

START-UP CONFERENCE 2022

on

**Climate-friendly and climate-resilient
prawn farming in Bangladesh**



ECOPRAWN



START-UP CONFERENCE 2022
on
**Climate-friendly and climate-resilient
prawn farming in Bangladesh
(ECOPRAWN)**

**Hotel City Inn, Khulna
28 November 2022**



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ECOPRAWN



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START-UP CONFERENCE 2022

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Climate-friendly and climate-resilient prawn farming in Bangladesh (ECOPRAWN)

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Message from the **HONORABLE MINISTER**

S M Rezaul Karim
Minister
Ministry of Fisheries and Livestock
Govt. of the People's Republic of Bangladesh
Bangladesh Secretariat, Dhaka

I am highly pleased to know that the start-up conference on climate-friendly and climate-resilient prawn farming in Bangladesh 'ECOPRAWN' is going to be held at Khulna on 28th November 2022. I think this conference will be very effective for the stakeholders, researchers, policy makers, development partners, and entrepreneurs. I believe that this conference will provide the opportunity for the stakeholders to strengthen the climate change mitigated prawn production in Bangladesh and will be highlighted at national and international levels through mass media.

Under the dynamic leadership of the Honorable Prime Minister Sheikh Hasina, Ministry of Fisheries and Livestock has set the mission to meet the demand of animal protein by enhancing production, productivity and value addition of fish and livestock products. Fish is one of the prime agricultural commodities in Bangladesh. The fisheries sector plays an important role in many dimensions associated with the poverty alleviation strategy by supplying food, improving livelihood, and generating employment and income as well as foreign exchange to the country. The contribution of this sector to GDP is 3.57% and to the country's export is 1.37%. Prawn and shrimp farming is one of the largest export sector with around 15% of annual production exported (30,036.18 metric tons) for a USD 347.55 Million value. The total annual prawn and shrimp production in 2020-21 is 251,964 metric tons. Department of Fisheries already took many initiatives to increase safe and sufficient shrimp and prawn production in the country. However, the production and export of shrimp and prawn are facing some problems due to adverse effect of climate change including severe diseases, and chemical application in land, thereby adversely affecting water quality and prawn habitation. I hope 'ECOPRAWN' project will address the issue relating to both climate change mitigation and adaptation of prawn farming in Bangladesh and suggest recommendations to increase production and export to meet the theme 'Sustainable development and climate change'. I expect, the project will provide with important policy recommendations to facilitate diseases resistant, climate resilient eco-friendly prawn production with international certification.

I would like to express my sincere thanks to the 'ECOPRAWN' research project team members from Bangladesh and Denmark counter-part for planning and organizing such a pivotal start-up conference, which has national as well as global relevance and interest. I firmly believe that the discussion of this start-up conference will be effective for the development of fishery sector in Bangladesh. Participants and PhD students will able to contribute sufficiently to this sector as well.

I wish a great success of the conference.

Joy Bangla, Joy Bangabandhu,
May Bangladesh Live Forever.

(S M Rezaul Karim MP)
November 28, 2022





Max Nielsen
Associate Professor
Department of Food and Resource Economics
University of Copenhagen, Denmark
Project Coordinator, Ecoprawn

Message from the ECOPRAWN COORDINATOR



Climate-friendly and climate-resilient prawn farming in Bangladesh shortly named as ECOPRAWN is a 5-years duration multidisciplinary DANIDA funded research project collaborated among PSTU, BAU, and University of Copenhagen, Denmark. The project funds eight PhD students.

The research activity is broken down into four work packages, each with two PhD students cooperating with their supervisors and researchers in Bangladesh and Denmark. Work package 1 deals with analyzing GHG (CO₂ and methane) emissions in prawn ponds, work package 2 deals with alleviating seawater-induced prawn diseases, work package 3 deals with techniques for measuring economic viability and efficiency, while work package 4 deals with options of implementing greenhouse gas emissions reduction pushed by governance of value chains.

The project started with an agreement between PSTU/BAU and University of Copenhagen. Meanwhile, several online meetings were conducted among partners of the three universities. Eight PhD students, two from each work package, have been selected from a bunch of good candidates, who were invited through newspapers, the Ecoprawn website and websites of the universities. The candidates were interviewed by a board consisting of experts from the Bangladeshi and European universities.

All expenses related to their PhD research are covered by the ECOPRAWN project, including travel expenses, accommodation, and tuition fee in Denmark. They will be enrolled in the double degree program and have to stay at the University of Copenhagen in Denmark for nine months for attending courses and achieving supervision. During their stay in Denmark, they receive a monthly allowance.

During this 5-days endeavour, all domestic and foreign partners along with the PhD students will physically visit the prawn farms, hatcheries, processing factories and the input providers in Khulna and Satkhira areas. The researchers and their students will plan for setting-up their experiment of prawn farming introducing IMTA and application of probiotics. A start-up conference will be held at Khulna on 28 November 2022, which aims to disseminate the project activities, sharing the ideas with the stakeholders, policy makers and related scientists, industrialists and other professionals. The project participants will also be enlightened and the activities will get a momentum through this conference. All the Bangladeshi and foreign partners will participate and exchange views on the Ecoprawn project in this conference.

I am very happy to know that a conference brochure containing the background of the research, its objectives, expected outcome, students' PhD titles and objectives etc. appear in printed form. I would like to convey my thanks to the package leaders, project partners, the members of the organizing committee for making the Conference a successful event. My special thanks go to both Professor Badiuzzaman, PSTU, for taking the lead, and to the European partners from Copenhagen and other organizations for travelling from Denmark to Bangladesh for participating in the conference.

I wish the conference a grand success.

(Max Nielsen)

November 28, 2022





Message from the **ECOPRAWN COUNTRY COORDINATOR**



Professor Badiuzzaman
Department of Economics and Sociology
Patuakhali Science and Technology University, Bangladesh
Country Coordinator, Ecoprawn

The project antitled 'Climate-friendly and climate-resilient prawn farming in Bangladesh (ECOPRAWN)' is a DANIDA funded multidisciplinary research project in collaboration with Patuakhali Science and Technology University (PSTU), Bangladesh Agricultural University (BAU), Bangladesh and University of Copenhagen (UCPH), Denmark. The project aims at improving prawn farms resilience and adaptive capacities to climate changes. More specifically, project objectives are examining GHG (CO₂ and methane) emission from prawn ponds, methods for controlling seawater-induced prawn diseases, examining economic feasibility and improving value chain governance. The project management and research activities are organized under four work packages (WPs).

The project kicked off on 1 April 2022 and has selected 8 PhD fellows for funding who will be admitted to partner universities in Denmark and Bangladesh with possibility to have double degree PhD. The PhD fellows will work on issues related to GHG emission, salinity intrusion, probiotic introduction, IMTA adaption and farm economics. I believe that the project will promote food and nutritional security and economic development through accelerating ecoprawn farming in Bangladesh.

