ujjwal Bikash Dutta Secretary, MoFL
11:00-11:20	Speech - Chief Guest	Mr. Md. Abdul Latif Biswas MP Hon'ble Minister, MoFL
11:20-11:30	Speech - Chairperson	Mr. Syed Arif Azad DG, Department of Fisheries (DoF)

11:30-12:00	Tea Break	-
12:00-13:30	**Technical Session I: Hilsa Biology and ecology, fishery**	**Dr. Michael J Phillips, WFC, Penang, Malaysia**
12:00-12:10	Social and cultural importance of hilsa	Prof. Anil Sharma, CIFRI
12:10-12:20	Biology & Ecology of Hilsa	Dr. Jalilur Rahman, BARC
12:20-12:30	Status of Hilsa Fishery in India	Dr. Utpal Bhaumik, CIFRI
12:30-12:40	Hilsa Fishery Management & Conservation in BD	Dr. Md. Sinar Alam, DoF
12:40-12:55	Open discussion	Participants' views on research needs
12:55-13:00	Concluding Comments	Chairperson
13:00-14:00	Lunch & Prayer Break	
14:00-15:30	**Technical Session II: Hilsa: Aquaculture & Culturability**	**Dr. V. Puvanendran, Nofima**
14:00-14:10	Potential Sources of Fry and Fingerlings	Dr. G C Halder, CNRS
14:10-14:20	Breeding and Genetics	Dr. B K Behera, CIFRI / Dr. Rama Bangera, Nofima
14:20-14:30	Food and Feeding of hilsa	Prof. Zoarder F. Ahmed, BAU
14:30-14:40	Status of Hilsa Aquaculture in India	Dr. Amiya Sahoo, CIFRI
14:40-15:00	Open discussion	Participants' views on research needs
15:00-15:10	Concluding comments	Chairperson
15:10-15:30	Tea break	
15:30-16:00	**Technical Session III** **Market demand / Utilization & consumption**	**Prof. Anil Sharma** **DG, CIFRI**
15:30-15:40	Hilsa Market Demand in India & BD	Dr. Ben Belton, WFC / Dr. Arun Padiyar
15:40-15:50	Nutritional values, Consumption & Utilization	Dr. A K M Nowsad Alam, BAU
15:50-16:20	Open discussion	Participants' views on research needs
16:20-16:30	Concluding comments	Chairperson

Day 02: 17 September 12

09:00-12:30	**Technical Session III:** **Goal: Viable Hilsa Aquaculture in South Asia**	**Dr. Michael J. Phillips, WFC, Penang, Malaysia**
09:00-09:20	Salmon aquaculture in Norway & its relevance to Hilsa aquaculture	Dr. Alte Mortensen, Nofima
09:20-09:40	Information gaps & research questions	Ms. Afrin Chowdhury, WFC & Dr. Md. Shahidul Islam, BSMRU
09:40-09:50	Biology and ecology-research needs	Dr. Jalilur Rahman, BARC & Dr. Utpal Baumik
09:50-10:00	Breeding & fry rearing – techniques known	NOFIMA, CIFRI, BFRI, Dr. Haldar
10:00-10:10	Genetics, selection of desirable traits –Gene sequence?	Dr. B K Behera, Dr. Rama Bangera