Furthermore, the project will help early career researchers who have just completed their PhD with generous funding from DAANIDA through BANGFISH project in capacity building by working together with senior researchers from UCPH, BAU and PSTU. The BANGFISH project was organized, managed and successfully completed by the same research team with around 30 peer reviewed scientific publications, several trainings, policy briefs, conferences and scientific workshops.

The ECOPRAWN project is also expected to produce peer reviewed scientific articles by PhD students in collaboration with early career researchers and senior researchers in the team. It will also develop a database of prawn farmers including information on farm level economic data, which might be used for further researches. The project will provide supports for capacity building of the faculty members and researchers of both PSTU and BAU by organizing a number of PhD level courses, research training, seminars, and conferences on the relevant topics.

With a view to fulfilling the objectives of the project, a start-up conference has been organized at Khulna, with all the Bangladeshi and Danish partners including owners of the prawn hatcheries and processing centers, traders, importers and researchers of this field. Moreover, the eminent scientists and experts from Universities, Department of Fisheries (DoF), BFRI, World Fish and the Danish Embassy will share their views and practical experiences of ecoprawn farming during the conference.

We are really grateful to the honourable Chief Guest, Special Guests, Guest of Honour for encouraging us with their physical presence in the conference. My special thanks goes to the project manager, Max Nielsen and to the European partners from UCPH, BAU, PSTU and other organizations for their contributions towards a good start of the Ecoprawn project, which is expected to strengthen the on-going collaboration, and work in future as well.

I wish the program a grand success.

(Professor Badiuzzaman)



Climate-friendly and climate-resilient prawn farming in Bangladesh (ECOPRAWN)

Abstract

The Ecoprawn project studies both how Bangladeshi prawn farmers can mitigate climate change by reducing CO₂ and methane gas emissions and how farmers can adapt to climate change induced salt intrusion. The option of reducing emissions through the introduction of “Integrated Multi Trophic Aquaculture” (IMTA) is studied and reduction techniques developed. Several types of aquatic organisms are co-cultivated and excess algal and plant growth is controlled by snails. Intrusion of saltwater into freshwater prawn ponds cause salinity stress and a higher susceptibility to diseases in prawns. Mitigation opportunities is developed applying probiotic bacteria that improve the immune system in prawns against common pathogens to increase resistance to diseases.

Research in the Ecoprawn project is conducted in collaboration between prawn farmers and universities in Bangladesh assisted by training at universities in Denmark. To ensure that prawn farmers and the prawn industry benefit economically from the project, economy at prawn farms and among actors in the value chain will be examined and related to outcome of the project. The results will continuously be disseminated to the private sector and public authorities through workshops, visits and interviews with farmers and companies in the value chain.

The research in the project is conducted by eight PhD students enrolled at Bangladesh Agricultural University and Patuakhali Science and Technical University. The project is funded by Danish Development Aid and runs for more than four years.

Background and description of project

In Bangladesh, prawn and shrimp farming is the second largest export industry (after garment) with an export of USD 433 Million in 2017. Prawn farming is a core industry in the coastal belt of Bangladesh where a total of 35 million peoples and 833,000 farmers are engaged in the industry. Thus, the prawn industry plays a vital role in export earnings, food production and livelihood opportunities, but is also a crucial element in poverty alleviation.

Prawn farming requires feeds or algal-stimulating fertilizers to feed the prawns, but the intensive breeding negatively affects the water quality by build-up of organic matter in the ponds. Microbial activity causes a high production of CO₂ and methane gasses from the ponds. The release of these gasses from Bangladeshi prawn farms is estimated to be 2 to 6 fold higher than from prawn production in China and Vietnam. To reduce these emissions, IMTA is implemented at prawn farms by adding local snails and aquatic plants to the ponds. Snails have been shown as efficient consumers of organic matter in ponds and can after harvest be used as a protein-rich ingredient in feed for fish or prawns. Thereby, organic matter is removed and recycled for new production with a low climate effect. CO₂ emissions is further reduced by adding floating plants, e.g., Azolla or duckweed, to the ponds to assimilate CO₂. Together, snails and floating weeds is expected to cause a major reduction of organic matter and reduce CO₂ and methane emissions for the benefit of both climate and prawn producers.

During cyclones, prawn farmers often experience intrusion of saltwater. In addition to climate change, a major reason for the saltwater intrusion is a reduced freshwater level, which has occurred after construction of the Farakka Barrage in 1975. Today, water supply from the Ganges to West Bangladesh has declined significantly, and draughts have led to intrusion of saltwater into rural, coastal regions. Salinity has further spread from empty marine shrimp ponds. These conditions all negatively affect farming of freshwater prawns. Almost 97% of prawn farmers express concern due to salinity changes that increase the prawn mortality due to a reduced tolerance to pathogenic bacteria, causing severe diseases. However, some bacteria, named probiotic bacteria, are beneficial and disease-preventing to prawns, and they can boost their immune defense to better resist microbial infections.

Certain locally produced probiotics are already used in fish farming in Bangladesh, but not in prawn farming. As supplement to probiotic bacteria, a novel phage therapy that involves virus for killing of specific pathogens will also be tested. Economic feasibility of both IMTA and adaptation measures to resist prawn diseases following salt intrusion in Bangladesh will be analyzed. For reducing greenhouse gas emissions and increase sequestration in the ponds, Ecoprawn study whether IMTA pay off economically and is socially acceptable. The best economic strategy of prawn farmers in adapting to salt intrusion is identified and the effectiveness of IMTA in reducing greenhouse gas emissions analyzed. Governance of the purchaser-driven value chain of prawns from Bangladesh to Europe is analyzed taking the greenhouse gas emission all through the lifecycle into account. The possible role of co-management in mitigating and adapting to climate change is considered.

Bangladesh is the partner country due to the huge potential to become one of the world's largest producers of eco-friendly farmed prawns. For now, the farmers need knowledge and technology to reduce greenhouse gas emissions and adapt to salt intrusion.

Research activities

The research is conducted by eight PhD students among whom four PhD students focus on biology and analysis of greenhouse gasses, while four PhD students study effects of measures on farm economics and values chains in the prawn industry.

In work-package 1, new methods for analysis of GHG emission (CO₂ and methane) in prawn ponds will be developed. The green house gasses will be related to abundance and activity of bacteria in the water column and in the bottom by application of molecular techniques. Next, different IMTA approaches (mixed communities of prawns, snails and floating weeds) are introduced and tested, and their effect on GHG fluxes will be determined. The nutritional value of the snails as protein-ingredient in feeds will be examined.