09:40-09:50	Grow-out technologies Full cycle farming Culture-based fisheries /Rancing	CIFRI, BFRI, NOFIMA & DoF
09:50-10:00	Market demand –domestic & export next 20 years	Ms. Masudara Momi, DoF, Dr. Ben Belton, WorldFish Dr. Arun Padiyar, & Mr. K M Soe (Mynmar)
10:00-10:20	Tea Break	
10:20-10:30	Utilization, consumption & nutrition values-women & child nutrition	Dr. Shakuntala Thilsted, WFC & Dr. Enamul Hoq, BFRI, Dr. WFC
10:30-10:40	Social and cultural importance - future dimensions	Dr. Benoy Kumar Barman, WFC Dr. Nirmal Chandra Roy, DoF
10:40-11:00	Participants' views & open discussion	English & Bengali expression
Group Exercise	Research questions	Facilitators: Amiya, Anis, Rama & Shahidul
11:00-12:00	A: Breeding & Seed availability	Participants will voluntarily choose any group
	B: Natural food & feed development	
	C: Grow-out Technologies	
	D: Genetics, desirable traits & nutritional values	
12:00-12:40	Group-wise presentations	
12:40-13:00	Concluding comments	Chairperson
13:00-14:00	Lunch Break	
14:00-15:30	**Technical Session IV: Program Development (Con'td)**	**Dr. Malcolm Beveridge, WorldFish Center / Dr. V. Puvanendran, Nofima**
14:00-15:00	Research needs- biology of hilsa at different stages of life cycle in different habitats	Group A (all institutions)*
	Research needs- water quality, hydrology, siltation, climate change, plankton, benthos of rivers, estuaries & BoB	Group B same as A
	Research needs-domestication, brood-stock, breeding on-board	Group C same as A & B
	Research needs- Growout technologies (freshwater ponds, coastal ponds /pens /inshore cages)	Group D same as A, B & C
	Research needs- Gene sequence of *T. ilihsa*, desirable traits for domestication, nutrient enrichment	Group E same as A, B, C & D
15:00-15:20	Group-wise presentation	All A, B, C, D, E groups
15:20-15:50	Chairpersons' comments	Wrap up of two day presentations & discussions
15:50-16:00	Vote of Thanks	William J Collis, Director, the World Fish Center

3.2 Workshop Report

In total 12 articles were published in the 238-page workshop report covering the biology, ecology, genetics, marketing, social importance and aquaculture possibility of hilsa. The details of the articles are given below.

1. **Biology and Ecology of Hilsa Shad *Tenualosa ilisha* (Ham.)**
   M. Jalilur Rahman, M. Anisur Rahman and Utpal Bhaumik

2. **Hilsa (*Tenualosa ilisha* Ham.) Fishery Management in Bangladesh**
   M. Anisur Rahman, M. Ashraful Alam, S. Jahedul Hasan and M. Zaher

3. **Status of Hilsa Fishery in India**
   Utpal Bhaumik

4. **Potential Sources of Fry and Fingerlings of Hilsa for Aquaculture**
   G.C. Haldar, M.A. Wahab, V. Puvanendran and M.J. Phillips

5. **Food, Feeding and Nutritional Requirement of Hilsa, *Tenualosa ilisha* (Ham.)**
   M.A. Wahab, D.K. De, Z.F. Ahmed and M.J. Phillips

6. **Prospect of Hilsa Aquaculture in Bangladesh**
   M. Anisur Rahman, M. Ashraful Alam and S. Jahedul Hasan

7. **Status of Hilsa *Tenualosa ilisha* (Ham.) Aquaculture in India: A Review**
   Amiya Kumar Sahoo and Velmurugu Puvanendran

8. **Population Genetic Structure of *Hilsa Tenualosa ilisha* (Ham.) and Prospects for Genetic Improvement: A Review**
   Bijay Kumar Behera, Rama Bangera and M. Samsul Alam

9. **Hilsa Market Trends in Bangladesh and India**
   Arun Padiyar, Ben Belton, Trilochan Swain, Masud Ara Momi

10. **Nutritional Values, Consumption & Utilization of Hilsa *Tenualosa ilisha* (Ham.)**
    A.K.M. Nowsad Alam, Bimal P. Mohanty, M. Enamul Hoq and S.H. Thilsted

11. **Hilsa: Its Social, Cultural, and Religious Importance**
    A.P. Sharma, Nirmal Chandra Roy and Benoy Kumar Barman

12. **Hilsa Fisheries Management in Bangladesh: A Paradigm in Natural Resources Conservation**
    Md Sainar Alam

3.3 Other relevant information

Following the workshop, a farm field trip was arranged for workshop participants. Interested delegates were taken to Bangladesh Fisheries Research Institute Riverine station, Chandpur and given a tour by Dr. Anis Rahman who heads the culture activities of hilsa at BFRI.

Further, Drs. Velmurugu Puvanendran, Atle Mortensen, Helge Tveiten (Nofima), Michael Phillips and William Collis (Worldfish Center) met with Norwegian Embassy officials in Dhaka on 18 September 2012 and discussed possible funding opportunities.

Further, a ministerial delegation from Bangladesh headed by Mr. Md. Abdul Latif Biswas MP, Hon. Bangladesh Minister of Fisheries and Livestock visited Nofima, Tromsø on 28 September 2013 and discussed how to expand the collaboration between Bangladesh and Nofima.