In work package 2, new methods for alleviating seawater-induced prawn diseases will be studied. The first approach will be to find and characterize local microbes with probiotic capacity to stimulate the prawn immune system to better prevent infection, e.g., by various *Vibrio* species. The probiotic bacteria will be tested in laboratory and at in-situ conditions for ability for disease-controlling properties. The final aim is to establish a commercial local, village-driven production of promising, probiotic microbes. Further, elimination of pathogenic bacteria by infection of the pathogens by specific viruses (also named bacteriophages) that attack and kill the pathogens, will be examined. This phage therapy has shown to be promising in some types of fish farms but has not yet been tested in prawn production. The research on phages will include application of new molecular procedures combined with infection challenges of prawns.

In work package 3, economic feasibility and efficiency of measures and techniques developed in work package 1 and 2 is studied. The option of reducing greenhouse gas emissions through changing management practices at the farm-level will be studied due to existence of production risk and climate vulnerabilities. The foundation is cost-benefit analysis.

In work package 4, the option of implementing greenhouse gas emissions reduction pushed by governance of value chains is studied to make prawn value chains climate change ready. Focus is at identifying the greenhouse gas footprint in the prawn value chain from Bangladesh to Europe and how it can be reduced. The foundation is value chain analysis focusing on governance, efficiency and organization.

These research activities aim at strengthening the research capacity on prawn farming in the scientific community in Bangladesh as well as to provide input to the government for new policies on making the prawn industry ready for climate change.

Climate-friendly and climate-resilient prawn farming in Bangladesh (ECOPRAWN)

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The total ECOPRAWN research has been divided into Four Work Packages (WP). These are described briefly in the following sections.

Work Package 1 (WP1) Brief

Prawn farming is fundamental coastal aquaculture practice to national GDP, employment and foreign currency earning, however, poses a significant carbon footprint. On the one hand, prawn farming is being affected by climate change, especially salinity intrusion, and on the other hand, the climate is changing due to the greenhouse gases (GHGs) produced by prawn farming. Therefore, the project aims at reducing GHGs emission from prawn ponds and improving resilience to diseases in prawns in areas threatened by salt intrusion. To address these vital issues, ECOPRAWN focuses at: (i) reducing the present GHGs emission by introduction of IMTA through removing and recycling organic waste produced in prawn ponds (WP-1); (ii) enhancing resistance to salt-water-induced diseases by microbial stimulation of the prawns' immune system and usage of phage therapy (WP-2); (iii) analyze the economic feasibility of mitigation and adaptation measures (WP-3); and (iv) analyze incentives and best practices of value chain actors of reducing the carbon footprint of prawn and the role of co-management in climate change (WP-4). The project involves farms level experimentation, detailed data collection at the fields, visiting fish farmers and value chain actors in Bangladesh.

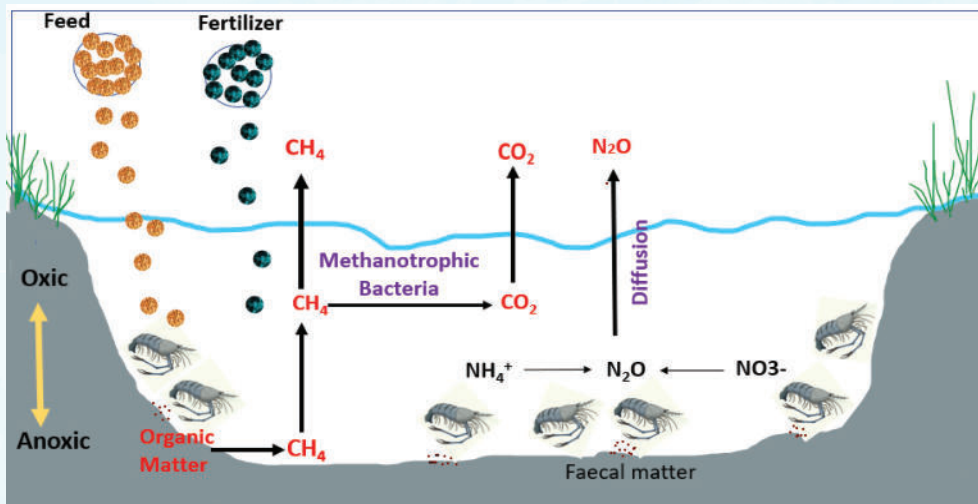


Figure 1: Thematic diagram of GHGs emission from traditional prawn farm; Illustration: Alif Layla Bablee

The specific aim of the research in WP1 is to reduce the emission of GHG from prawn farms and improve resilience to emerging diseases of prawns in areas threatened by salt intrusion in Bangladesh. Considering IMTA as potential candidate in GHGs turnover, the WP-1 aims to design and assess prawn-based IMTA system focusing on productivity and further, investigate on the caliber of IMTA in reducing GHGs emission through offering two excellent PhDs.

PhD-1: Designing Integrated Multi-Trophic Aquaculture (IMTA) system combining freshwater prawn as primary species, and snails and aquatic plants as extractive species to reduce GHG emission.

It focuses the study on taxonomic diversity and ecology of aquatic plants and snails based on local knowledge for designing IMTA systems in prawn farms. Research activities under the PhD project include the following objectives:

- Taxonomic identification of potential snails and aquatic plants species based on the indigenous knowledge of the local people in the southwest Bangladesh that can contribute to designing IMTA system.
- Assessing general water quality parameters throughout the production cycle of prawn IMTA systems that include physical (temperature, duration of light, water depth, etc.), chemical (dissolved oxygen, pH, ammonia, etc.) and biological (phytoplankton, zooplankton, etc.).

- Assessing production of snail and their application to produced snail-based pelleted feed production for fish.
- Monitoring the growth and production of aquatic plants use of this to produce organic fertilizers for crop fields.

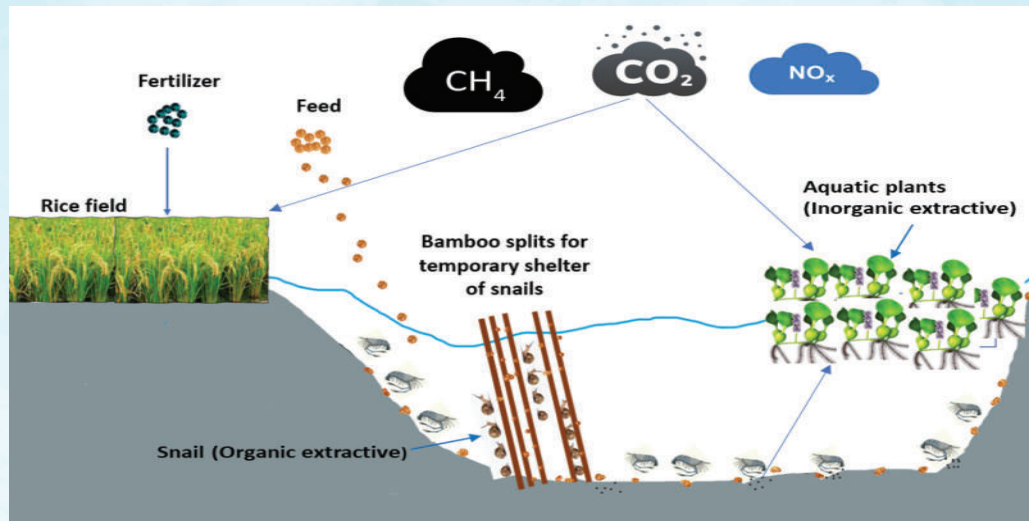


Figure 2: Hypothetical diagram of the work package-1 showing how integration of organic and inorganic extractive could reduce the organic load of prawn ponds and thereby GHGs emissions. Illustration: Alif Layla Bablee

This will be improving our understanding of how different extractive organisms in IMTA systems affect water quality and entire prawn farm productivity. The research design and methods will include field based taxonomic identification of snails and aquatic plants species general water quality characteristics, production of different produces, using of snails to prepare prawn feed and using of aquatic plants to produce fertilizers for crop fields.