Initiatives are taking place within Nofima to take this collaboration to the next level and meetings with NORAD, Innovation Norway and Ministry of Foreign Affairs are planned.

4 Dissemination of results

Results and the outcome of the workshop were disseminated through various channels.

1. Publishing the workshop report – This report will be soon made available to the public in the Worldfish Center and Nofima web site.

2. Press release from the Royal Norwegian Embassy in Dhaka, Bangladesh. (link: http://www.norway.org.bd/News_and_events/press/Norway-supports-regional-efforts-to-develop-hilsa-fish-breeding/

3. Coverage of Bangladesh Fisheries Ministers' visit to Nofima on 28 September 2012 was published in Fiskerbladet on 1 October 2012, highlighting the hilsa project.

4. Bangladesh Fisheries Ministers' visit was also covered by the TV2 and broadcasted on 7 October 2012.

5. News article about hilsa project in Nordlys was published on 5 November 2012.

6. Several number (7) of news articles in Bangladesh newspapers (The Daily Manabzamin, The Daily Al-Ihsan, The Daily Gramer Kagoj etc.) published in Bengali language.

5 References

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Appendix

Report from Dr. Arun Padiyar

Subcontractor's

Final Project and Financial Report

Prepared and Submitted by:

Dr. Arun Padiyar P.,

Consultant Aquaculture Specialist and Chief Mentor, Sri Subrahmanyeshwara Aquaculture Farmer's Welfare Society, Mogalthur, India

Submitted to:

Norwegian Institute of Food, Fisheries and Aquaculture – Nofima AS, Norway

Background:

Nofima AS has awarded a subcontract to the sub-contractor Dr. Arun Padiyar P., under the project agreement between Nofima AS and The Norwegian Research Council to carry out a project entitled "Norway-India-Bangladesh consortium for Hilsa aquaculture in South Asia" with project number 21668 which was executed during 1 May 2012 to 31 October 2012.

Terms of Reference to the Sub-contractor

The specific terms of reference for the sub-contractor's participation in the project and consortium are as follows:

- To contribute to selected review papers to be prepared for the workshop, in line with the project requirements;
- To assist in organization of the workshop in Dhaka;
- To contribute to the preparation of a detailed research and development concept for achieving a viable hilsa farming industry;
- To promote and support improved cooperation among consortium partners aiming to create a collaboration platform for future hilsa research activities.

Accomplishments

The sub-contractor has actively participated and contributed in the project activities with particular focus on the above mentioned terms of references.

Contribution to the review papers for the workshop

The sub-contractor was asked to prepare a review paper on "Hilsa market trends in India and Bangladesh". For this purpose, the sub-contractor has hired a field staff in India (Dr. Trilochan Swain) and collaborated with the staff of the WorldFish Center in Dhaka (Mr. Ben Belton) and the staff of Department of Fisheries in Dhaka (Ms. Masud Ara Momi). The paper was prepared and presented in the Dhaka workshop during 16-17 September 2012.

Other activities

1. The sub-contractor has made following consultations/meetings with the project partners in preparation for the Dhaka workshop.
2. On 5 March 2012, the sub-contractor has participated in a skype teleconference that held among the project partners (Nofima, WorldFish Ceter, CIFRI and BFRI). He visited CIFRI, Barrackpore, India for this purpose.
3. During 29-30 April 2012, the sub-contractor held meeting with Dr. Michael Phillips, Senior Scientist and Dr. Malcolm Beveridge, Director, Aqauaculture and Genetics, WorldFish Center at ICRISAT (CGIAR), Hyderabad, India. Detailed note on planning for various papers required in the project and for Dhaka workshop was prepared and circulated among the project partners.
4. On 16 June 2012, the sub-contractor has recruited a field staff – Dr. Trilochan Swain and held a meeting with him at Kundapur, Karnataka, India. Planning for field survey on hilsa market trend was done at this meeting.

The sub-contractor has regularly, as and when required, supported the project team for preparing detailed research and development concept for achieving a viable hilsa aquaculture industry in South Asia.

Report from CIFRI

Subcontractor's

Final Project and Financial Report

Prepared and Submitted by:

Sub contractor's name, address

Prof. Anil Prakash Sharma
Director
Central Inland Fisheries Research Institute (CIFRI)
(Indian Council of Agricultural Research)
Barrackpore, Kolkata 700120
West Bengal, India

Submitted to:

Norwegian Institute of Food, Fisheries and Aquaculture – NofimaAS, Norway

Background

Nofima AS has awarded a subcontract to the sub-contractor "**Central Inland Fisheries Research Institute (CIFRI), Barrackpore, Kolkata 700120, West Bengal, India** ", under the project agreement between Nofima AS and The Norwegian Research Council to carry out a project entitled "Norway-India-Bangladesh consortium for Hilsa aquaculture in South Asia" with project number 21668 which was executed during 1 May 2012 to 31 October 2012.

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Accomplishments

The sub-contractor has actively participated and contributed in the project activities with particular focus on the above mentioned terms of references.

Contribution to the review papers for the workshop

Scientists from Central Inland Fisheries Research Institute (CIFRI) contributed four review papers in collaboration with other partners for the Workshop held at Dhaka, Bangladesh. These includes

1. Hilsa: Its Social, Cultural, and Religious Importance by Prof. A.P.Sharma
2. Status of Hilsa Fishery in India by Dr. Utpal Bhaumik
3. Population Genetic Structure of Hilsa, *Tenualosa ilisha* (Ham.) and Prospects for Genetic Improvement by Dr. B.K.Behera
4. Status of Hilsa, *Tenualosa ilisha* (Ham.) Aquaculture in India by Dr. A.K.Sahoo
5. Biology of hilsa with joint authority with Dr. Zalifur Rahman & Dr. Anis of Bangladesh and Dr. Utpal Bhaumik of CIFRI, India

In addition, an article on "Nutritional Values, Consumption and Utilization of Hilsa *Tenualosa ilisha"* was contributed by Dr. B.P.Mohanty, CIFRI with other scientists from Worldfish. The review clearly focused the importance of Hilsa for conservation and aquaculture for livelihood of millions of fishers. From conservation point of view an urgent attention is warranted for sustaining the prized hilsa fishery in the country by regulation of selective fishing by adjusting mesh size of the gears. The intensive fishing pressure in the coastal zones of the estuaries almost round the year, especially breeding season adversely affect breeding, migration, spawning and recruitment success and overall fisheries of hilsa. This will ensure the fish, having a length and weight up to 340 mm and 500 g respectively to have a chance to escape for breeding. From aquaculture perspective, detailed on reproductive biology, artificial

breeding, rearing and culture practices of Hilsa from 1950 was discussed to find out the gaps for the future research work in farming.

Other activities

1. The sub-contractor has made following consultations/meetings with the project partners in preparation for the Dhaka workshop.
2. On 5 March 2012, a skype teleconference

The sub-contractor has regularly, as and when required, supported the project team for preparing detailed research and development concept for achieving a viable hilsa aquaculture industry in South Asia.

Report from Worldfish Center

Norway-India-Bangladesh consortium for Hilsa aquaculture in South Asia: Report on participation in the project by WorldFish

Background

WorldFish is an international non-profit, non-governmental organization working in partnership with a wide range of government and non-governmental agencies at regional, national and local levels in the developing world, and with advanced research institutions worldwide. It is a member of the CGIAR consortium, and works in more than 25 countries across Asia, Africa and the Pacific, providing an unrivalled network and expertise in aquaculture and fisheries.

WorldFish was a partner in the Hilsa consortium project. WorldFish South Asia regional office in Dhaka led participation by the organization, with support from scientists based in WorldFish headquarters in Penang, Malaysia. A senior scientist from Bangladesh (Prof. M.A.Wahab) was assigned/contracted by WorldFish to coordinate the preparation of papers for the workshop, and lead the preparation of the workshop.

This project for drawing together of scientific knowledge on Hilsa aquaculture, and establishment of a consortium for Hilsa aquaculture has been successful, and we believe the project has laid an important foundation for future development of aquaculture of this important species for people of South Asia and the Bay of Bengal region. Below we summarize the WorldFish participation in and contributions to the project:

(1) Preparation with partners of the workplan and analytical structure for the various papers prepared and presented to the workshop on Hilsa fisheries and aquaculture. The papers broadly covered a wide range of relevant technical, social, economic and environmental aspects of Hilsa, intended to (1) critically review current knowledge of Hilsa; and (2) identify research gaps and research activities required to develop a viable industry for brackish waters of the Ganges river delta.