PhD-2: *Impacts of Integrated Multi-Trophic Aquaculture (IMTA) on reduction of Greenhouse Gas Emission in Prawn Farming*

This study focuses on improving our understanding of how extractive organisms like snails and aquatic plants reduce organic and inorganic wastes and greenhouse gases. Research activities under the PhD project include the following objectives:

- Analyzing the reduction in CO_2 and CH_4 emissions by snails and floating vegetation on-site by portable detectors using floating chambers, while gasses dissolved in water and sediment are measured by a gas exchange approach.
- Determination the role of photosynthesis as sink for CO_2 and microbial degradation of organic matter as source of CO_2 . Similarly, estimation of CO_2 formed by bacterial degradation by standard BOD method by converting O_2 consumption to CO_2 quota.
- Quantification of the dynamics of CH_4 producing Archaea in sediments and other anoxic sites by qPCR targeting the *mcrA* gene.
- Fluxes of CO_2 and CH_4 will be related to seasonality, biomasses of prawns, snails and floating plants, to primary production and heterotrophic microbial activity, and to dynamics of methanogens and methanotrophs.

This study includes on-field experimentation on estimation of GHGs emission through floating chamber method and CO_2 tradeoff through photosynthesis and standard BOD method. Laboratory analysis will be adopted to trace methane producing and breaking *Archaeal* communities through qPCR, targeting *mcrA* and *pmoA* genes. Relationship among the data obtained and climate variables will be established using high performance network clustering and meta-analysis.

In addition, the PhDs will be encouraged to publish their results as articles in international peer-reviewed scientific journals in cooperation with the senior staff.

As part of the ECOPRAWN project, this work package will leverage existing knowledge to motivate farmers towards adoption of climate-friendly farming system and also advocate for potential policy interventions and capacity buildings at regional and national scale.

People involved:

Principal Investigators:

1. Dr. Mohammad Mahfujul Haque, WP1 Leader & Professor, Department of Aquaculture, Bangladesh Agricultural University, Mymensingh
2. Dr. Lars H. Hansen, WP1 Leader in Denmark & Professor, Department of Plant and Environmental Sciences, University of Copenhagen

Co- investigators:

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3. Dr. Mohammad M.R. Jahangir, Professor, Department of Soil Science, Bangladesh Agricultural University, Mymensingh
4. Dr. Md. Mehedi Alam, Assistant Professor, Department of Fishery Resources Conservation and Management, Khulna Agricultural University, Bangladesh

PhD Students:

1. Alif Layla Bablee, PhD Fellow, ECOPRAWN
2. Abul Bashar, PhD Fellow, ECOPRAWN

Work Package 2 (WP2) Brief

Farming of freshwater prawns (*Macrobrachium rosenbergii*) rise has attracted a lot of attention during the past few decades due to Bangladesh's economic growth, export potential, and employment opportunities. Nowadays, prawn production has been declining due to bacterial pathogens and their antimicrobial resistance caused by the Farakka Dam, climate change, salinity intrusion, and banned antibiotics. Additionally, banned antibiotics and pesticides may discourage western consumers from purchasing prawns, impede their growth, and alter market prices.

The specific aim of the research in WP2 is to boost the immune system in salt-stressed prawns using microorganisms from prawn farms in Bangladesh. Considering Probiotic and Phage Therapy as promising immune-boosting candidates for salinity-threatened prawns through offering two excellent PhDs.

PhD-1: *Develop and manage production of promising local stress-alleviating microbes and establish effects of probiotics in salt-stressed giant freshwater prawn farms in Bangladesh.*

Disease mitigation and enhance prawn production using beneficial microbes to ensure sustainable growth of the industry would be the key concern of this study. To achieve the goal, the following objectives will be considered:

- A checklist of pathogenic and beneficial bacteria will be developed by random sampling from the saline stressed prawn farms of Khulna and Bagerhat region.



- Probiotic properties of the beneficial bacteria will be evaluated in terms of its inhibition efficacy against the propagation of the pathogenic bacteria and growth promotor.
- Once the probiotic bacterial isolates got selected, mass production of probiotic bacteria at a commercial scale will be started for a wider range application into the farmers pond to assess the impact of local probiotics.