(2) Direct contributions to a number of the papers prepared (see Annex 1)

(3) Consultation with Bangladesh and India government authorities (and subsequently Myanmar) in organization of a successful workshop, that was hosted in Dhaka on 16-17 September 2012, and associated field trip on 18 September. The workshop program is attached as Annex 2.

(4) Made selected presentations, and co-chaired selected workshops, as outlined in the workshop program provided as Annex 2.

(5) Scientific contributions to the preparation of a detailed research and development concept for achieving a viable industry.

Project outcomes and future actions

WorldFish considers that the project has achieved its objectives, and successfully laid a foundation for cooperation in the future development of farming of hilsa (*Tenualosa ilsha*) within the south Asian region. It has also helped bring Myanmar as a further important country in the Bay of Bengal

region where Hilsa is an important fishery, and where there is strong interest in aquaculture in the future. A partnership between Norwegian scientists and partners in India, Bangladesh and Myanmar, together with WorldFish, has now been established, and the Center remains committed to continue to further such cooperation in the future.

The papers prepared for the meeting represent an important collection of scientific knowledge on Hilsa. These documents have been circulated to all participants, but could certainly (with some further editing) be published as a book.

Annex 1: Scientific papers prepared for the Hilsa workshop

[extracted from the draft book prepared for the workshop]

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Annex 2. Hilsa workshop program

Organized by: The World Fish Center, Bangladesh & South Asia Office

Partners:

Department of Fisheries (DoF)

Bangladesh Fisheries Research Institute (BFRI)

Central Inland Fisheries Research Institute (CIFRI), India

Nofima, Norway

Venue: Conference Room, Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka
Dates: 16 - 17 September 2012

Day 01: 16 September 2012

Inaugural Session: 9:00-11:30 am

Time	Activity	Speakers/Presenters
09:00-09:30	Registration	Nusrat, Romena, Sharif
09:30-09:40	Recitation from the Holy Quran	
09:40-09:50	Welcome address	Mr. William (Bill) J Collis Director, WorldFish Center
09:50-10:10	Hilsa: Status of Fishery & Potential for Aquaculture	Dr. Md. Anisur Rahman, Hilsa Specialist, BFRI
10:10-10:20	Overview of the Concept	Dr. V. Puvanendran, Nofima
10:20-10:30	Speech-Guest of Honour	Prof. Dr. Subhash Chandra Chakraborty, DG, BFRI
10:30-10:40	Speech- Guest of honour	Dr. B. Meenakumari D-DG Fisheries, ICAR, New Delhi
10:40-10:50	Speech- Special Guest	Her Excellency Ragne Birte Lund Ambassador, The Norwegian Embassy, BD
10:50-11:00	Speech - Special Guest	Mr. Ujjwal Bikash Dutta Secretary, MoFL
11:00-11:20	Speech - Chief Guest	Mr. Md. Abdul Latif Biswas MP Hon'ble Minister, MoFL
11:20-11:30	Speech - Chairperson	Mr. Syed Arif Azad DG, Department of Fisheries (DoF)
11:30-12:00	Tea Break	-
12:00-13:30	**Technical Session I: Hilsa Biology and ecology, fishery**	**Dr. Michael J Phillips, WFC, Penang, Malaysia**