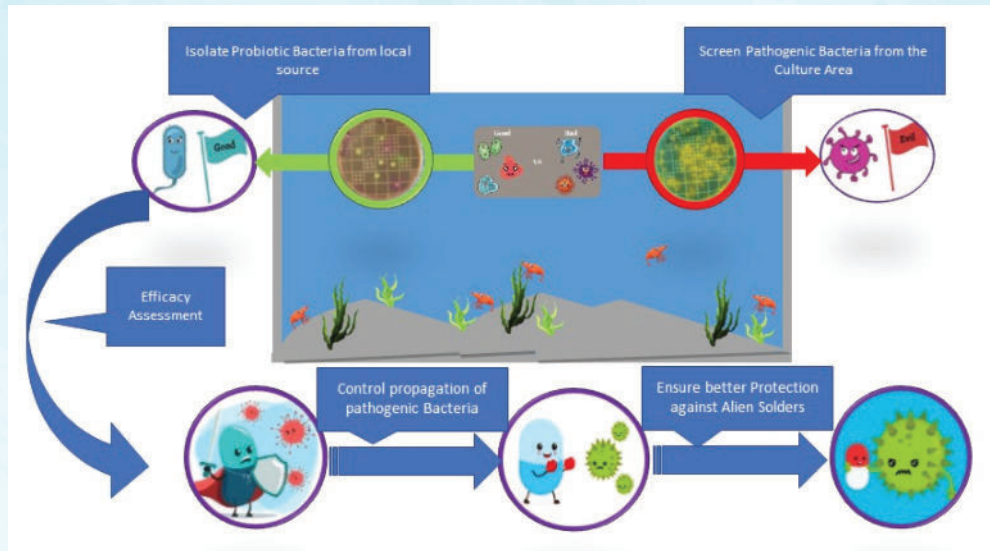


Figure 1: Thematic outline of the proposed study

Under the proposed project “ECOPRAWN”, efforts will be given to isolate beneficial microbes with probiotic properties with an intension to produce region specific probiotic bacteria considering the wide range of salinity and temperature gradient for better performance. For the screening of both pathogenic and beneficial bacteria, metagenomics approach along with conventional bio-chemical and PCR tests will be performed. Efficacy of the isolated bacteria will be assessed both invitro and in-vivo with particular attention to immunological aspects. Finally, efforts will be given to mass production of the isolated probiotic bacteria using localized substrate media to make the process more congenial to the rural farmers. The successful intervention of the project will explore the immense opportunity of using local probiotic to address disease outbreak and other adverse issues at the prawn industry. Introduction of the indigenous isolates and products will ensure the increased earning of foreign currency not only by maximizing the production but also limiting the import of costly foreign probiotic and aqua drugs, the fastest growing market in aquaculture.

PhD-2: *Efficacy of novel-local microbes and applicability of phage therapy for preventing disease in salinity-threatened giant freshwater prawn farms in Bangladesh*

It focuses the study on screening and application of a novel phage therapy for elimination of specific pathogens in salt-stressed prawn. Research activities under the PhD project include the following objectives:

- Isolation and sequencing of bacteriophages using the in-house methods at University of Copenhagen (Illumina Next Seq 550 platform and NEB next library preparation kit).
- Genome assembly, annotations and comparative genomics will be done to select phages with different modes of action. Host range efficiency will be tested against selected and identified bacterial pathogens.
- Development of efficient phage formulations (phage cocktails) that will exhibit a maximal diversity and broad host range for the selected pathogens. These cocktails will be consisting of multiple phage strains (>5), likely to increase the efficacy in comparison with single strain-formulations.

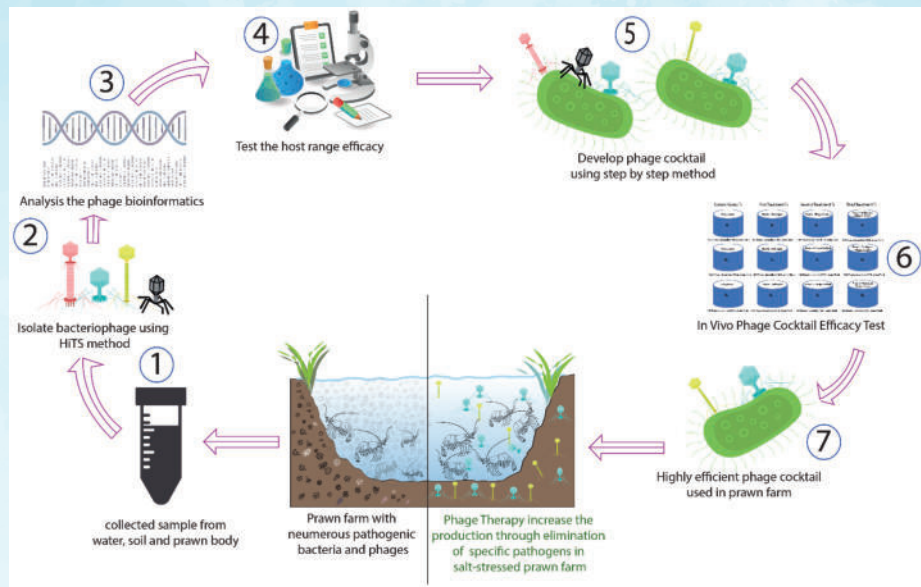


Figure 2: Conceptual diagram of the PhD-2 under Work Package-2 showing the development of innovative phage therapies and their use in prawn farms to improve the immune response of prawn.

- Testing of the efficiency of the phage cocktails in a small-scale set-up in combinations of prawns, pathogens and phages. Subsequently, the survival rate of prawns, the number of pathogens and phages (using qPCR), and 16S rRNA gene amplicon libraries will be established. For monitoring the impact of the treatments on the general “pond” microbial diversity, alpha and beta diversity and other community analysis will be applied.
- Small- and large-scale testing of phages for elimination of specific prawn pathogens in prawn farms.

This will help us learn more about the bacteriophages found in prawn farms and how they work to kill pathogens. The design and methods of the research will include isolating and sequencing bacteriophages, assembling, annotating, and comparing genomes, determining the host range of effectiveness, making phage cocktails, testing the effectiveness of the cocktails in living organisms, and small- and large-scale testing of phages to get rid of specific prawn pathogens.

In addition, the PhDs will be encouraged to publish their results as articles in international peer-reviewed scientific journals in cooperation with the senior staff.

People involved:

Principal Investigators:

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2. Dr. Lars H. Hansen, Professor, WP 2 Leader in Denmark, Department of Plant and Environmental Sciences, University of Copenhagen

Co- investigators:

1. Dr. Md. Sazedul Hoque, Professor, Department of Fisheries Technology, Patuakhali Science and Technology University
2. Dr. Muhammad Abdur Razzak, Assoc. Professor, Department of Aquaculture, Patuakhali Science and Technology University
3. Dr. Niels O. G. Jørgensen, Associate Professor, Department of Plant and Environmental Sciences, University of Copenhagen, Denmark

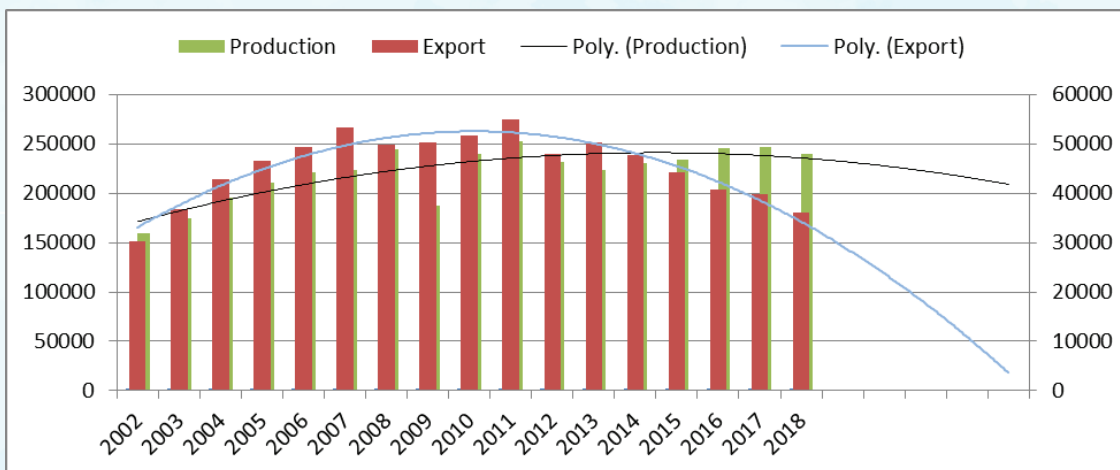
PhD Students:

1. H M Rakibul Islam, PhD Fellow. ECOPRAWN
2. Md. Hafijur Rahman, PhD Fellow. ECOPRAWN

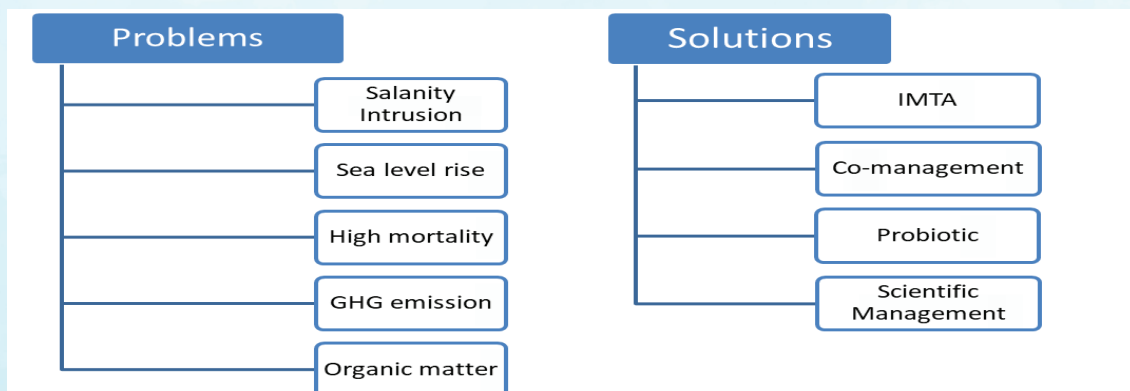
Work Package-3 in Brief

Economic Feasibility, Farm Efficiency and Co-management of Climate Vulnerable Prawn Farming in Bangladesh

Shrimp and prawn culture in Bangladesh has emerged as an important aquaculture industry over the last four (4) decades and became the second-largest source of export earnings sector after Ready-Made Garments (RMGs). No other primary commodity enjoyed such spectacular growth in post-independence Bangladesh and the area under shrimp and prawn cultivation has increased from 52,000 ha in 1982-83 to 263025 in 2020-21 (DoF 1983-84 & DoF 2020-21). Freshwater prawn farming has already been successful in Bangladesh and many farmers have had incredible success in experimental freshwater prawn farming with carp. However, total amount of prawn production has been fluctuating and export has been declining during 2011 to 2018, followed by a declining trend in the future (Figure 1). There are many factors contributing to this declining trend (Ahmed et al. 2017, Nupur, 2010) including the factors, which are manageable by improving management practices (managerial inefficiency) and others environmental factors (GHGs emission, Salinity intrusion) that require improved technological intervention. Changing climatic conditions have considerable direct and indirect effects on prawn farm economics. The main direct impacts relate to loss of productivity, efficiency, profitability, risks and increased costs of production, which challenge a sustainable production of prawns at the farm level (Maulu, 2021 and Li et al., 2016). The indirect impacts involve food security, employment, and household welfare (Dey et al., 2016).



Core environmental challenges and proposed solution through ECOPRAWN project



Two (2) PhD students has been employed to conduct research activities in WP3 and their specific research title is as follows:

PhD-1: “Economics of climate change mitigation and adaptation strategies: Salt intrusion in prawn farming”



Specific objectives (Phd -1)

1. To examine the cost and benefits of adopting probiotics in prawn farming taking into account the scale of operation and the farmer's ability to implement the proposed GHG emission reduction measures.
2. To examine how different salinity mitigation and adaptation strategies affect the farms' productivity, efficiency and risk in a varying environment and farming practices.
3. To examine the externalities of existing and potential technologies and evaluate existing and possible policy provisions regulating environmental externalities of the recommended technologies.

PhD-2: "Economic Feasibility of Introducing IMTA and Co-Management Systems in Prawn Farms of Bangladesh"

Specific objectives (PhD- 2)

1. To examine the cost and benefits analysis of introducing IMTA in the existing prawn farming system taking into account the scale of operations.
2. To explore and identify of best practice in terms of productivity, environmental efficiency and production risk of prawn farming in Bangladesh.
3. To examine the economic effects of co-management system in prawn farming and its effects on GHG emission

Methodology

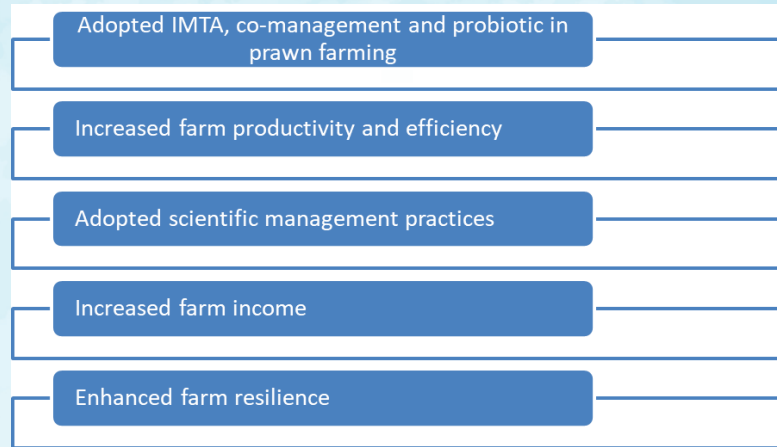
The economic feasibility analysis of IMTA, co-management and introduction of probiotics in prawn farming will be based on Cost-Benefit Analysis (CBA) and Bio-Economic Models (Peñalosa-Martinell, 2021). The economic impact analysis will be based on production econometric frontier and mathematical models, such as, Stochastic Frontier Analysis (SFA), and Data Envelopment Analysis (DEA). Pooled meta-frontier (parametric/non-parametric) and Propensity Scores Matching technique will be used when estimating productivity and technical efficiency depending on varying exposure of prawn farmer to climate change risk and varying management practices (Rahman et al. 2021). Studies using these methodologies for analyzing climate change impact are scarce in aquaculture. Nguyen et al. (2018) has estimated the impact of climate change on technical efficiency, whereas Hukom et al. (2021) used second stage DEA examining the impact of co-management on technical efficiency of shrimp farms in Indonesia. The theory of co-management has been widely applied to marine and inland capture fisheries (Islam et al., 2021; Bloor et al., 2021; Galappaththi et al., 2021; Islam et al., 2021). However, empirical evidences of combining the use of IMTA and co-management in aquaculture prawn farming are innovative and novel.