12:00-12:10	Social and cultural importance of hilsa	Prof. Anil Sharma, CIFRI
12:10-12:20	Biology & Ecology of Hilsa	Dr. Jalilur Rahman, BARC
12:20-12:30	Status of Hilsa Fishery in India	Dr. Utpal Bhaumik, CIFRI
12:30-12:40	Hilsa Fishery Management & Conservation in BD	Dr. Md. Sinar Alam, DoF
12:40-12:55	Open discussion	Participants' views on research needs
12:55-13:00	Concluding Comments	Chairperson
13:00-14:00	Lunch & Prayer Break	
14:00-15:30	**Technical Session II: Hilsa: Aquaculture & Culturability**	**Dr. V. Puvanendran, Nofima**
14:00-14:10	Potential Sources of Fry and Fingerlings	Dr. G C Halder, CNRS
14:10-14:20	Breeding and Genetics	Dr. B K Behera, CIFRI / Dr. Rama Bangera, Nofima
14:20-14:30	Food and Feeding of hilsa	Prof. Zoarder F. Ahmed, BAU
14:30-14:40	Status of Hilsa Aquaculture in India	Dr. Amiya Sahoo, CIFRI
14:40-15:00	Open discussion	Participants' views on research needs
15:00-15:10	Concluding comments	Chairperson
15:10-15:30	Tea break	
15:30-16:00	**Technical Session III Market demand / Utilization & consumption**	**Prof. Anil Sharma DG, CIFRI**
15:30-15:40	Hilsa Market Demand in India & BD	Dr. Ben Belton, WFC / Dr. Arun Padiyar
15:40-15:50	Nutritional values, Consumption & Utilization	Dr. A K M Nowsad Alam, BAU
15:50-16:20	Open discussion	Participants' views on research needs
16:20-16:30	Concluding comments	Chairperson

Day 02: 17 September 12

09:00-12:30	**Technical Session III: Goal: Viable Hilsa Aquaculture in South Asia**	**Dr. Michael J. Phillips, WFC, Penang, Malaysia**
09:00-09:20	Salmon aquaculture in Norway & its relevance to Hilsa aquaculture	Dr. Alte Mortensen, Nofima
09:20-09:40	Information gaps & research questions	Ms. Afrin Chowdhury, WFC & Dr. Md. Shahidul Islam, BSMRU
09:40-09:50	Biology and ecology-research needs	Dr. Jalilur Rahman, BARC & Dr. Utpal Baumik
09:50-10:00	Breeding & fry rearing – techniques known	NOFIMA, CIFRI, BFRI, Dr. Haldar
10:00-10:10	Genetics, selection of desirable traits –Gene sequence?	Dr. B K Behera, Dr. Rama Bangera
09:40-09:50	Grow-out technologies • Full cycle farming • Culture-based fisheries /Rancing	CIFRI, BFRI, NOFIMA & DoF
09:50-10:00	Market demand –domestic & export next 20 years	Ms. Masudara Momi, DoF, Dr. Ben Belton, WorldFish Dr. Arun Padiyar, & Mr. K M Soe (Mynmar)
10:00-10:20	Tea Break	
10:20-10:30	Utilization, consumption & nutrition values-women & child nutrition	Dr. Shakuntala Thilsted, WFC & Dr. Enamul Hoq, BFRI, Dr. WFC
10:30-10:40	Social and cultural importance - future dimensions	Dr. Benoy Kumar Barman, WFC Dr. Nirmal Chandra Roy, DoF
10:40-11:00	Participants' views & open discussion	English & Bengali expression
Group Exercise	Research questions	Facilitators: Amiya, Anis, Rama & Shahidul
11:00-12:00	A: Breeding & Seed availability B: Natural food & feed development C: Grow-out Technologies D: Genetics, desirable traits & nutritional values	Participants will voluntarily choose any group
12:00-12:40	Group-wise presentations	

12:40-13:00	Concluding comments	Chairperson
13:00-14:00	Lunch Break	
14:00-15:30	**Technical Session IV: Program Development** (Con'td)	**Dr. Malcolm Beveridge, WorldFish Center / Dr. V. Puvanendran, Nofima**
14:00-15:00	Research needs- biology of hilsa at different stages of life cycle in different habitats	Group A (all institutions)*
	Research needs- water quality, hydrology, siltation, climate change, plankton, benthos of rivers, estuaries & BoB	Group B same as A
	Research needs-domestication, brood-stock, breeding on-board	Group C same as A & B
	Research needs- Growout technologies (freshwater ponds, coastal ponds /pens /inshore cages)	Group D same as A, B & C
	Research needs- Gene sequence of *T. ilihsa*, desirable traits for domestication, nutrient enrichment	Group E same as A, B, C & D
15:00-15:20	Group-wise presentation	All A, B, C, D, E groups
15:20-15:50	Chairpersons' comments	Wrap up of two day presentations & discussions
15:50-16:00	Vote of Thanks	William J Collis, Director, the World Fish Center

*Each group will examine the technical, environmental, economical, and social aspects

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