The potential economic impacts of climate change and its mitigation and adaptation strategies on prawn farming may also be related to change in prices of prawns and inputs and changes in productivity, efficiency and profitability (direct effects) (Arnason, 2013; Brooks, 2003; Brooks, Adger & Kelly, 2005). To capture indirect effects of climate change at farm level profitability production economic models (Kumbhakar and Lovell, 2000) will be used. The impacts of climate changes and resilient strategies will be investigated based on general Ricardian models (Kurukulasuriya and Mendelsohn, 2006) and different econometric models estimating the direct effects of adaptation strategies like Endogenous Switching Regression (ESR), and Random parameter logistic regression analyzing marginal effects of climate change variables (salt intrusion) and adapted strategies (Nguyen, 2015).

All analyses will be supported by knowledge obtained by WP 1, 2 and 4. Further, the WP will use cross section data along with forming a farm level panel data collected during the project establishing a base line and further collect data midterm and in the end of the project period.



Expected Outcome of Research



People involved:

Principal Investigators:

1. Dr. Akhtaruzzaman Khan
WP 3 Leader & Professor, Department of of Agricultural Finance, Bangladesh Agricultural University, Mymensingh
2. Dr. Rasmus Nielsen
WP 3 Leader in Denmark & Associate Professor, Department of Food and Resource Economics, University of Copenhagen, Denmark

Co- investigators:

3. Dr. Mohammad Saidur Rahman
Professor, Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh
4. Dr. Md. Takibur Rahman
Professor, Department of Accounting and Information Systems, Patuakhali Science and Technology University, Dumki, Patuakhali.
5. Dr. Mahmuda Nasrin
Associate Professor, Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh
6. Mashrufah Khatun
Assistant Professor, Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh

PHD Students:

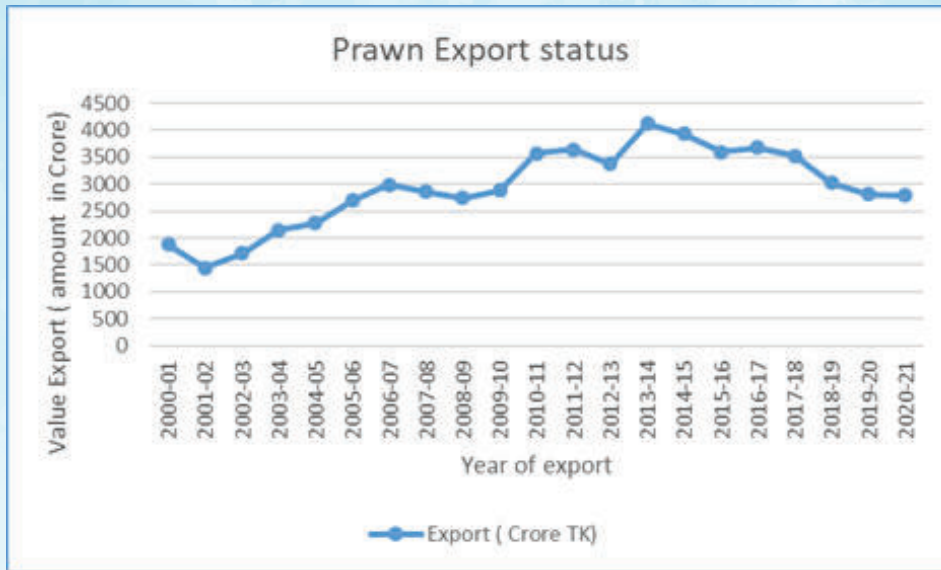
1. Mohammad Sabbir Hossain, PhD Fellow, ECOPRAWN
2. Md. Nezam Uddin, PhD Fellow, ECOPRAWN

Work Package 4 (WP 4) Brief

PhD 1: *Consumers' willingness to pay for climate-friendly prawn domestically and internationally.*

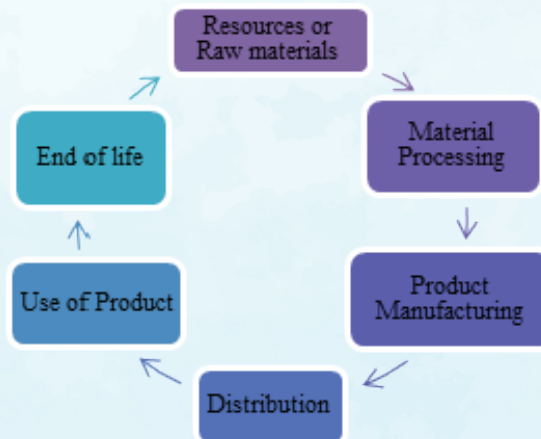
Project Background and Justification:

Bangladesh is considered as one of the most potential countries in the world for prawn farming in ponds and rice fields, due to its agro-climatic conditions and fortunate resources. The sector employs around 1.23 million people and contributes around 4.5% to the GDP (DOF 2021). The global prawn market reached at 8 million tons in 2020 (MRR, 2021), with major market share from India, Ecuador, Vietnam, Indonesia, Argentina, Thailand, and China. India is the world's largest exporter of prawn, accounting for about 22% of the world's demand (OEC, 2020). However, the production of prawns has remained constant from 2011 to 2020 (Islam et al., 2021) with excellent progress in the early years, due to the poor yielding varieties. Export has also fallen during the same period due to the failure to meet the quality requirements of different certification schemes (Emran et al., 2015).



Sources: Statistical Yearbook Bangladesh 2020

The worldwide fisheries industry contributed 4% to GHG emissions in 2011, with a 28% increase between 1990 and 2011 due to increasing fishing operations (Daw et al., 2009; Parker et al., 2018). Aquaculture ponds emit more carbon than other inland waterbodies due to input management (Boyd et al., 2007). Without addressing climate change, aquaculture cannot be sustained. It's also crucial to note that the effects of climate change will influence not just aquaculture production systems but the entire value chain (Fleming et al., 2014; Barange et al., 2018). For measuring the impact of climate change on prawn value chain, Life cycle analysis (LCA) will be used under this work package 4. LCA is a thorough process for assessing all direct and indirect environmental impacts over the complete life cycle of a product system, from materials acquisition to usage and final disposal or reuse (Hill J.,2013).



Components of Life Cycle Assessment (LCA)

However, demand for value-added prawn is increasing domestically and globally (OEC, 2020), which can be seen as a unique opportunity for Bangladesh because of the availability of a prawn production-friendly environment and resources. To avail of this opportunity and revive the prawn industry of Bangladesh, a sustainable prawn farming technique, ensuring climate-friendly, strong immunity, and quality prawns must be introduced and adopted to survive in the global market. Therefore, in order to reduce and adapt to climate change, the objective of work package 4 ("Value chains and markets") is to enhance the knowledge base of international prawn value chain governance and consumer preferences for Eco prawn at both the domestic and international levels.



Two (2) doctoral students have been selected to conduct research in WP4, and their respective research titles are as follows:

PhD 1: Consumers' willingness to pay for climate-friendly prawn domestically and internationally.

The proposed research will focus primarily on investigating how the prawn value chain can be reconfigured to mitigate and adapt to climate changes and improve our understanding on consumer preferences for Eco prawn on both domestic and international levels, with the following specific objectives:

1. To explore and identify market levels, channels, price formation and transmission, actors of the value chains, and price transmission of prawn in Bangladesh.
2. To assess the export potential and demand for prawns from Bangladesh to the global market and trade policies in potential buyer countries based on international economics.
3. To examine economic values of the implicit price of the quality attributes of prawn through the value chain in domestic and in international markets as well.

The study will be based on a survey of existing and potential stakeholders of the industry including the actors in the value chain. The data may include information on prices, sales, marketplace, logistics, etc. collected through face-to-face interviews using interview schedules from actors at different levels in the chain.

The following quantitative analysis can be applied to achieve the desired objectives:

For objective 1: Value Chain Approach and Price Transmission Models

For objective 2: Export Potential Map

For objective 3: Hedonic regression methods and Experimental Auction model

PhD 2: Analyzing prawn value chain governance of Bangladesh for implementation of global governance and life cycle analysis

The overall goal of the study is to concentrate on enhancing the knowledge of how Bangladesh's prawn value chain contributes to economic performance and, in turn, examines the governance of global prawn value chains. The specific objectives of this study are:

1. To examine the governance, different actors in the value chain and major factors influencing the global value chain.
2. To assess the environmental impact of prawn value chain in Bangladesh
3. To analyze node to node transaction costs in the prawn value chain.
4. To assess the financial and power status of the actors that form governance in the prawn value chain.

The study will involve various data collection tools such as interview schedules and focus group discussions. Data will be statistically analyzed using STATA 16 and also software named Simapro 9 will be used as life cycle inventory tool to analyze the inventory data.

To attain the desired outcomes, the following quantitative analysis can be applied:

- **Objective 1:** The international input-output framework for analyzing global value chain governance and Logit or Probit model for assessing the factors affecting the existing global prawn value chain.
- **Objective 2:** Life Cycle Assessment (LCA) tools
- **Objective 3:** Transaction cost economics theory will be used.
- **Objective 4:** Power cube framework or Stochastic Frontier Analysis

People involved:**Principal Investigators:**

1. Professor Badiuzzaman
Country Coordinator & WP4 Leader, Department of Economics and Sociology, Patuakhali Science and Technology University
2. Dr. Max Nielsen
Project Coordinator & WP4 Leader in Denmark, Associate Professor, Department of Food and Resource Economics, University of Copenhagen, Denmark

Co- investigators:

1. Dr. Olivier Jolliet
Professor, Department of Environmental Health Sciences, School of Public Health, University of Michigan
2. Dr. Md. Sujahangir Kabir Sarkar
Professor, Department of Economics and Sociology, Patuakhali Science and Technology University
3. Dr. Md. Takibur Rahman
Professor, Department of Accounting and Information Systems, Patuakhali Science and Technology University
4. Dr. Imranul Islam
Professor, Department of Marketing, Patuakhali Science and Technology University
5. Dr. Afjal Hossain
Professor, Department of Marketing, Patuakhali Science and Technology University
6. Anup Kumar Mandal
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7. Fariha Farjana
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PhD Students:

1. Shah Mahmud Sumon, PhD Fellow, ECOPRAWN
2. Farhana Arefeen Mila, PhD Fellow, ECOPRAWN



Different Committees for ECOPRAWN

Start-up Conference-2022

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Programme Schedule

Climate-friendly and Climate-resilient prawn farming in Bangladesh

27 November – 1 December 2022

Venue: Khulna and Dhaka

Date	Time	Activities
Day 1 27.11.22 Sunday	09.00 AM – 10.30 AM	Status of the ECOPRAWN project. WP leader meeting and Steering Committee meeting for finalizing the content of conference presentation. Steering Committee meeting 1. Information on the Steering Committee 2. Settlement of the Steering Committee 3. Others
	10.30 AM – 12.00 AM	Preparation for Stakeholder Conference. WP leader group and project participants with a core role at the Stakeholder Conference.
	12.00 AM – 01.00 PM	Plenary meeting with all project participants.
	01.00 PM – 02.00 PM	Lunch Break
	02.00 PM – 03.30 PM	Plenary meeting continued
	03.30 PM – 05:00 PM	Separate meeting in: (i) WP1-WP2 together and (ii) WP3-WP4 together.
	07.00 PM – 08.00 PM	Dinner
Day 2 28.11.22 Monday <i>Stakeholder Conference</i> Venue: Hotel City Inn, Khulna.	09.30 AM – 10.00 AM	Registration
	10.00 AM – 10.05 AM	Recitation from the Holly Quran
	10.05 AM – 10.20 AM	Welcome speech
	10.20 AM – 10.30 AM	Presentation on project overview
	10.30 AM – 11.00 AM	Tea-break
	11.00 AM – 11.40 AM	Presentation on project plan
	11.40 AM – 01.00 PM	Speech from the guests
	01.00 PM – 02.00 PM	Prayer and lunch break
	02.00 PM – 03.30 PM	Stakeholders' participation in open discussion
	03.30 PM – 03.45 PM	Vote of thanks
03.45 PM – 04.00 PM	Closing speech	
Day 3 29.11.22 Tuesday	09.00 AM – 1.00 PM	Visit to prawn farms and other companies in the prawn value chain.
	01.00 PM – 02.00 PM	Lunch Break
	02.00 PM – 06.00 PM	Supervisor meetings with PhD students. Meetings are done with PhD students one by one with all supervisors and co-supervisors.
	07.00 PM – 08.00 PM	Dinner
Day 4 30.11.22 Wednesday	09.00 AM – 10.30 AM	Coordination of data collection between WP1-WP2 and WP3-WP4
	10.30 AM – 01.00 PM	Separate meeting in: (i) WP1-WP2 together and (ii) WP3-WP4 together.
	01.00 PM – 02.00 PM	Lunch
	02.00 PM	Leave for Dhaka
	07.00 PM – 08.00 PM	Dinner at Dhaka Hotel Rafflesia, Gulshan, Dhaka.
Day 5 01.12.22 Thursday	11.00 AM – 03.00 PM	Office visit at Dhaka (Mathso Bhaban and World Fish).
	05.00 PM	Leave for Hazrat Shahjalal International Airport, Dhaka (flight 09.30 PM)







Vision

Capturing Global Market with the Climate-Friendly and Climate-Resilient Farmed Prawn of Bangladesh

Slogan

Climate-Friendly and Sustainably Grown Prawn is the Flagship of Aquatic Food from Bangladesh

Research Partners of ECOPRAWN

University of Copenhagen, Denmark

Patuakhali Science and Technology University

Bangladesh Agricultural University



Funded by:

Danish International Development Agency (DANIDA)

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